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IBM 5250 Information Display System

Functions Reference Manual

IBM

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Information Display System

Functions Reference Manual

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This major revision makes obsolete SA21-9247-5 and Technical Newsletters SN21-0403 and SN21-0407. Information on the IBM Enhanced Keyboard has been added. Miscellaneous technical changes and additions have also been made. Changes are periodically made to the information herein; these changes will be reported in technical newsletters or in new editions of this publication.

This publication is for system programmers familiar with systems network architecture (SNA) and synchronous data link control (SDLC). It contains information about programming the 5250 Information Display System devices. This publication contains examples of the data streams used by the 5250 devices. All names used in these examples are fictitious and any similarity to names or addresses used by an actual business enterprise is coincidental.

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About This Manual

The 5250 Information Display System is a cluster of work stations directly attached to a host system or attached to a host system by means of a remote work station controller. The remote work station controller can be a 5251 Model 2 or Model 12, or a 5294 Control Unit.

Note: The 5251 Models 1 and 2 Display Stations and the 5252 Dual Display Station are no longer available. However, this manual does include information about these display stations for users who have these display stations installed.

This manual describes the programming requirements for communicating with the controller that controls all attached 5250 work stations. This manual also contains information that will allow a system programmer to implement a configuration using the 5250 system and to determine problem-causing areas within the remote link to that system.

There is no separate functions reference manual for the 5251 Models 1 and 11 Display Stations, the 5291 Display Station, the 5292 Color Display Station, the 5252 Dual Display Station, the 5224 Printer, the 5225 Printer, or the 5256 Printer. For information about developing a program to control one of these work stations, the programmer should refer to this manual or to the functions reference manual for the host system.

The 5250 controller can use the SDLC/SNA protocols and commands to establish, maintain, and regulate communications between itself and the host system. The programmer using this manual must be familiar with both SDLC and SNA. Details given about SDLC and SNA are only in respect to the specific protocols and commands that the 5250 implements.

The 5294 Control Unit does not use the SDLC protocol with the X.25 feature. The protocols used with X.25 networks are described in the *IBM X.25 Interface for Attaching IBM SNA Nodes to Packet-Switched Data Networks, General Information Manual*, GA27-3345.

The 5294 Control Unit with the X.21 Circuit Switched feature uses an additional protocol to establish the connection with the network. This protocol is described in the *IBM Implementation of X.21 Interface General Information* manual, GA27-3287.

Purpose of This Manual

The purpose of this manual is to give the system programmer enough information about the 5250 to allow him to implement his own configurations and to create the data streams and SDLC/SNA linkages and controls necessary to solve program-related problems.

Organization of This Manual

This manual is divided into two sections. Section 1 is for the reader who is unfamiliar with the 5250 system. It describes (1) the system, (2) basic SDLC and SNA concepts utilized by the system, and (3) basic terms necessary to understanding the presentation of the topics relating to SNA and SDLC. Examples of the 5250 device data streams conclude Section 1.

Section 2 is an encyclopedia that presents topics for use by the programmer familiar with the operation of the 5250 system but in need of specific detailed information about a particular area of the programming.

Both sections use cross-references that lead the reader to other topics of interest. These cross-references take the form of the following example: See the index entry *display, commands*.

If You Need More Information

The following setup procedures give step-by-step instructions for setup of each machine:

- *IBM 5251 Display Station Models 1 and 11 Setup Procedure*, GA21-9286
- *IBM 5251 Display Station Models 2 and 12 Setup Procedure*, GA21-9289
- *IBM 5291 Display Station Setup Procedure*, GA21-9408
- *IBM 5292 Color Display Station Setup Procedure*, GA21-9415
- *IBM 5252 Dual Display Station Setup Procedure*, GA21-9288
- *IBM 3180 Model 2 Display Station User's Guide*, GA21-9469
- *IBM 3196 Display Station Setup Instructions*, GA18-2488
- *IBM 5256 Printer Setup Procedure*, GA21-9290
- *IBM 5224 Printer Setup Procedure*, GA34-0093
- *IBM 5225 Printer Models 1, 2, 3, and 4 Setup Procedure*, GA34-0085
- *IBM 5294 Setup Procedure*, GA21-9369
- *IBM 4224 Printer Product and Programming Description*, GC31-2551
- *IBM 4224 Printer Setup Instructions*, GC31-3607
- *IBM 4210 Printer Guide to Operations*, SC31-3783
- *IBM 4214 Printer Setup Instructions*, GC31-2565
- *IBM 4214 Printer Model 2 Product Description*, GC31-2582
- *IBM 5219 Printer Model D01/D02 Setup Procedures/Operator Guide*, GA23-1019
- *IBM 5262 Printer Model 1 Setup Instructions*, GA24-3978
- *IBM 3179 Model 2 Color Display Station Introduction and Preinstallation Planning*, GA18-2404

The following operator's guides describe the procedures required to operate each machine:

- *IBM 5251 Display Station Models 1 and 11 and IBM 5252 Dual Display Station Operator's Guide*, GA21-9248
- *IBM 5251 Display Station Models 2 and 12 Operator's Guide*, GA21-9323
- *IBM 5291 Display Station Operator's Guide*, GA21-9409
- *IBM 5292 Color Display Station Operator's Guide*, GA21-9416.
- *IBM 5256 Printer Operator's Guide*, GA21-9260
- *IBM 5224 Printer Operator's Guide*, GA34-0092
- *IBM 5225 Printer Models 1, 2, 3, and 4 Operator's Guide*, GA34-0054
- *IBM 5294 Operator's Guide*, GA21-9370
- *IBM 4224 Printer Operating Instructions*, GC31-2546
- *IBM 3180 Model 2 Display Station User's Guide*, GA21-9469
- *IBM 3196 Display Station User's Guide*, GA18-2482
- *IBM 4210 Printer Product and Programming Description*, SC31-3784
- *IBM 4214 Printer Model 2 Operating Guide*, GC31-2581
- *IBM 5262 Printer Model 1 Operator's Guide*, GA24-3976
- *IBM 3179 Model 2 Color Display Station User's Guide*, GA18-2387

The following publications might also be of interest:

- *IBM 5250 Information Display Station System Introduction*, GA21-9246, describes the work stations that make up the 5250 and their available functions and features.
- *IBM 5250 Information Display System Planning and Site Preparation Guide*, GA21-9337, provides environment, electrical, communications, space, furniture, and cable specifications to assist in planning for setup of the IBM 5250 Information Display System. This manual also provides information to help the system programmer configure the system and prepare instructions for setup personnel at remote sites.
- *IBM Data Communications Concepts*, GC21-5169, gives an introduction to teleprocessing for persons who plan to include a 5251 Model 2 or Model 12 in their system.
- *IBM System Network Architecture General Information*, GA27-3102, describes the terminology, concepts, and scope of system network architecture (SNA).
- *IBM Synchronous Data Link Control General Information*, GA27-3093, describes procedures that comprise synchronous data link control (SDLC), a brief background, and a basic description of the terminology and concepts of SDLC.
- *IBM Implementation of X.21 Interface General Information*, GA27-3287, describes the CCITT recommendation X.21 interface to Public Data Networks as implemented by IBM.
- *IBM X.25 Interface for Attaching IBM SNA Nodes to Packet-Switched Data Networks, General Information*, GA27-3345.

Section 1. Description of the 5250 Information Display System

General Functional Information

The 5251 Models 2 and 12 and the 5294 Control Unit contain the SNA support necessary to communicate with a host system. This includes LU 4 and 7 protocols. For a more detailed description of the operation of SNA, refer to the *IBM Systems Network Architecture Format and Protocol Reference* manual, SC30-3112.

The 5251 Model 1 or Model 11, 5291, 5292, 5252, 5224, 5225, 5256, 3180, 3196, and 4224 work stations are attached to the controller via a twinaxial cable. The transfer of information over the cable interface is called *local operations*.

The 4224 is an intelligent printer data stream (IPDS) printer. Refer to the *IBM 4224 Printer Product and Programming Description*, GC31-2551, for more details.

Functional Characteristics of the 5251 Models 2 and 12 and 5294 in Remote Operations

The 5251 Models 2 and 12 and the 5294 (controllers) consist of a microprocessor and a shared storage area. The storage areas temporarily hold data or commands as they pass between the addressed device and the host system.

The 5251 Models 2 and 12 and the 5294 microprocessors (1) determine the type of commands the host system has sent, (2) translate these commands into microcoded transmission commands that can be sent to the attached device, and (3) send these microcoded commands in the acceptable transmission protocol to the addressed work station.

In addition to routing commands, the microprocessors route data and status information between the 5250 work stations and the host system. The controller, attached display stations, and attached printers all contain storage areas that hold commands and information until they can be either processed or routed to the intended receiver.

Overview of 5250 Implementation of SDLC

The Synchronous Data Link Control (SDLC) protocol consists of (1) an established format for sending link-level commands and data, (2) a pattern for initiating a transfer link between the host system and the controller, and (3) a format for transmitting SNA protocols. The format SDLC uses to convey information is the SDLC frame. See Figure 1-1. An SDLC frame is a bit pattern that contains flags for synchronization, both SDLC link-level control information and SNA data information. The SDLC frame that contains the SNA RUs is called the I (information) frame; this is the only SDLC frame type that contains the 5250 user data. See the index entry *frames (SDLC)* for details about the frame contents and types.

Typically, SDLC's requirements are set and remain unaltered by the user. The SDLC XID response can be an exception to this general usage; therefore, specific details about the contents of the XID response are given in the index entry *SDLC, commands and responses*. In addition, the other SDLC commands are briefly described to help an interested user determine or locate the causes of SDLC-generated errors.

The 5250 implementation of SDLC is half-duplex (HDX). This means that the 5251 Model 2 or 12 can be in either the receive state or the transmit state, but they cannot be in both simultaneously.

The 5294 Control Unit uses SNA full duplex (FDX) if it has the X.25 feature installed. Figure 1-1 shows the SNA relationship.

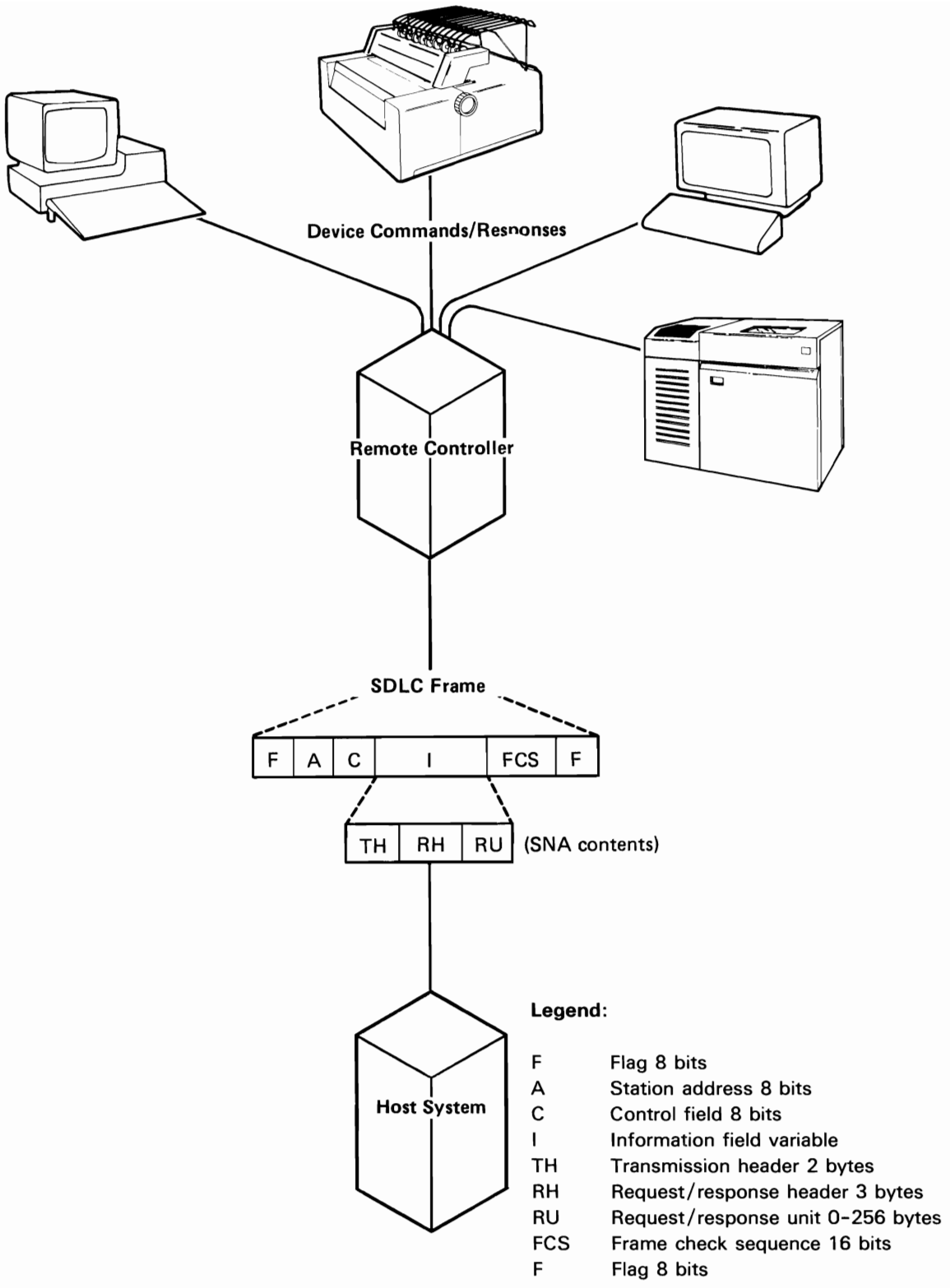


Figure 1-1. SDLC/SNA Relationship

Overview of the 5250 Implementation of SNA

Systems Network Architecture (SNA) is a system of hierarchical rules commonly called protocols. These rules define such things as the data stream format (RUs) and the process for routing data (data flow control). The user's primary concern in programming the 5250 devices is the SNA support that the 5250 system implements. See Figure 1-2. The 5250 uses a subset of SNA; the following text describes the implementation of this SNA subset.

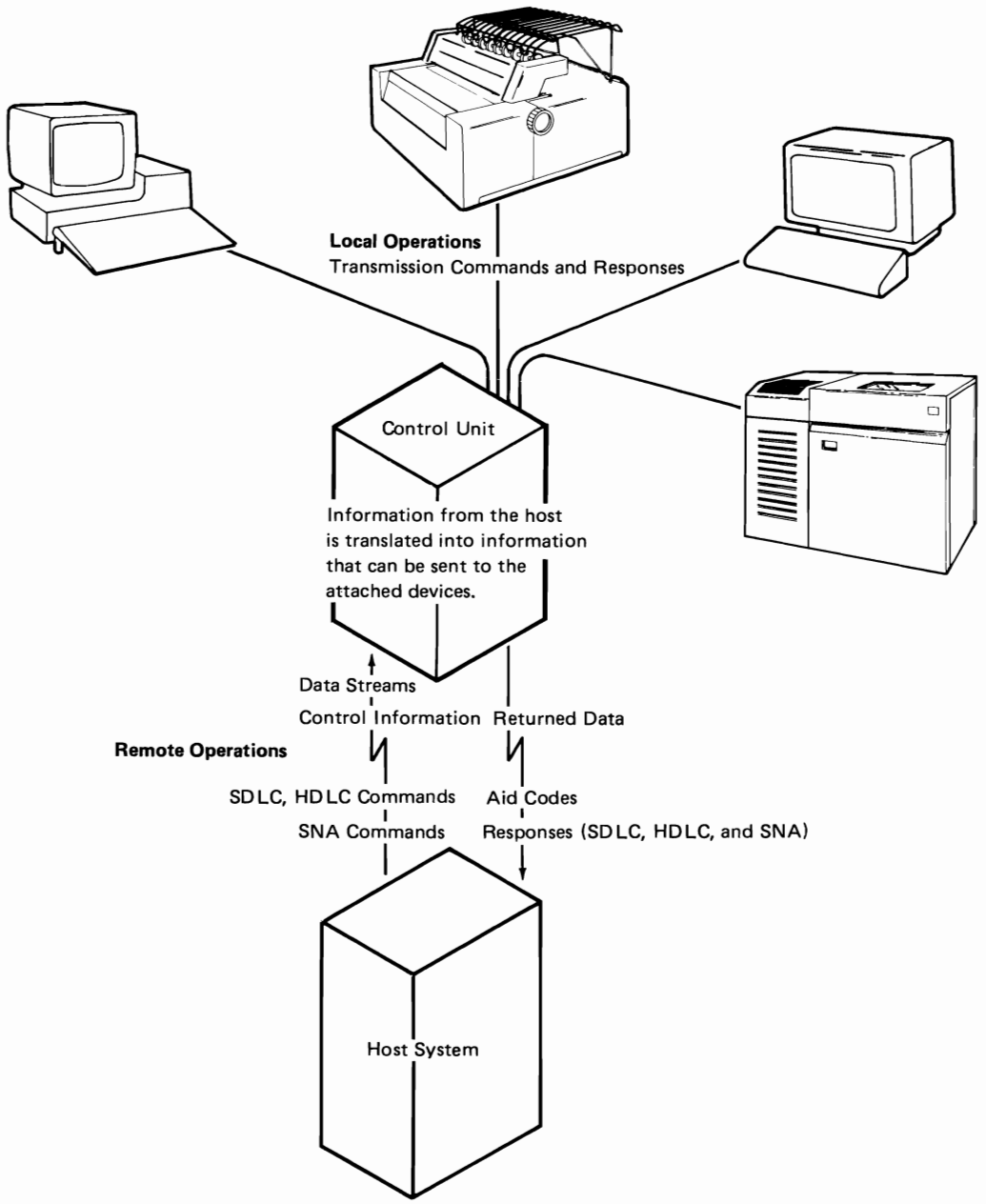


Figure 1-2. Overview of Data Flow for the 5250 Information Display System

Description of General SNA Terms Used in This Manual

When in operation, terminals are normally connected to two independent control points. These are a supervisory control point and an application user control point. Logical unit (LU) types 4 and 7 provide two independent sessions, one for each control point. The supervisory control is accomplished on the supervisory services-logical unit (SS-LU) session. Because each control point has different requirements, the sessions have different protocols. The LU-LU session controls the entire display screen or printer page. The SS-LU session has limited control over the devices, has one display line (called the system message line), and has no print capability. The supervisory control point may control application programs using these terminals.

The supervisory services in the host system may also communicate with the controller on another session with the physical unit. This session protocol allows only maintenance information to be passed between the controller and the host system.

A session is the logical connection that exists between two control points. To establish these sessions two different commands are used, Activate Logical Unit (Actlu) and Bind. The supervisory services-physical unit (SS-PU) session is assumed automatically whenever communication at the data link level or X.25 packet level is established. The SS-LU session is established after the SNA Actlu command is positively responded to; the LU-LU session is established after the SNA Bind command is positively responded to.

A request/response unit (RU) is an SNA data area. It is a maximum of 256 bytes long. The RUs contain (1) all the information (commands, parameters, and associated data) required by the controller to make the LUs perform a user-specified (SS or application program) function, (2) all data returned to the host system in response to a command, and (3) responses both from the controller (initiated by either the controller or the LU) and from the host system. RUs can be linked in multiple SDLC I frames such that multiple RUs can be sent. This is called *chaining*; see the index entry *chaining*. When chaining is used, the relative position of each RU in the chain must be indicated to the host system; the heading "Protocols and Synchronization for 5250 Implementation of SNA" in this section describes this subject. In addition, the rate at which the receiver can accept SNA RUs can also be adjusted. This is called *pacing*. See the index entry *pacing* for details.

Each RU is prefixed by header information defining its type. Together, the header information and the RU form the path information unit (PIU). The headers are the TH and RH parts of the frames. TH stands for transmission header and RH stands for request/response header. The TH and RH define the session type and RU characteristics; the RU contains all LU information such as the commands, data, and responses required.

The types of RU flow vary. The RUs can be normal or expedited and can consist of (1) session control (SC), (2) data flow control (DFC), or (3) function management data (FMD) RUs. These RUs flow on either the SS-LU or LU-LU session. There are different protocol restrictions for each type of RU. For example, LU data streams are always in the normal FMD flow. See the heading "Protocols and Synchronization for 5250 Implementation of SNA" in this section.

In the 5250 implementation of SNA, the two SNA *session partners* are the host system and the controller. The host system controls the LUs (5250 work stations) by sending commands and data to each LU. These commands and data are embedded in the SNA RUs. The sender determines the type of response requested by coding bits 0 and 3 of byte 1 of the RH. The sender specifies RQE or RQD.

Request exception (RQE) asks for a response only if the RU is unacceptable; that is a *negative response*. A negative response RU identifies the type of RUs and carries information identifying the error condition.

The other type of response request is *request definite* (RQD). RQD requests that the receiving partner always respond to the RU that has been sent. If the RU is without error, the receiver responds positively; this response may consist of returning the SNA command code that was sent. If an error is encountered in the RU, the receiving partner returns a negative response.

Addressing in the 5250 System

The three addresses that the 5250 system uses and that the system programmer must determine (or default to) are the station address, the work station address, and the local session identifier (LSID). Note that the LSID includes the local station address. Figure 1-3 shows the relationships of the addresses. For detailed information on configuring the 5250, see the *IBM 5250 Planning and Site Preparation Guide.*

Legend:

Local Station Address (Unit Address)
This is six bits of the LSID. The system programmer determines this when he configures the system. These bits identify either the keyboard/display of the 5251 Models 2 or 12, or a specific work station attached to the 5251 Models 2 and 12 or the 5294. For details, see the index entry *local station address.*

LSID
This is eight bits of the TH. The system programmer determines this by determining the local station address, which is six bits, and the session type identifier, which is two bits. See the index entries *LSID* and *sessions.*

Controller Station Address
The host system uses this to identify the controller. The controller scans the A part of the SDLC frame for its controller station address. See the index entries *frames* and *station address.*

Work Station Address
This is the address that is set with the switches or from a display on the work station. The controller uses this to identify a specific device attached to it. See the index entry *work station address.*

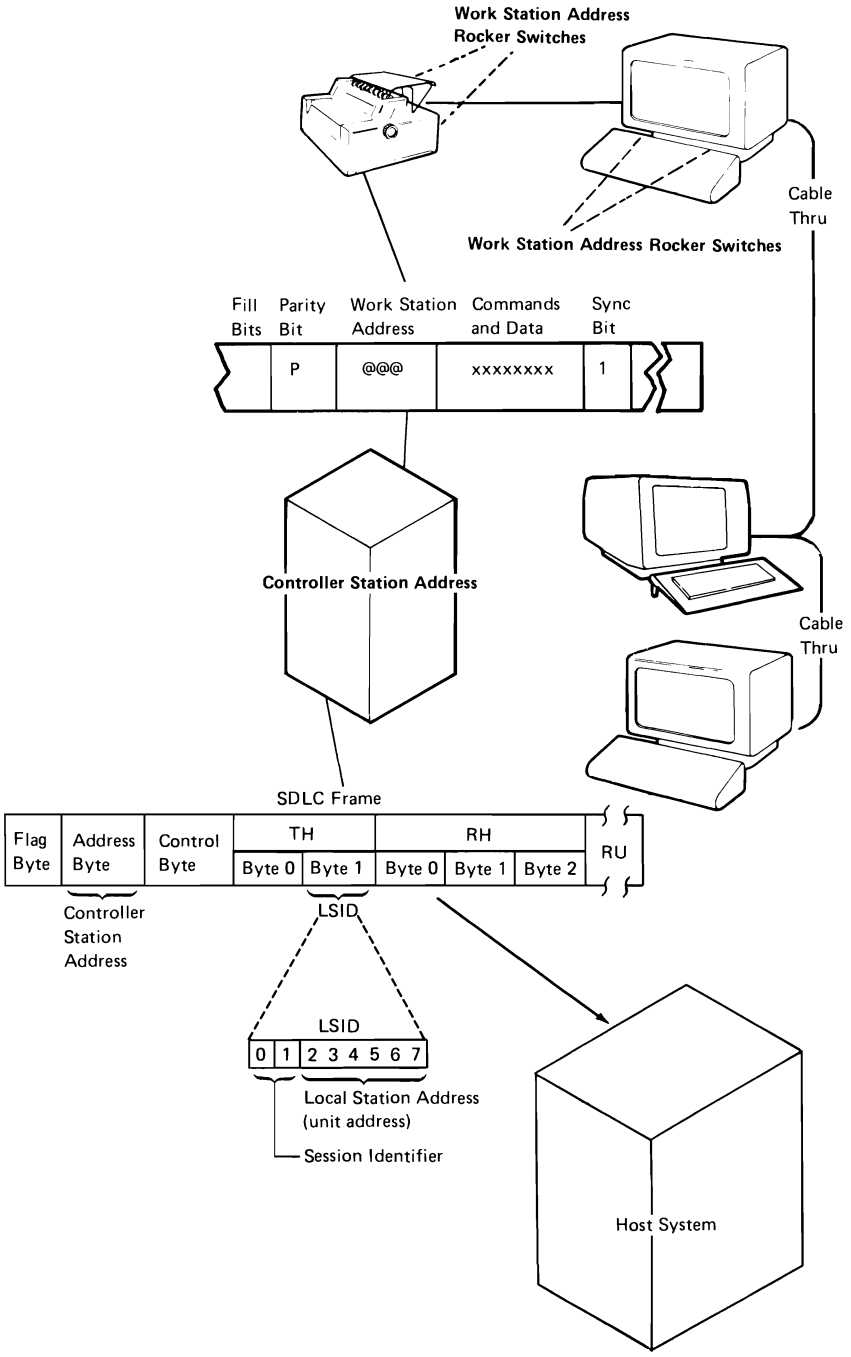


Figure 1-3. Relationship of Addresses

Controller Station Address

The station address field is 8 bits long; it is the A part of the SDLC frame. For the controller, this field carries the controller station address. See the index entry *frames*. The programmer uses this address to identify the controller that he wants to communicate with. The programmer determines the address and then uses the addresses during system configuration. See Figure 1-3.

Work Station Address

The work station address is 3 bits long. It is in the transmission frame. The controller uses it to address the devices attached via the twinaxial interface. Cable Thru has a direct effect on the work station address:

- If Cable Thru is not installed (or used), the work station address is 000. Without address switches, the system automatically defaults to 000 for the 5251 Models 1 or 11, the 5225, and the 5256, and to 000 and 001 for the 5252.

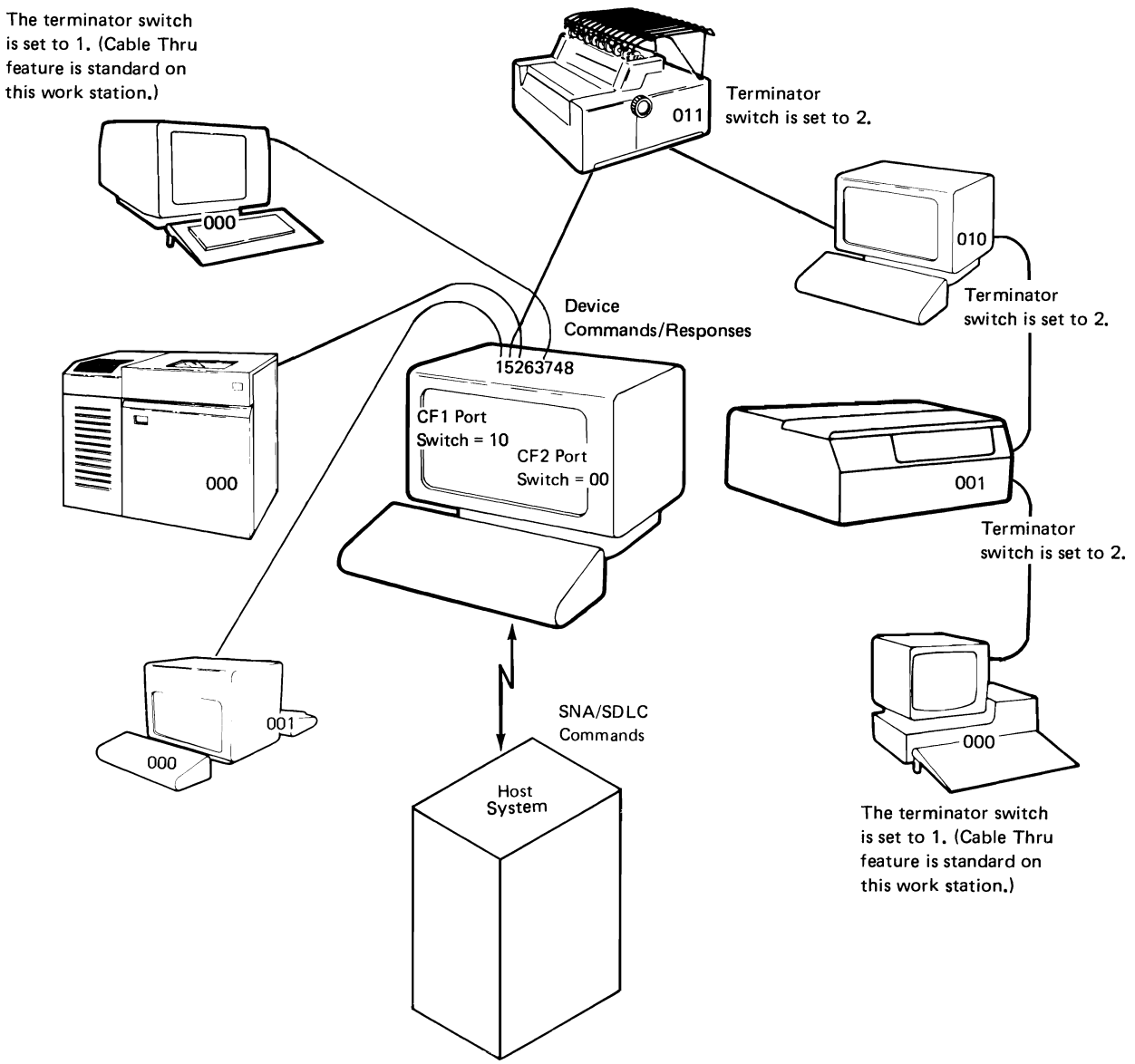
- If Cable Thru is installed (Cable Thru is standard on the 5291, 5292, 3179, 3180, 3196, 4210, 4214, 4224, 5219, 5224, and 5262), assign appropriate work station addresses to all devices. See the *IBM 5250 Planning and Site Preparation Guide*, GA21-9337, for information about these addresses.

Note: There is only one set of these switches for each 5252.

Make the work station address assignments by setting the work station address switches (or by setting the address from the keyboard); you do not directly use the work station address to communicate with the specific device. You address a device attached via a cluster feature through the local station address bits (LSID). Figure 1-4 illustrates a sample configuration with work station addresses assigned using a 5251 Model 2 or Model 12.

Figure 1-5 illustrates a sample configuration using the 5294 Control Unit. This example is described in detail in the *IBM 5250 Planning and Site Preparation Guide*, GA21-9337.

The 4224 work station address is selectable from the operator's panel. For more information, see the *IBM 4224 Printer Operating Instructions*, GC31-2546.



Legend:

Cluster Feature (CF1)

No Cable Thru feature is installed. A 5252 Dual Display Station is attached to port 1. A 5225 Printer and a 5291 Display Station are attached to ports 2 and 3.

Dual Cluster Feature (CF1 and CF2)

The Cable Thru feature is installed and being used on three of the devices attached to port 5 of CF2. A 5256 Printer, a 5251 Model II Display Station, a 5224 Printer, and a 5291 Display Station are attached to port 5 using the Cable Thru feature. A unique work station address must be assigned to each work station. If the last device does not have the Cable Thru feature installed, its work station address defaults to 000.

Figure 1-4. Sample Configuration of the 5250 Information Display System with 5251 Model 12 Addressing

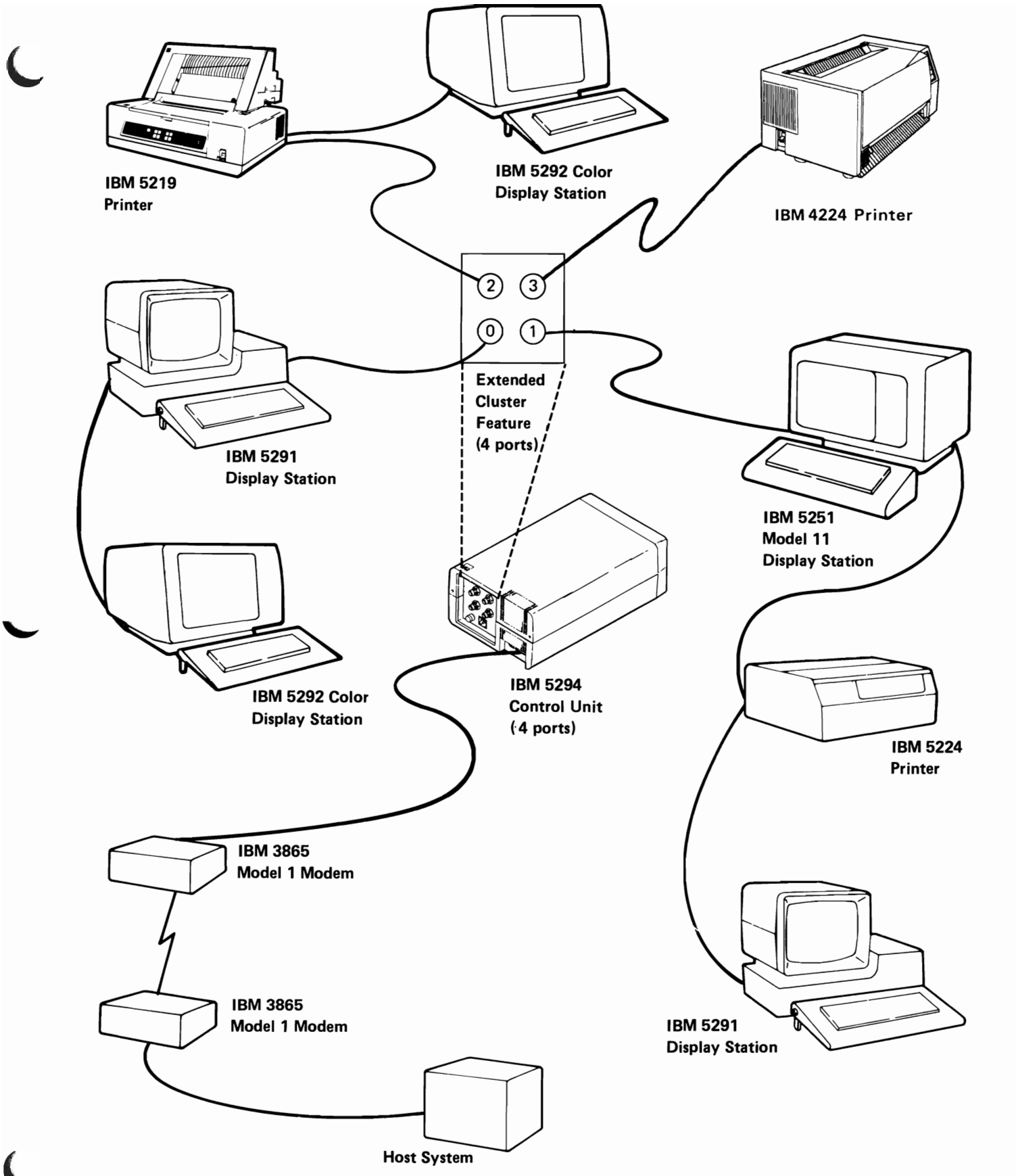


Figure 1-5. Sample Configuration of the 5250 Information Display System with a 5294 Control Unit

LSID and Local Station Address

The local station address is a 6-bit part of the LSID, which is in TH byte 1 (in the SNA header). See the index entry *TH*. The 6 bits identify the specific device (LU) that the host system wants to address. The remaining 2 bits of TH byte 1 are session flow information and indicate which SNA session is used in communicating with the LU.

Note: LSID = 0 (hex 00) indicates an SS-PU session, which is used only for maintenance services by 5251 Models 2 and 12 and the 5294.

You must provide both the local station address and the session flow information for the LSID. See the index entry *sessions* for information about the sessions and session flow bits.

The keyboard/display of the 5251 Models 2 and 12 always has the local station address 000000. All other local station addresses are determined by the programmer. Use the local station address specified for the device as the 6-bit address part of the LSID. Determine the session type and code the remaining 2 bits accordingly.

Error Handling in the 5250 System

The SNA protocol determines the error-handling process used by the 5250 system; for operator errors, this association is indirect as described in the following text. The type of error and the point of processing at which it occurs in the RU chain determine the resulting error code (SNA command or negative response).

The error codes identify both the device in which the error is occurring and the reference to the condition causing the error. These error codes are found in the Signal commands, negative responses, and error log. The format for the error codes is:

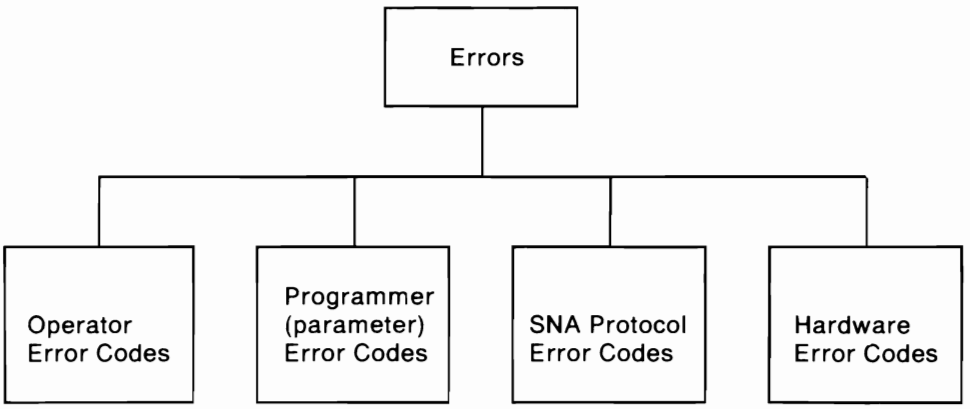
XXYY

XX = device type:
- 00 = controller
- 01 = display
- 02 = printer

YY = error identifier

See the index entries for these topics to find detailed information.

The basic categories of errors within the 5250 system are: (1) operator-associated errors, (2) programming (parameter) errors, (3) SNA protocol errors, and (4) hardware errors. Figures 1-6 and 1-7 illustrate the resulting SNA commands and responses and error codes implemented by these error types. As you can see by looking at Figures 1-6 and 1-7, SNA uses the SNA Signal, Rshutd, Lustat, and Cancel commands and the negative response to identify errors in the programming and hardware areas of the 5250 system.



Type of Error Code	Result
Operator	The error message provided by the host is accessed by the operator using the Help key, on the display station, to generate a Signal command. Some operator error codes are logged.
Programmer (parameter) Error	Lustat or negative response is sent to the host.
Hardware	See Figure 1-7.
SNA Protocol	No operator intervention required.

Figure 1-6. Types of Errors and the Results of These Errors

Operator Errors

The 5250 uses operator error codes that appear on the display and that are returned to the host system in the Signal command (when the operator uses the Help key in an error state) to identify operator errors. The operator accesses descriptive information about the error condition by using the Help key in the error state; the information obtained by using the Help key is the responsibility of the host programmer. One way to provide this information to the operator is via the Write Error Code command. If the host system does not provide additional information, the original error code remains and the work station enters the posthelp error state. The index entries *operator error codes, signal command, command and response code, help key*, and *write error code command* refer to text containing specific information about these subjects. The index entry *error states* refers to the descriptions of the conditions that exist while the device is in an error state.

FMD Programming Errors

FMD programming errors are the result of incorrect or unacceptable coding being used by the sending partner. For programming errors, if the LU is in a receive state when the error occurs, the controller sends the host system a negative response. If the LU is in a send chain state (LU has CD) and is sending when the error occurs, the controller sends the host system a Cancel command and a Lustat command. See index entries *negative responses* and *lustat command* for additional information.

SNA Protocol Errors

If an SNA protocol error is detected, a negative response is generated immediately, regardless of the state of the LU. No Cancel, Rshutd, or Lustat command will be sent.

Hardware Errors

The hardware errors are those errors detected in the controller, display station, and printer physical devices. Figure 1-7 shows the paths the hardware error conditions take.

If a hardware error is detected when the controller is in a receive chain state, it sends a negative response, a Rshutd command, and a Lustat command to the host system. The negative response identifies the error condition; the Rshutd command requests the host system to terminate the session and send an Unbind command; and the Lustat reports the LU as unavailable to the SS. If the LU is not in a chain state, it sends the Rshutd and Lustat commands. These commands request the host system to terminate the session and report the unavailability of the LU respectively. See index entries *negative responses, rshutd command,* and *lustat command* for details.

The handling of printer hardware errors is the most complex of all the error conditions. Figure 1-7 shows the paths the printer hardware error conditions take. The method used for identifying the printer hardware errors depends on the condition of the error; in other words, it depends on whether or not the error condition can be corrected by the operator. In addition, the state of RU chaining determines the resulting SNA code sent by the controller to the host system to identify the error.

When an operator-correctable error occurs in the printer (such as a forms jam), the controller sends the host system a Signal command. If the operator successfully corrects the error, the controller sends the host system another Signal command indicating that the error condition no longer exists. See the index entry *signal command, command and response code*. If, however, the operator cannot correct the error, the operator positions the printer Status switch to Cancel and the controller sends the host system a negative response. This indicates that the error has not been corrected and that other action is required. The host programmer determines what must be done when a negative response is received. See the index entries *CD, chaining, rshutd command, lustat command, negative responses,* and *cancel command.*

In addition to identifying errors, the controller implements an error log buffer in the controller. This error log holds error information about selected error conditions. The user obtains the log in one of two ways: (1) the user requests the log contents using the SNA Reqms command, or (2) the log contents are automatically sent when a log overflow condition exists (Recfms command). See index entries *reqms command, recfms command,* and *errors, error log.*

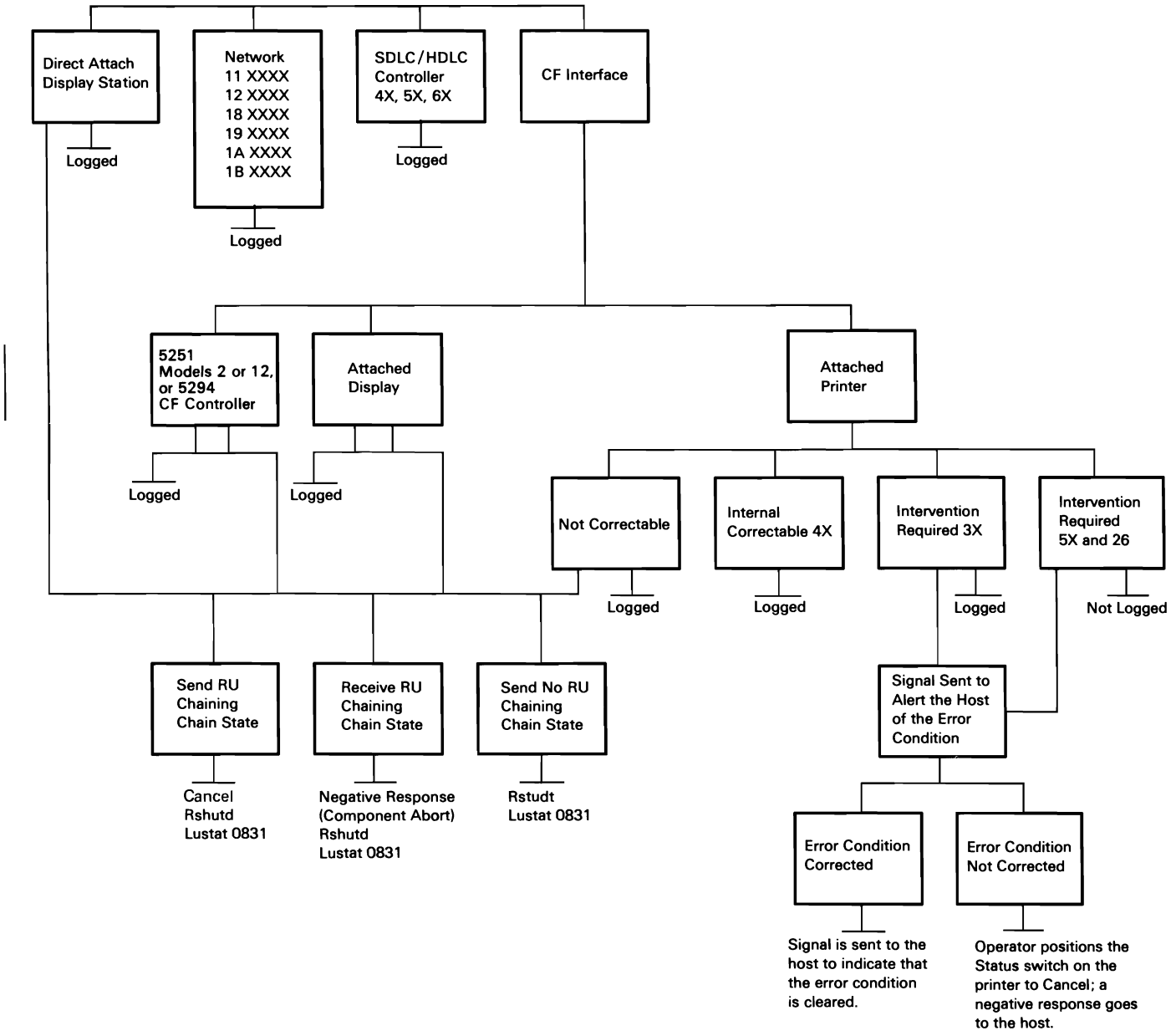


Figure 1-7. Hardware Errors and the Responses Generated by These Errors

SNA Session Flow

The three types of sessions that allow RUs containing user-defined commands and responses (to varying extents) are SS-PU, SS-LU, and LU-LU. See Figure 1-8.

The host system-to-controller commands (such as Reqms) are used in the SS-PU sessions; the host system-to-LU commands (such as Actlu) are used in the SS to LU sessions; and the application program-to-LU commands (such as Write to Display) are used in the LU-LU sessions. The controller-to-LU commands are the transmission commands. The TH and RH determine the type of session and the RU type for the RU data flow. Figure 1-9 shows which commands are valid on each session and whether those commands are normal or expedited flow. The SS-PU session is always considered active whenever communications at the data link or X.25 packet level are established.

Only one session is available for user data. The user application program data stream flows only on the LU to LU session. Certain RUs may contain SNA commands (session control or data flow control commands) that allow the host system to establish, control, and terminate sessions with the addressed LU.

The type of LU, display or printer, that is addressed by the host system determines what the data stream must include. For example, the printer data stream contains only control characters and data. The control characters are mixed with the data; they determine the format of the lines and specify a write operation. On the other hand, the display station LUs are both input and output devices. The host system can issue both Read and Write commands to them. Because the screen is a field-formatted input/output device, it also requires formatting controls such as control characters and orders to be intermixed with data.

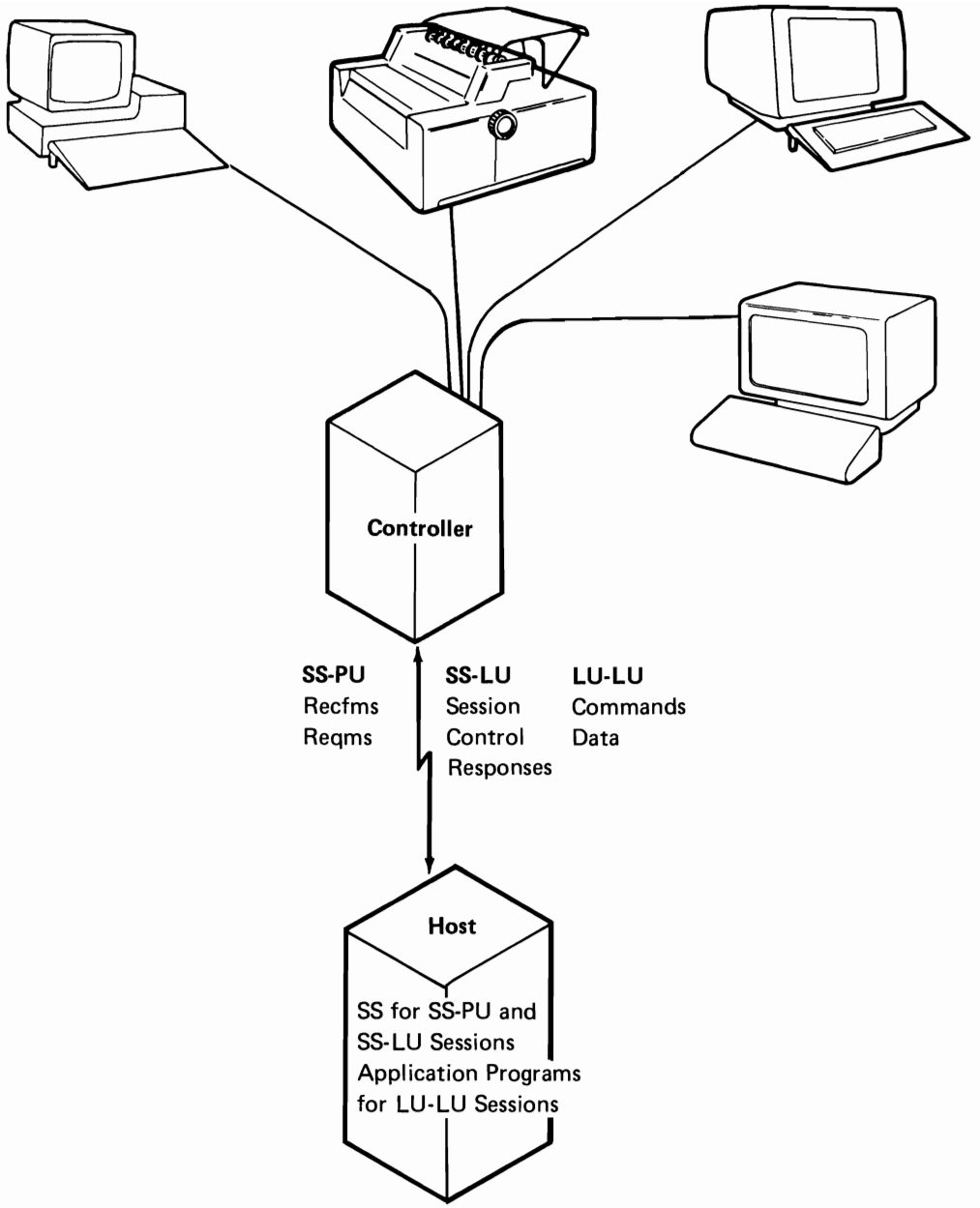


Figure 1-8. Types of Session Flow

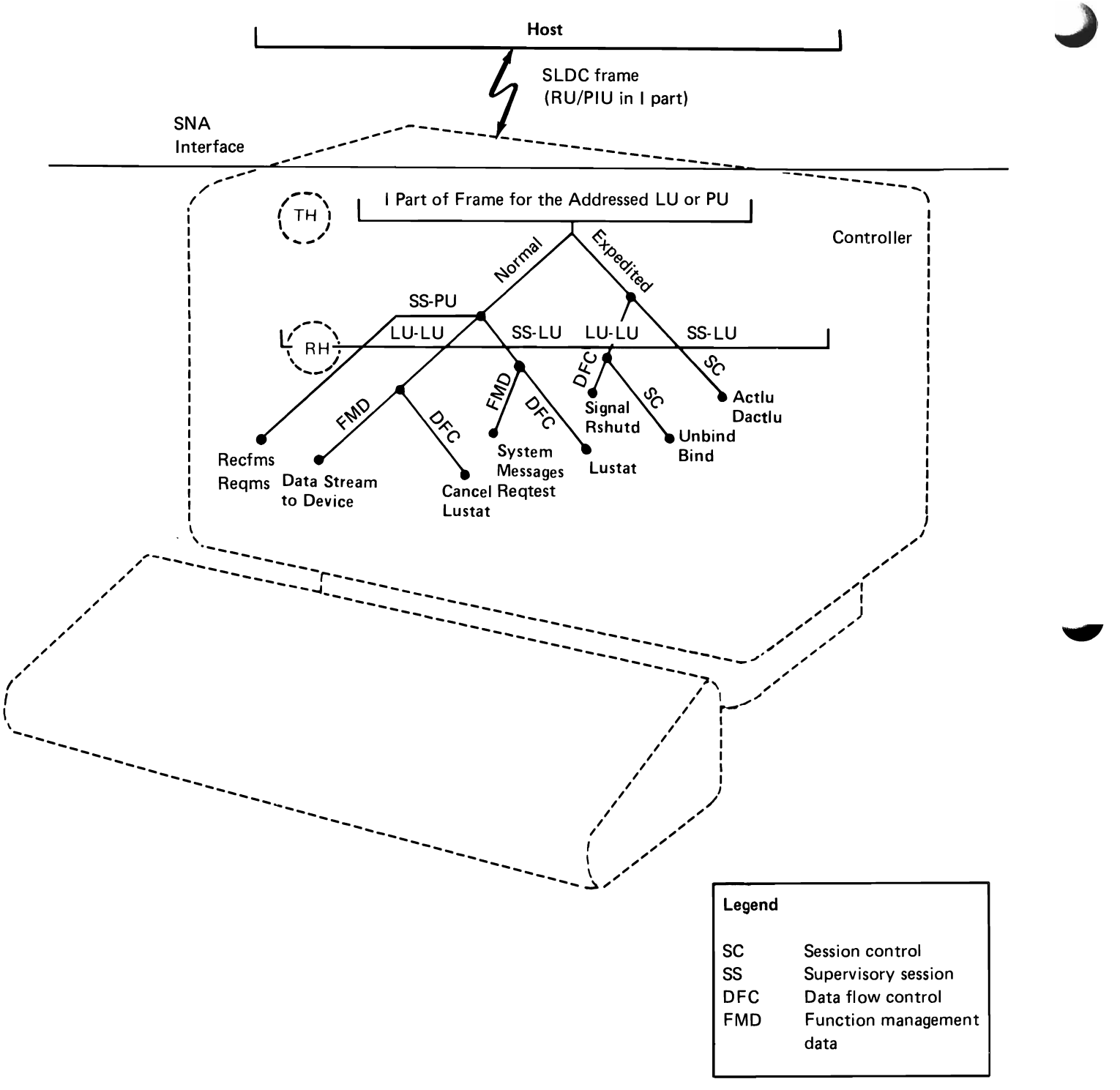


Figure 1-9. Allowable Sessions and RU Types for Commands and Data Sent to or from the Controller

SNA Session Control and Data Flow

Before any data stream commands can be sent to the addressed LU, a session must be established between the host system and the addressed LU. This is accomplished by the session control (Actlu and Bind) commands. A detailed description follows Figures 1-10, 1-11, and 1-12.

Note: See "Protocols and Synchronization for 5250 Implementation of SNA" in this section for an example of session flow control. Some of the normal activities that occur between the host system and LU are:

- Session established between the SS and the LU
- User program established to LU session-binding
- Commands sent by user to the LU (Read/Write Display or Write Printer)
- Information sent from LU to the host system
- Error history documentation for maintenance purposes
- Unit tests sent to a selected work station.

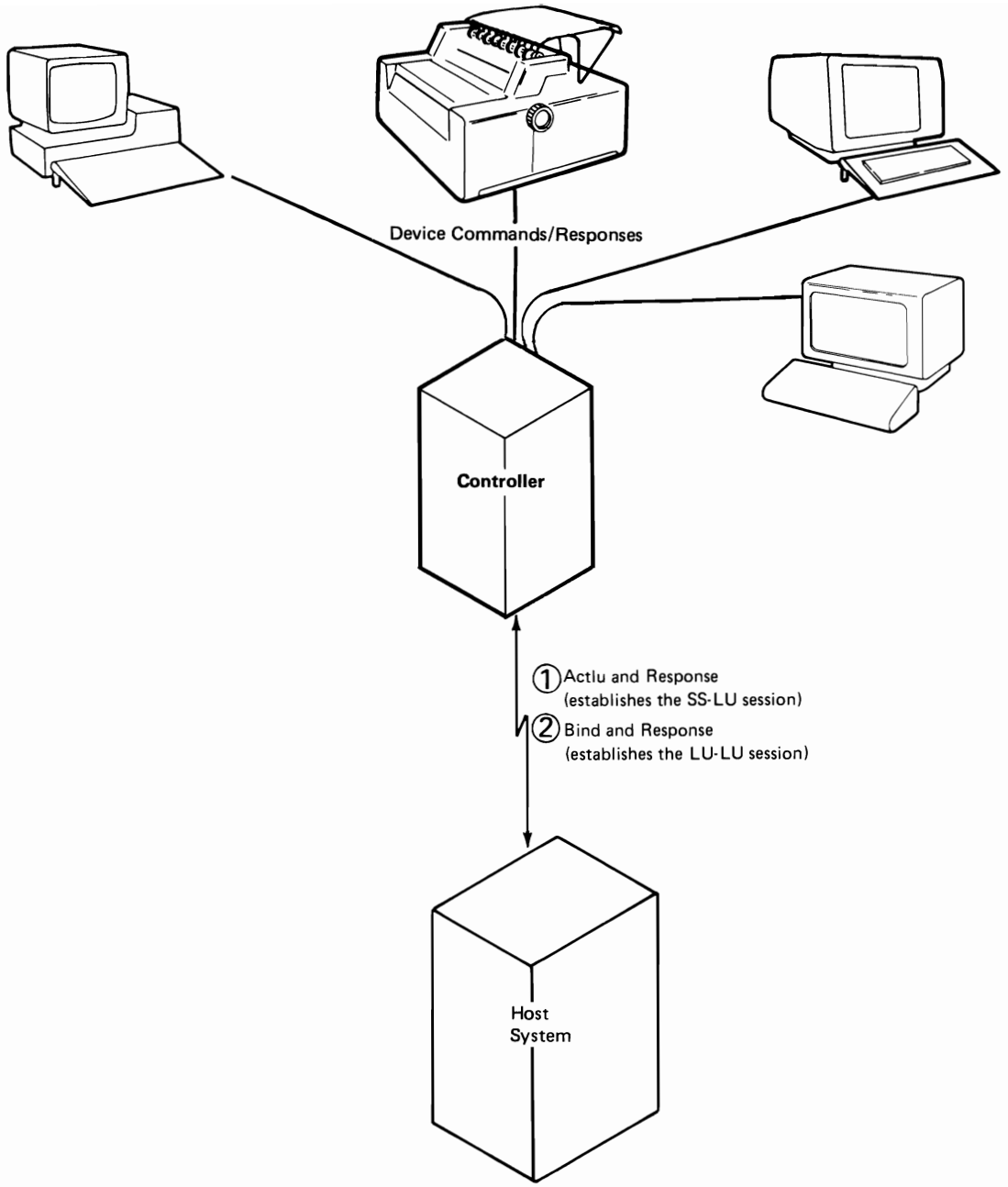


Figure 1-10. Establishing Sessions

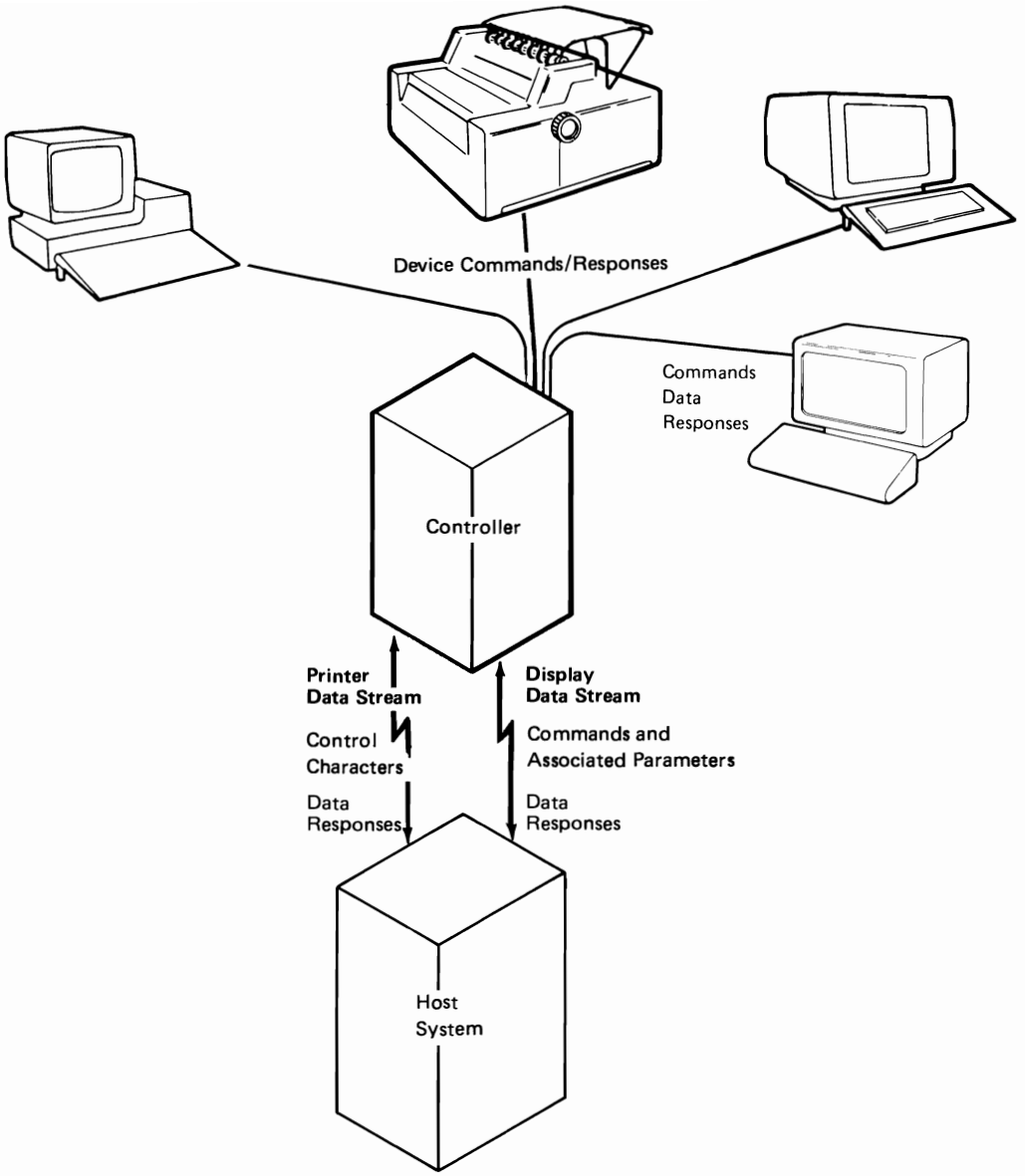


Figure 1-11. Display and Printer Data Streams

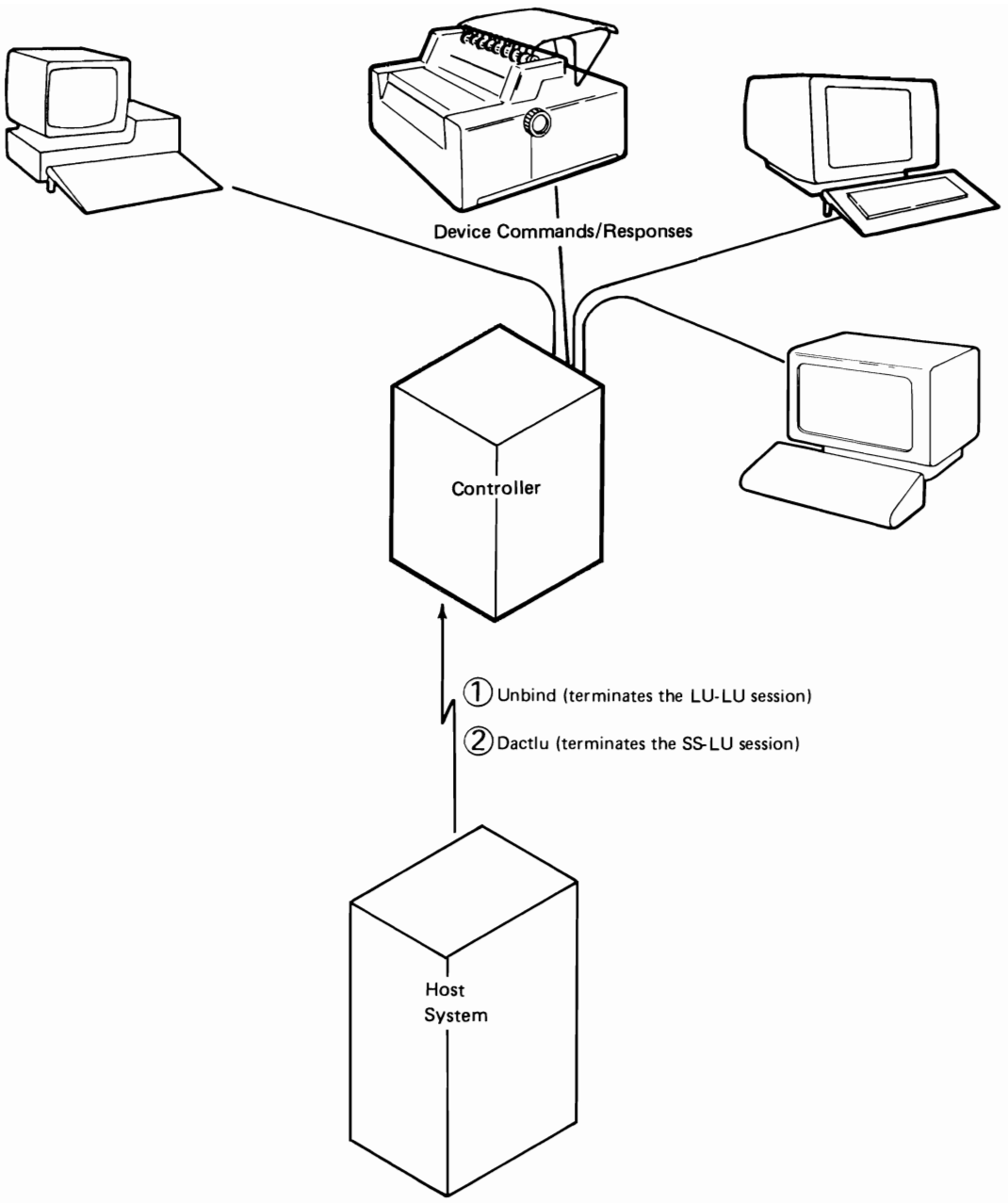


Figure 1-12. Terminating Sessions

Establishing a Session

The terminal cannot initiate a session. The host system must do this. Prior to the host system initiating a session, a typical display station operation might look like this:

1. Power is on.

2. The keyboard is unlocked and in free keying mode. When the operator presses a key that requires host system action, an operator error occurs. The operator presses the Error Reset key and the keyboard returns to the free keying mode. See the index entries *signal keys* and *aid-generating keys* for information about the keys that require host system action.

3. The host system initiates the SS-LU session by sending an Actlu. The LU sends a positive response back to the host, indicating the requested device's status and an SS-LU session is established.

Establishing a User Program to LU Flow-Binding

Now that an SS-LU session has been established, the host initiates an LU-LU session:

1. The host or user sends a Bind command to the requested device to establish an LU-LU session between the user's application program and the 5250 device.

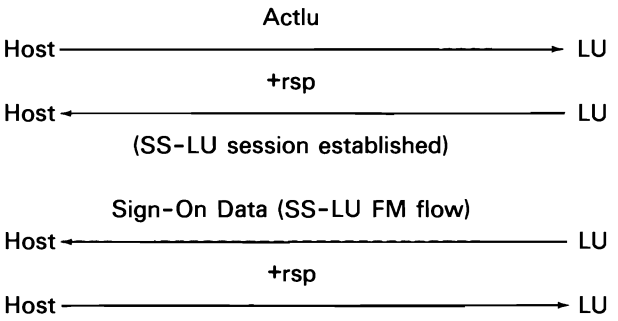
2. The device (LU) responds positively with session and device parameters in the bind response RU. See the index entry *bind command, responses* for details.

3. An LU-LU session is established between a program in the host system and the requested 5250 device.

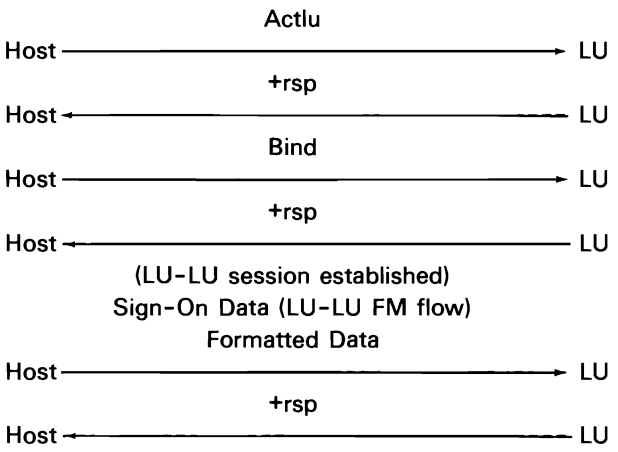
Signing On

For the 5251 Models 2 and 12, use either the SS-LU or LU-LU session to sign on. For the 5294, use the LU-LU only. The two session flow types are illustrated here:

SS-LU Flow Sign On



LU-LU Flow Sign On



User-LU Communication

Write Commands (User to LU)

The user communicates with the LU by performing the following:

1. First, the host sends an RU. Typically, the RU begins with an escape character, followed by a Clear Unit command, followed by another escape character.

2. Then, in the same RU, the host programmer sends the next command, which is a Write to Display (WTD) command. See the index entry *write to display command* for details. This builds the format table, which determines the field characteristics of the display.

3. The host programmer sends more information and commands (such as the Read commands), and when the end of the chain is reached (LIC), the LU responds as directed by the host system (either RQE or RQD). See "Protocols and Synchronization for 5250 Implementation of SNA" in this section for additional information about LIC, RQE, and RQD.

Read Commands (LU to User)

The user receives information from the LU by performing the following:

1. The operator begins entering data when the keyboard is unlocked after the Write to Display command has been processed. This results in:

   a. The keystrokes being translated into EBCDIC

   b. The translated keystrokes being put into a buffer and held until the LU is given authority by the host system (in the CD bit and Read command) to send the information, and the operator presses an aid-generating key

   c. Cursor movement.

2. The operator presses the Enter/Rec Adv key. If the host system has sent a Read command and the CD bit, SNA puts the information that is in the buffer in one or more RUs and sends it to the host system (for the user's program) in the normal flow.

Printer Write Operations

The user writes to the printer by coding the appropriate control characters (see the index entry *control characters, printer*) into the data stream where the user wants the control to occur. When the printer receives the data stream, it prints the information as formatted.

Maintaining an Error Log

The controller contains a local error log which is sent to the host system on the SS-PU SNA session whenever the buffer containing the log is almost overflowing. In addition, the SS can request this log by issuing a Reqms command. See the index entry *reqms command* for details. See the index entry *errors, error log* for a description of the contents of this log.

Testing a Unit Device

To request a test operation, the operator:

1. Presses and releases the Cmd key.

2. Presses and releases the Character Backspace (←—) key on the typewriter-like keyboard or the rightmost blank key on the top row of the data entry keyboard. As a result, the controller sends an SNA command called Reqtest on the SS-LU flow to the SS. The SS can reply with either test routines or menus to select tests; this is a user-defined or system-defined function.

Protocols and Synchronization for 5250 Implementation of SNA

The controller uses the SNA protocol in communicating with the host system. This protocol consists of (1) formats and sequences to manage multiple sessions and (2) the data flowing with these sessions. The following text describes this protocol. A description of specific SNA terms precedes the protocol description because an understanding of the definitions is a prerequisite to an understanding of the text and illustrations that follow.

Terminology Used in Describing the SNA Protocols

The following definitions are some of the fields involved in the SNA flow. For a complete description of the Request/Response header, see the index entry *RH*.

CD: Change of direction; bit 2, byte 2 of the RH. It reverses the direction of flow when examined on LIC. See the index entries *CD* and *RH*.

Chain: A unit of error recovery composed of RUs. See the index entry *chaining*.

FIC: First in chain; this refers to the first RU in a chain of RUs. See the following chart.

MIC: Middle in chain; this refers to the RUs within a chain of RUs. See the following chart.

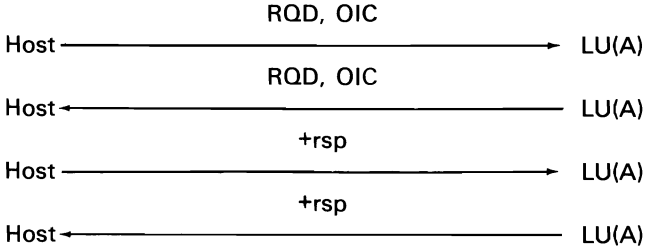
LIC: Last in chain; this refers to the last RU in a chain. See the following chart.

OIC: Only in chain; this refers to one RU in a chain. See the following chart.

RH - Byte 0

Position of the RU in the Chain	Bit 6	Bit 7
FIC	1	0
MIC	0	0
LIC	0	1
OIC	1	1

FDX: FDX stands for full duplex. Within the SNA structure, this means that both session partners can be in send state simultaneously. However, because the controller implementation of SDLC allows only half duplex, a buffer is required to hold information sent by one session partner while the other session partner is transmitting. This is how a full duplex SS-LU flow looks:

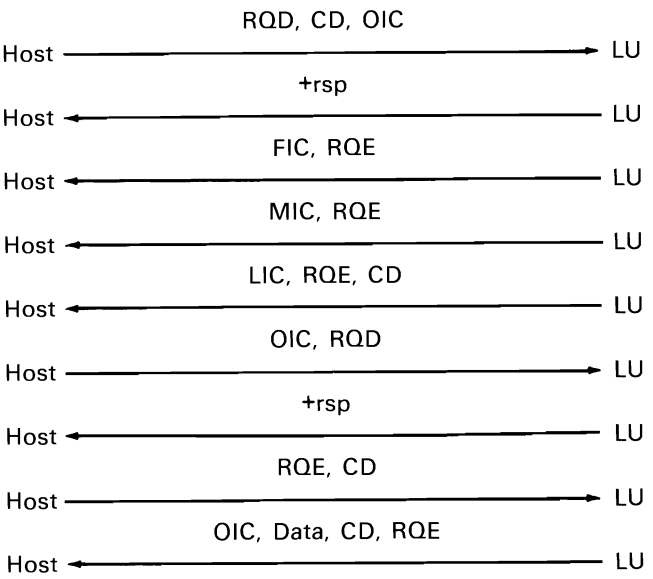


Although both stations are in SNA send state simultaneously, only one SDLC transmission can occur at a time because of the half-duplex restrictions of the SDLC communications lines. Therefore, the extra information must be held.

Flow: Flow is the SNA path routing the RU type takes. The two types of flow are normal and expedited. See Figures 1-9 and 1-13.

Formatted: Formatted refers to the SNA-defined format required for an RU. To the programmer, this means that bit 4 of byte 0 in the RH is on. See Figure 1-13 to determine when formatting occurs.

HDX: Stands for half duplex. Within the SNA structure, it means that only one session partner can be sending at a time. The sending session partner must include a CD bit in the flow in order to give authority to the remaining session partner to send information. Without CD, the other session partner cannot send information. The CD is required only to send an RQ (RQE and RQD) and not to send a response (rsp). This is an FM example of half-duplex flow:



RU Types: The RU types used by the 5250 system are function management data (FMD), data flow control (DFC), and session control (SC). Figure 1-13 shows the characteristics and contents of these. The data stream for the LUs is in the FMD LU-LU normal flow. Bits 1 and 2 of byte 0 in the RH part of the SNA header contain the code for the various RU types. See the index entry *RH*.

-rsp: Negative response. Allows the controller or host system to report to its session partner that an invalid condition exists. See the index entry *negative responses* for details about the use of the negative response with the 5250 devices.

+rsp: Positive response. Allows the controller or host system to report favorably to its session partner in response to a command (such as the Bind response code). See the index entry *SNA, commands* for details.

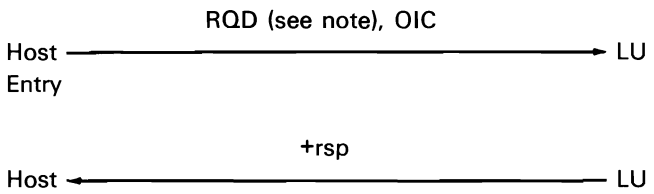
RU Type	**FMD**				**DFC**		**SC**	
Sessions	**SS-LU**		**LU-LU**	**SS-PU**	**SS-LU**	**LU-LU**	**SS-LU**	**LU-LU**
Flow	Normal	Normal	Normal	Normal	Normal	Normal Expedited	Expedited	Expedited
Mode	FDX	FDX	HDX	FDX	FDX	HDX FDX	Not applicable	Not applicable
Chain and RU Restrictions	1 RU $\leq$ 128 bytes OIC (Note)	9 bytes OIC	$\leq$ 256 bytes Normal	$\leq$ 256 bytes OIC	5 bytes OIC	5 bytes OIC	3 bytes OIC	26 bytes OIC
Response and CD	RQD no CD	RQD no CD	RQE-CD RQD-CD and no CD	RQD no CD	RQD no CD	CD optional for Lustats CANCEL RQD	RQD no CD	RQD no CD
Contents	Message in EBCDIC characters from or to a display station or system request data	Reqtest	LU data stream	Reqms Recfms	Lustat	Cancel Lustat Signal Rshutd	Actlu Dactlu	Bind Unbind
SNA Formatted	Unformatted	Formatted	Unformatted	Formatted	Formatted	Formatted	Formatted	Formatted
Note: The controller truncates data allowed on the display to 78 bytes.								

Figure 1-13. SNA Protocols Used by the 5250 Information Display System

Display Protocols

The following topics show what happens when the user LU sends RUs and the addressed display station LU executes them.

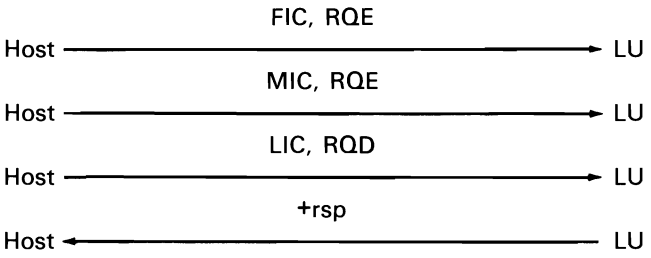
Log On



The programmer determines the sign-on sequence. See the heading *Signing On* earlier in this section.

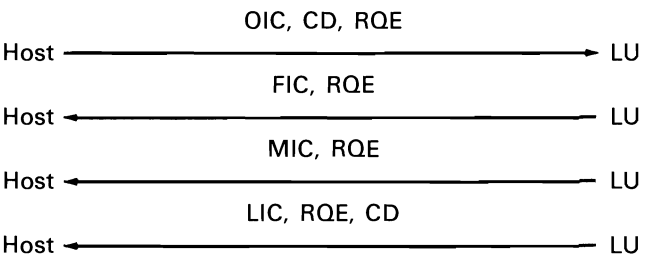
Note: A response required (RQD) is required only on the SS-LU flow.

Write Command Flow



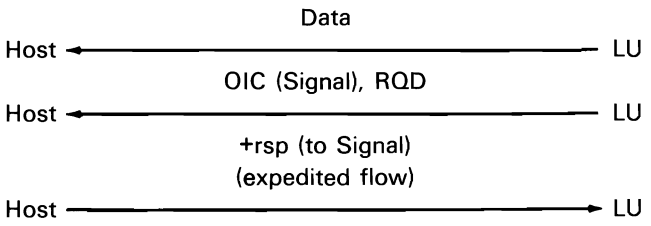
Add more writes (if needed) in the above format.

Read Commands



Operator Uses the Attn Key

Note: The keyboard can either be locked or unlocked.



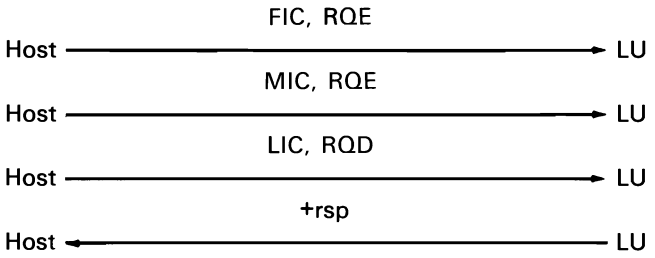
For a description of the Signal command, see the index entries *signal command, command and response code.*

Printer Protocols

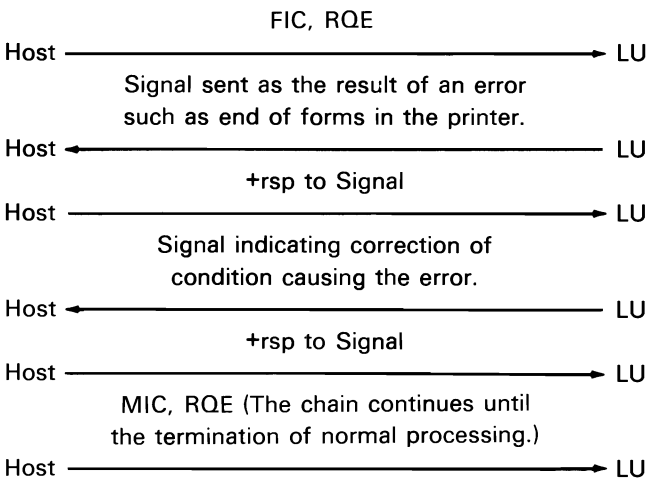
The following topics show acceptable printer protocols.

Note: CD should not be sent to the printer; if it is sent, the printer returns a Lustat of 00 02 00 00 to the host system. See the index entry *lustat command* for details.

Writing to the Printer

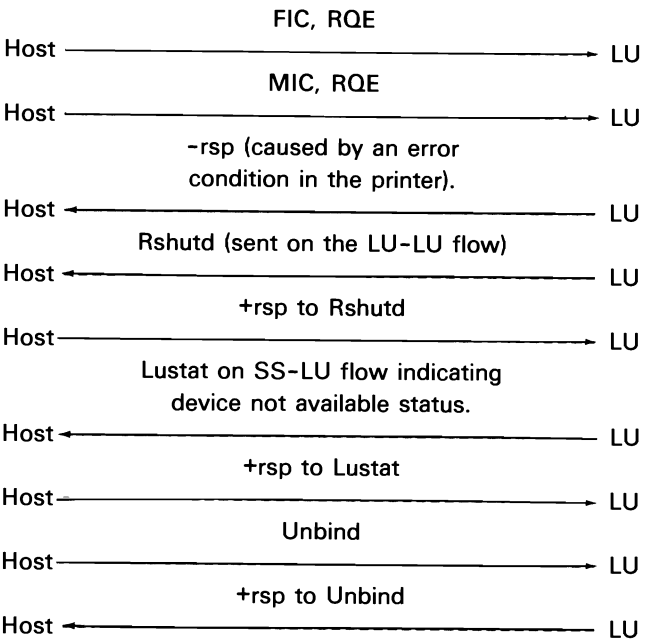


A Correctable Error Occurs



For a description of the Signal command, see the index entries *signal command, command and response code*.

A Noncorrectable Error

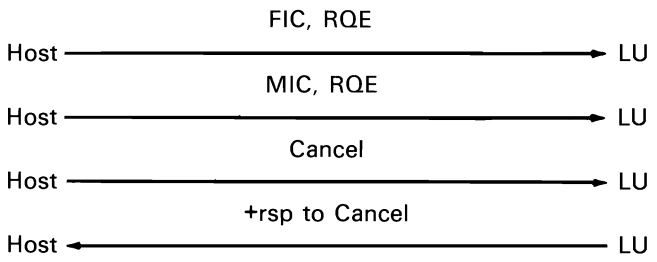


The host system determines whether to unbind (use the Unbind command) or deactivate (use the Dactlu command). See the index entries *dactlu command* and *unbind command* for details.

Note: By using the Unbind command, the 5251 Models 2 or 12 will notify the host system when the device is available again by issuing another Lustat. If the host system issues a Dactlu command, no Lustat can be issued.

For descriptions of Lustat, Rshutd, and Unbind, see the index entries *lustat command, rshutd command,* and *unbind command*.

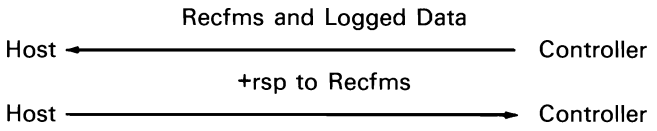
The Host System Terminates a Chain



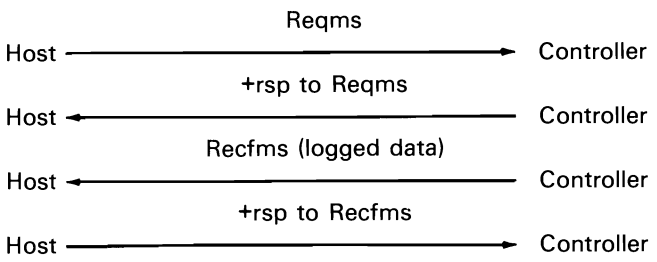
Note: For details about the Cancel command, see the index entry *cancel command*.

The following topics illustrate communications between the host system and the controller involving error logging.

Error Log Overflow Condition (Unsolicited)



Requested Log Data (Solicited)



For a description of Reqms and Recfms, see the index entries *reqms command* and *recfms command*. For a description of the logged errors, see the index entry *errors, error log*.

Requesting Status from an IPDS Printer

Multiple Status Commands

The IBM 4224 responds to two different status commands: Read Multiple Status and Reset Multiple Status.

Read Multiple Status

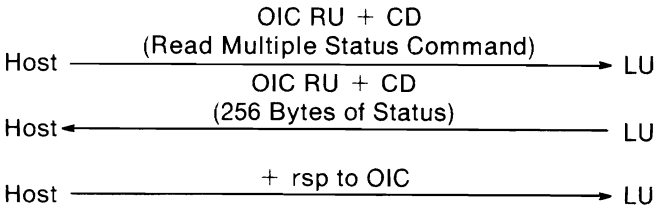
ESC	470100

ESC — Escape character (hex 04), required to begin each RU chain.

470100 — A hex value for Read Multiple Status command.

The Read Multiple Status command generates an IPDS Acknowledge Reply (ACK) response from the 4224. The reply contains 256 bytes of status information. The printer uses the ACK to return device status, sense information, and any additionally requested information back to the host application program. Refer to the *IBM 4224 Printer Product and Programming Description* manual, GC31-2551, for more details concerning the Acknowledge Reply command.

Printer Protocol for a Read Multiple Status Command



Note: The Read Multiple Status command must be sent in an OIC RU with CD.

Reset Multiple Status

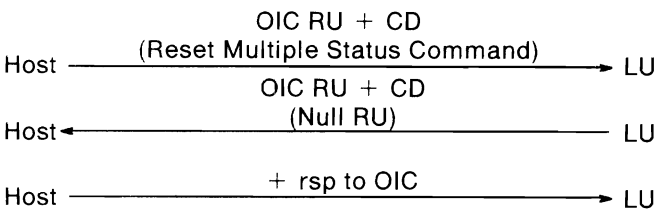
ESC	470000

ESC — Escape character (hex 04), required to begin each RU chain.

470000 — A hex value for the Reset Multiple Status command.

The Reset Multiple Status command is processed the same way as a Read Multiple Status command, but does not generate any returned information.

Printer Protocol for a Reset Multiple Status Command



Note: The Reset Multiple Status command must be sent in an OIC RU with CD.

Display Data Stream Example

This topic consists of examples showing the coding required to write to an alphanumeric and graphics display, read from a display, and respond to an error condition in the display. In the examples, the comma (,) is used as a byte separator. Single quotes delineate a character string. Within the character string, each character represents one byte of EBCDIC code. The row and column parameters for the Set Buffer Address (SBA) and Insert Cursor (IC) orders and the length parameter for the Start of Field (SF) order are given in decimal in this example. In an actual programming environment, these parameters must be in hexadecimal notation. For example, SBA, 10,27 should appear as hex 110A1B in actual code.

No attempt has been made to represent the SDLC/SNA headers and flags; only the contents of the SNA RUs are given.

Note: In the following illustrations, @ represents the screen attributes. These attributes are not normally displayed; they are shown in these illustrations to help you understand their location within the displays. If you are operating 5251 Models 1, 2, 11, or 12, or a 5252 dual display station, and want to see the screen attributes, display them by positioning the Status switch to Test. To display attributes on other display stations, refer to the appropriate operator's guide for the display device.

Writing to a Display

First, a display must initially be built from the information provided in the Write to Display command; next, the information must be updated to reflect changes made by the operator.

Building an Alphanumeric Display

```
ESC, CU, ESC, WTD, CC,
```

ESC

Escape character (hex 04), required to begin each RU chain.

CU

Clear Unit command (hex 40), recommended to ensure the integrity of the data to be written to the display. This command clears the display and format table of all information. See the index entry *clear unit command*.

ESC

Escape character, required to link commands within an RU chain.

WTD

Write to Display command (hex 11), required to write any information to the display. This command has many associated parameters. As used here, these consist of the SBA and SF orders, control characters, screen attributes, display control words and field control words. See the index entry *write to display command* for details.

CC

Two-byte control character associated with the Write to Display (WTD) command. In this case, the CC bytes are hex 00 and 08. In this example, only the second byte is functional; it unlocks the keyboard. See the index entry *control characters, display* for details.

```
SBA,01,15,@,'ACCOUNTS RECEIVABLE -- UPDATE
MODE',@,
```

SBA

Set Buffer Address order (hex 11), required to locate the beginning position of the data to be written on the display. The two numbers that follow the order (which in this example are 01 and 15) are the row and column address that define the beginning data position. See the index entry *SBA order* for details.

@

Screen attribute that determines how the field is displayed.

'ACCOUNTS RECEIVABLE -- UPDATE MODE'

Data to be written to the field in the position defined by the preceding SBA order. The characteristics of this data on the display have been defined by the screen attribute.

```
SBA,03,01,@,'ACCOUNT:',SBA,03,15,SF,FFW,@,21,
```

SBA

Set Buffer Address order (hex 11). This order defines the position of the next data field to be written as row 3 and column 1.

SF

Start of Field order (hex 1D). This order defines the beginning position of the first operator-entry field. The parameters following the order locate the field and define its characteristics. The parameters are FFW, @, and length. The field can contain data; in this event, the data is alterable. See the index entry *SF order* for details.

FFW

Field Format Word (2 bytes). In this example, the field is a numeric-only (hex 4300) field with no other restrictions. See the index entries *fields* and *field format word* for details.

@

Screen attribute that determines how the field is displayed.

21

Field Length. This parameter consists of 2 bytes. It specifies the length of the field. In this example, 21 locations are required, so hex 0015 will appear in the RU.

Note: The controller automatically writes a normal attribute (hex 20) at the end of the field.

In the same manner, build the name, address, city, state, and zip fields. See Figure 1-14.

```
SBA,09,01,@,'--DATE---     --CODE--
   --LEDGER XREF--     --DEBIT--
   --CREDIT--',@
```

This coding writes the data headings on a line beginning at row 9 and column 2. The screen attributes will be on row 9, column 1. The screen attributes that the user defines determine the characteristics of the line. Remember, if the screen attributes are other than normal, an ending screen attribute should be specified to reset all fields that follow to normal display.

```
SBA,10,1,SF,FFW*,@,8,SBA,10,18,SF,FFW*,@,2,
SBA,10,26,SF,FFW*,@,10,SBA,10,45,SF,FFW**,@,7,
SBA,10,58,SF,FFW**,@,7,. . ..(This coding scheme
continues for all 24 rows.)
```

Note: The asterisks are explained in the following text.

Some of the entry fields are not only numeric-only but also mandatory entry (*) and some are right-adjust fields with blank fill (**). This field entry control is accomplished with the FFW. For numeric-only fields with mandatory entry, the FFW = hex 4308. For numeric fields with right adjust and blank fill, the FFW = hex 4306.

Figure 1-14 shows how the display looks after all previously described orders have been processed.

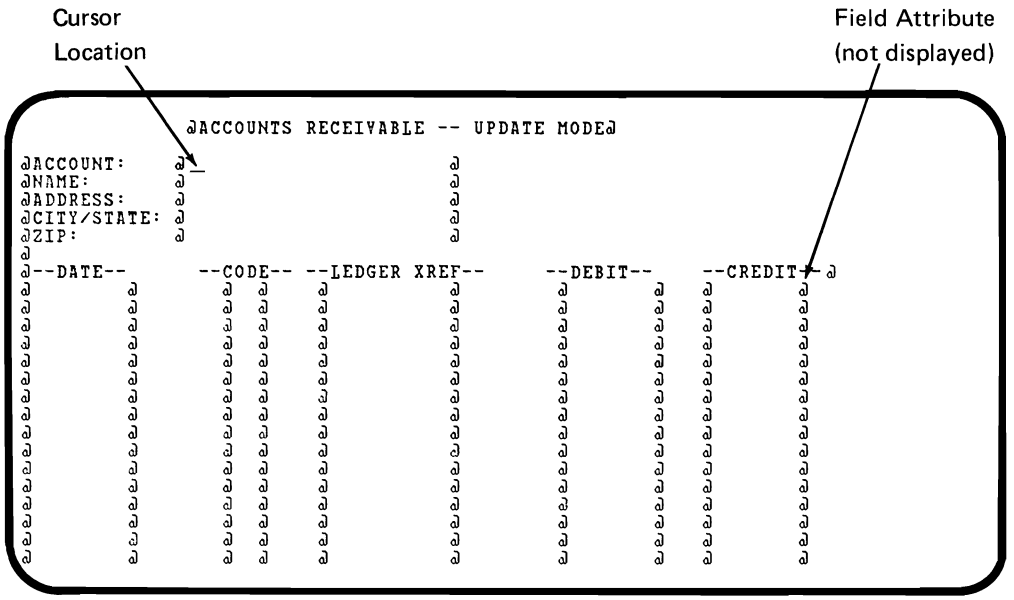


Figure 1-14. Display Initially Written by the Programmer to the Screen

Updating the Display

When the display is built as shown in the previous illustration, you may choose to fill some of the fields and make them available for user update. This is accomplished in the following coding:

```
ESC,WTD,CC,SBA,3,16,'7-333',
SBA,4,16,'JOE SMITH',
SBA,5,16,'0000 B STREET',
SBA,6,16,'SOMETOWN, MN',
SBA,7,16,'99999',
SBA,10,02,'11-10-77',SBA,10,19,'20',
SBA,10,27,'125670-100',SBA,10,46,...
```

Continue to fill fields until all required fields are made available for operator update. Figure 1-15 illustrates how the display will look.

Remember, the RU chain is still being formed. Now insert a Read command so you can read any data the operator provides.

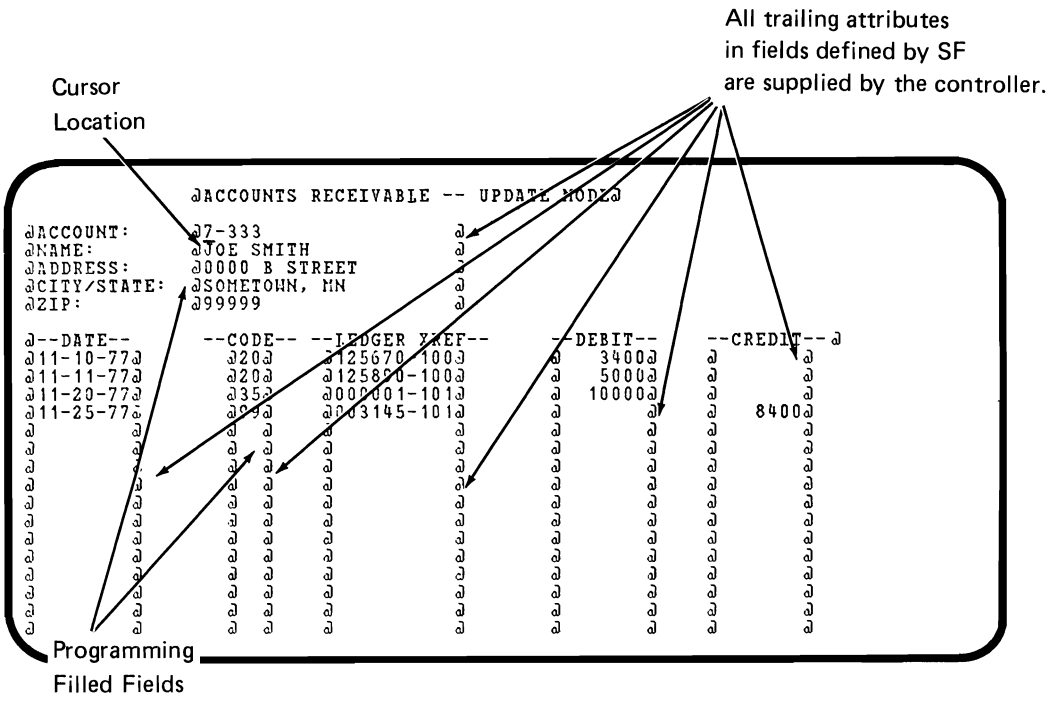
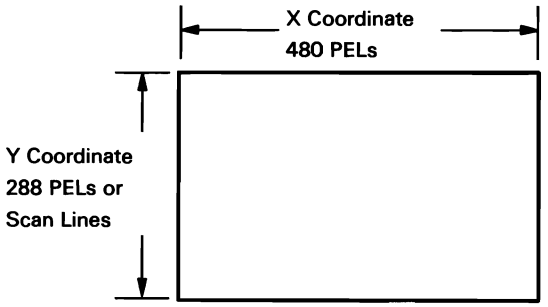


Figure 1-15. Display with Filled-In Update Fields

Building a Graphics Display

The 5292 Color Display Station Model 2 can display alphanumeric (A/N) and graphic images, such as pie charts and line drawings, using flexible line styles and line widths. The displays can be in seven colors (plus black, which cannot be changed), selected from a palette of 512.

The graphic images are displayed by selecting the color and a combination of addressable dots (PELs or picture elements) on the display screen. The PELs are addressed by X and Y coordinates as shown below.



5292 Model 2 Graphic Orders allow the programmer to draw a line between X and Y coordinates (vector graphics), fill areas, and vary line style and width.

The data stream for a graphics display is similar to the data stream for an A/N display. The main difference is that the graphics display is defined in a unit called the graphic byte. The graphic bytes take the place of the data portion in an A/N data stream. All orders, locations, and colors are defined in a string of graphic bytes presented to the 5292 Model 2 as shown below.

A/N Data Stream

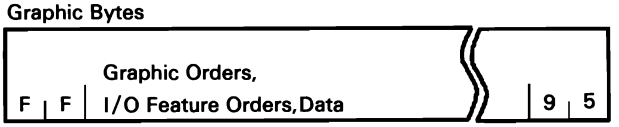
```
,@,'DATA'
```

Graphics Data Stream

```
,GRAPHIC BYTES
```

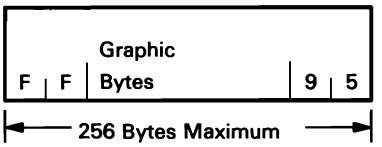
The graphic bytes consist of Graphic orders, I/O feature orders, and data associated with the orders. The graphic bytes in a graphics data stream must begin with hex FF (Begin Graphics order), and end with hex 95 (End Graphics order) as shown below.

Graphic Bytes



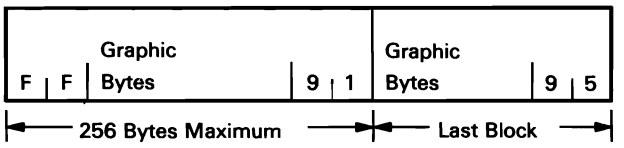
Graphic bytes are sent to the 5292 Model 2 in write blocks. A graphic write block has a maximum length of 256 bytes and a minimum length of 11 bytes. Graphic blocks may be sent to the 5292 Model 2 by single blocks, where each graphic write block begins and ends graphic mode as shown below.

Single Write Block



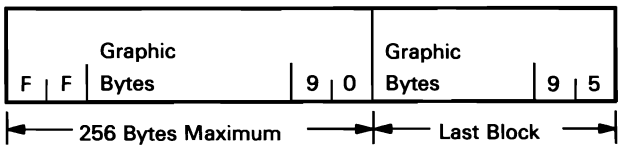
If a group of blocks is sent, graphic data for certain orders may span blocks. For orders in which data can span blocks, the data can be split by using the More-Data-to-Come order (hex 91) as shown below. A detailed description of each Graphic order and whether data can span blocks for that order is contained in Section 2 of this manual.

Multiple Write Spanned Blocks

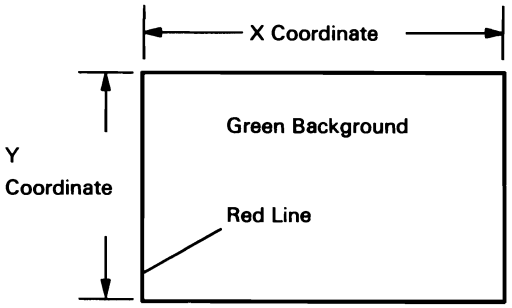


A group of graphic write blocks can also be sent by using the End Graphics Block order (hex 90) to specify the end of a graphics write block without ending graphics mode as shown below.

Multiple Write Nonspanned Blocks



The following data stream example shows the data stream that draws a red line on a green background that connects the x and y coordinates defined in the graphic bytes.




```
ESC,CU,ESC,WTD,CC,
```

```
ESC,CU,ESW,WTD,CC,
```

ESC

Escape character (hex 04), required to begin each RU chain.

CU

Clear Unit command (hex 40), recommended to ensure the integrity of the data to be written to the display. This command clears the display and format table of all information. See the index entry *clear unit command.*

ESC

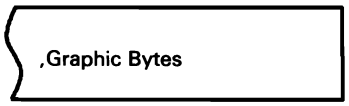
Escape character, required to link commands within an RU chain.

WTD

Write to Display command (hex 11), required to write any information to the display. This command has many associated parameters. As used here, these consist of the SBA and SF orders, control characters, screen attributes, display control words, and field control words. See the index entry *write to display command* for details.

CC

Two-byte control character associated with the Write to Display (WTD) command. In this case, the CC bytes are hex 00 and 08. In this example, only the second byte is functional; it unlocks the keyboard. See the index entry *control characters, display* for details.



Graphic Bytes (11 Bytes Minimum)

If there are fewer than 11 graphic bytes, pad with hex 40.

The following string of graphic bytes contains graphic orders and data that turn on the graphics display at the 5292 Model 2, define the color, display the graphic image, and define the end of graphic bytes. A complete description of each graphic order is contained in Section 2 of this manual.

Byte 1

F	F

The first graphic byte value of hex FF identifies the following string of bytes as graphic bytes.

Byte 2

9	3

The second byte value of hex 93 (Graphic Display-On order) turns on the graphics display at the 5292 Model 2.

Bytes 3 and 4

A	3	4	2

The third byte value of hex A3 (Write Background order) writes the entire screen background with the color specified in byte 4.

The fourth byte value of hex 42 (color index 2) identifies the color index to be written for the background. In this example, the default for color index 2 (green) is used.

Bytes 5 and 6

B	0	4	1

The fifth byte value of hex B0 (Set Color order) sets the color to be displayed for subsequent Draw orders. This color remains in effect until another Set Color order is processed.

The sixth byte identifies the color index to be used. In this example, hex 41 (color index 1), the default value red is used.

Bytes 7 through 11

A	0	4	0	4	0	4	0	4	A

The seventh byte value of hex A0 (Draw Polyline order) draws a line that connects the X and Y coordinates defined in the graphic data bytes that follow. This order will connect all points defined by the graphic data bytes until an End Of Data order is encountered.

The eighth and ninth bytes identify the Xa coordinate.

The tenth and eleventh bytes identify the Ya coordinate.

Bytes 12 through 15

4	1	6	4	4	0	7	2

The twelfth and thirteenth bytes identify the Xb coordinate.

The fourteenth and fifteenth bytes identify the Yb coordinate.

Byte 16

9	2

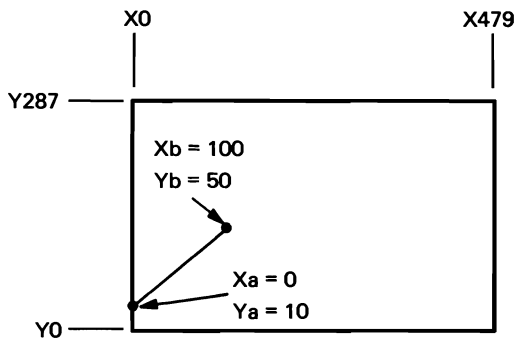
The sixteenth byte value of hex 92 (End Of Data order) delimits the graphics data to be used by the Draw Polyline order.

Byte 17

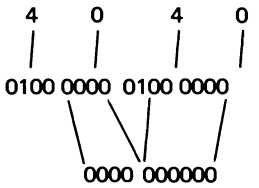
9	5

The seventeenth byte value of hex 95 (End Graphics order) delimits the graphics display data stream that started with the first graphic byte of hex FF.

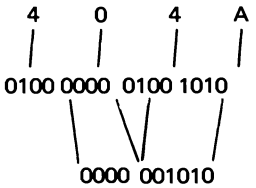
How to Code X and Y Coordinates



The a coordinate is defined first in this data stream. The hexadecimal value for coordinates are determined by the 10 bit binary value as shown below.



This 10 bit binary value defines the coordinate of Xa = 0.



This 10 bit binary value defines the coordinate of Ya = 10.

Note: Bits 0 and 1, value of 01, identify the graphic byte as data.

Reading Fields from a Display

ESC,Read MDT,CC,

ESC

Escape character (hex 04). It signals the beginning of another command.

Read MDT

The Read Modified Data Tag (MDT) command (hex 52). When the operator alters a field on the display, the MDT bit for the field is set. Any field with an MDT bit on is sent to the host system when the operator presses an aid-generating key and when all field requirements have been met. See the index entries *display, commands* and *aid-generating keys* for details.

CC

The control characters are associated with the Read MDT command. In this example, the CC is hex 4000, which specifies that MDT bits of nonbypass fields are to be cleared after the Read command is serviced.

Note: The master MDT bit is also cleared.

The complete SNA RU is now sent to the LU. The operator updates the display and presses the Enter/Rec Adv key. Figure 1-16 shows the changes the operator made on the display.

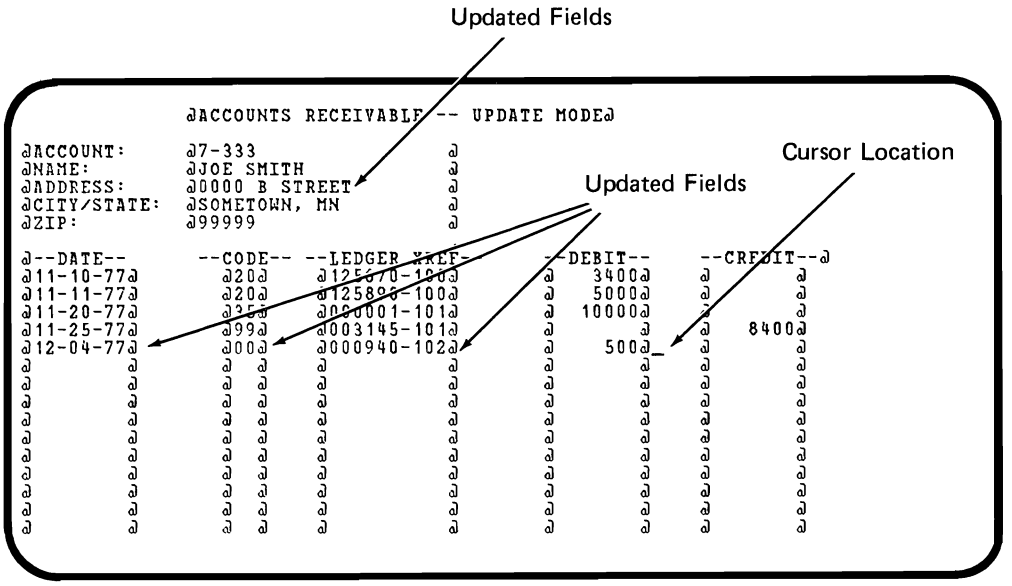


Figure 1-16. Display Updated by Operator Entry

The controller sends the host system the following data stream when the operator presses the Enter/Rec Adv key. See the index entry *aid-generating keys* for details.

```
14,59,Enter,
SBA,5,16,'0000 B STREET',
SBA,14,02,'12-04-77',SBA,14,19,'00',
SBA,14,27,'000940-102',
SBA,14,46,'  500',
```

14,59,Enter

> 14,59 is the cursor address at the time the operator pressed the Enter/Rec Adv key. Enter stands for the aid code (hex F1) that the Model 2 or 12 sends the host system when the operator presses the Enter/Rec Adv key.

Error Identification and Recovery

1. When the host system checks the incoming data, it finds that the numbers sent in the last transaction are invalid; it sends an error message to the operator to alert him of the problem. The code for the error message looks like this:

```
ESC,Wrt Error Code,IC,14,19,@,
'9001 -- INVALID TRANSACTION CODE,
PRESS RESET AND CORRECT',@,
ESC,Read MDT,CC,
```

Wrt Error Code

> The Write Error Code command (hex 21) allows the host system to force the keyboard into the prehelp error state. When the operator presses the Error Reset key in response to the Write Error Code command, the keyboard unlocks, so no Write to Display command is needed. See the index entry *write error code command*.

IC,14,19

> IC is the Insert Cursor order (hex 13). 14 and 19 define the row and column where the host system wants the Model 2 or Model 12 to set the cursor. This is the location of the error.

@

> The host system is responsible for the screen attribute. It should be high intensity blink for the first @ and nondisplay for the last @. Characters appearing in columns 2-5 of the error line (9001 in this example) should be some user text message that can be used to index help messages. The host system should not duplicate error codes generated by the controller. See the index entry *errors, codes*.

Figure 1-17 shows the display when the error message is generated.

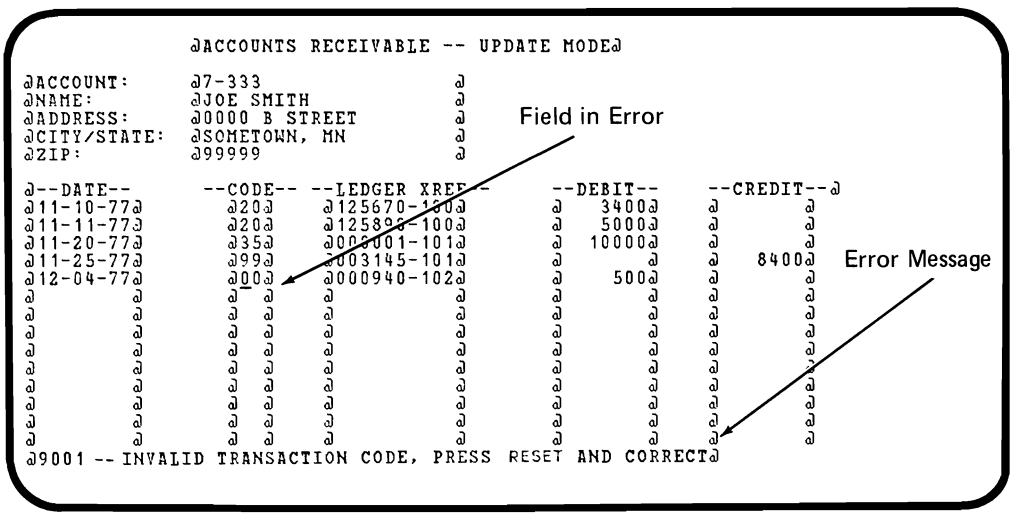


Figure 1-17. Display Containing an Error Message

2. The operator presses the Error Reset key, corrects the error, and then presses the Enter/Rec Adv key. This data stream goes to the host system:

```
14,27,Enter,
SBA,14,19,'20',
```

14,27,Enter

This is the cursor location by row and column and the Enter aid code.

SBA,14,19,'20'

This is the SBA order and associated parameters that tell the host system that the number 20 is now to be placed into row 14 and column 19 in place of whatever data was previously there.

Note: Only the corrected fields are sent; previously corrected fields are not resent. This is accomplished by the control character (MDT reset) that followed the first Read command.

Figure 1-18 shows what the display looks like now that the error has been corrected.

You can now write another RU chain to the display.

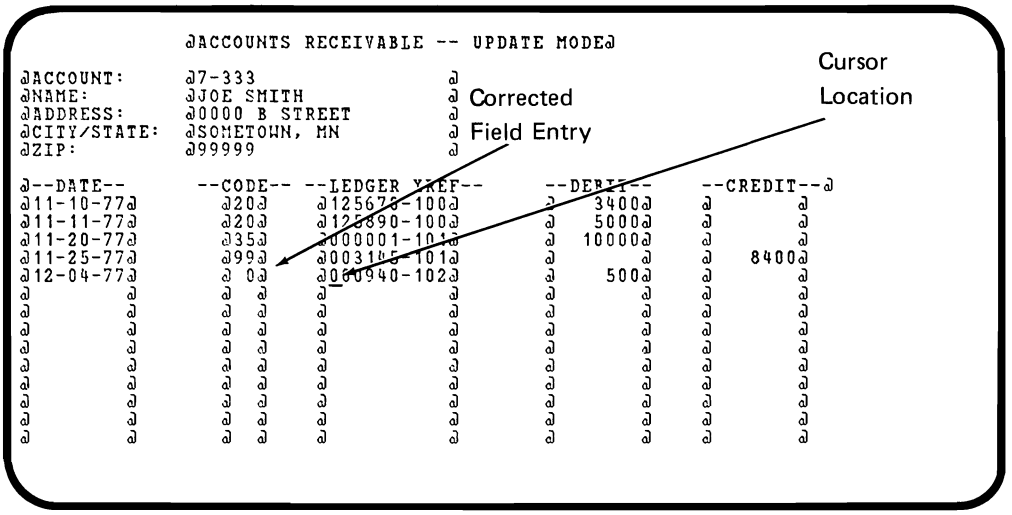


Figure 1-18. Final Display

Printer Data Stream Example

This example shows the contents of a printer data stream. In normal applications, the data stream is a continuous stream of control characters and data; in this example, for purposes of explanation only, the data stream is broken into pieces. The comma is a byte separator. Within the character strings, each character represents 1 byte of EBCDIC code. No attempt has been made to represent the SNA headers or flags. Only the contents of the RU are given in this example. The example given here is a 256-byte block which is the maximum single transmission size. Figure 1-19 illustrates the result of the data stream.

```
34,C4,0B,
```

34

The print position (PP) control character. It establishes the print position where the next two parameters designate it.

C4

The absolute vertical functional parameter of the PP control character. It establishes the vertical print position at the value set by the next parameter.

0B

The hexadecimal value of the vertical print position. In this example, the printing will start on row 11.

```
34,C0,10,'ABC ELECTRIC CO.',
```

34

The PP control character.

C0

The absolute horizontal functional parameter of the PP control character. It defines the print position at the horizontal value given in the next parameter.

10

The hexadecimal value of the horizontal print position. In this example, the beginning horizontal print position is column 16.

ABC ELECTRIC CO.

The data that is written beginning in row 11 and column 16 of the page.

```
15,34,C0,10,1234 SNELLING AVE.,15,34,C0,10,
MINNEAPOLIS, MINN.,15,34,C0,10,55401,
```

15

The hexadecimal code for the new line control character. It positions the printer at the first print position of the next line.

The remainder of this code has the same meaning as the previous code did for the first line printed. These values will cause the printer to align the data given here with the data previously printed.

```
15,15,34,C0,10,XYZ ELECTRIC INC.,
15,34,C0,10,WEST LAKE,
15,34,C0,10,MINNETONKA, MINN.,
15,34,C0,10,55003,
```

The only thing that differentiates this coding from the preceding coding is the use of the 15,15 to insert a blank line between the preceding block of data and this block of data.

```
15,34,4C,03,34,C0,04,92354,
```

In this block of coding, the programmer inserts three blank lines between the previous data and the data being written. This is accomplished by using the relative vertical functional parameter (4C) of the PP (34) control character. The 03 defines the move as three lines down from the last print position.

```
34,C0,10,PARCEL POST,34,C0,22,219614,
34,C0,2E,40280,34,C0,3A,06/07/78,
```

This block of code is writing the data horizontally at print positions 16 (hex 10), 34 (hex 22), 46 (hex 2E), and 58 (hex 3A).

```
15,15,34,C0,04,245-2890,34,C0,10,Insulator,
34,C0,27,2,34,C0,2E,  .73,34,C0,49,1.46,15, etc.
```

This coding skips two lines and then begins to print the data in the positions defined by the parameters of the PP control character. This data stream continues until the entire 256 bytes have been transmitted. The result is shown in Figure 1-19. See the index entry *control characters, printer*.

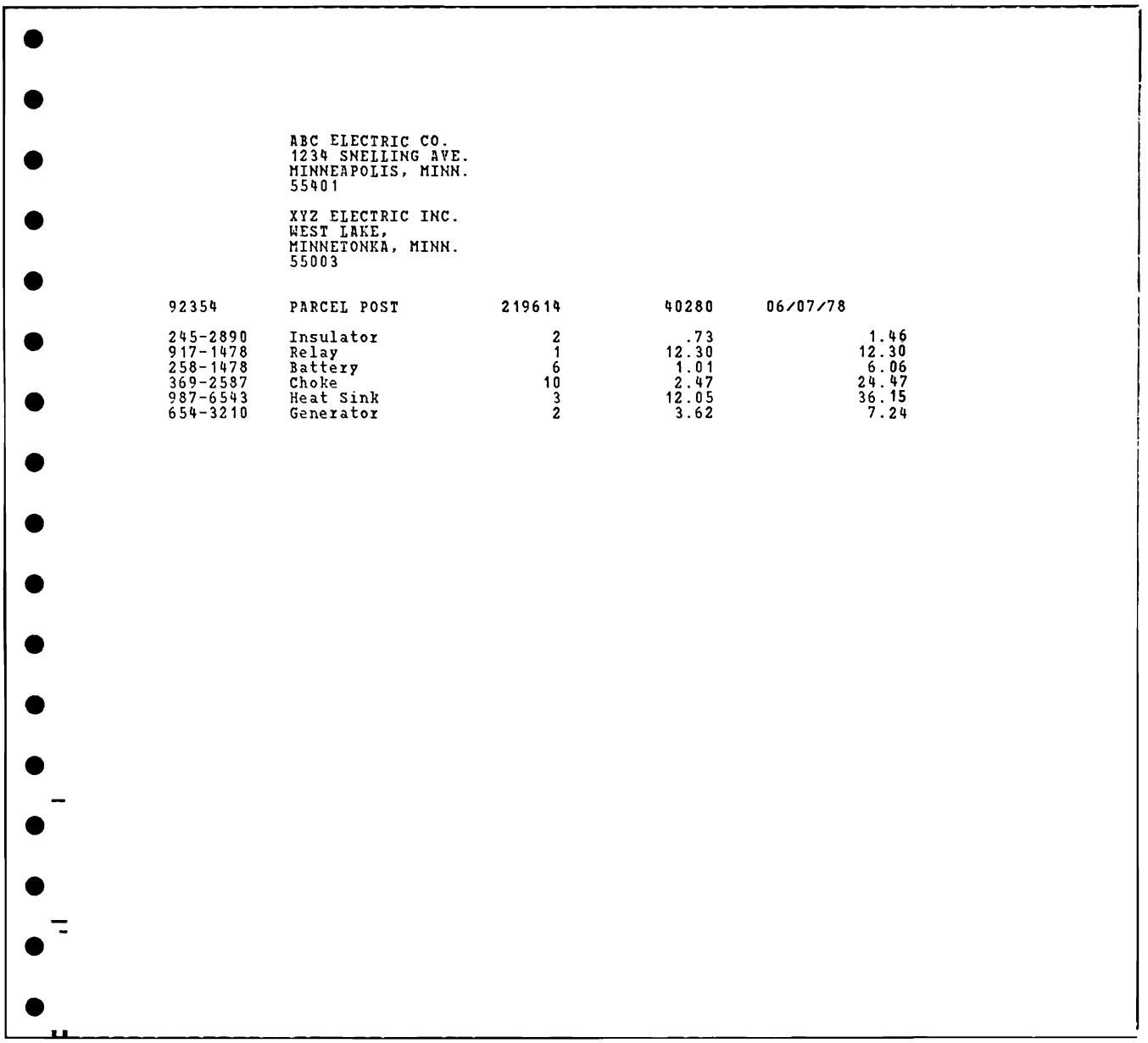


Figure 1-19. Printer Output

Section 2. Encyclopedia

Addresses

The three addresses the controller uses when it is attached to the host system via a communications network are the LSID address, the controller station address, and the work station address.

LSID Address

The local session identification (LSID) is in byte 1 of the SNA transmission header (TH); see the index entry *TH*. This address allows the host system to identify to the controller which specific work station (LU) it wants to communicate with. *Addressing in the 5250 System* in Section 1 of this manual describes the process the user must go through to determine the local address part of the LSID. The local station address is the last 6 bits of the LSID address. The first 2 bits are session type identifiers.

The following chart shows the local station addresses for the 5294 Control Unit. The coordinate of the work station address and the port number is the local station address.

	Work Station Address						
Port	**0**	**1**	**2**	**3**	**4**	**5**	**6**
0	00	01	02	03	04	05	06
1	07	08	09	0A	0B	0C	0D
2	0E	0F	10	11	12	13	14
3	15	16	17	18	19	1A	1B

The following chart shows the local station addresses for the 5251 Model 12 work station controller.

CF Port Switch	CF Port	Work Station Address	LSID Local Address
00	CF1-1	000	000010
	CF1-1	001	000011
	CF1-1	010	000100
	CF1-1	011	000101
00	CF2-5	000	000110
	CF2-5	001	000111
	CF2-5	010	001000
	CF2-5	011	001001
01	CF1-1	000	000010
	CF1-1	001	000011
	CF1-2	001	000011
	CF1-2	000	000100
	CF1-1	010	000101
	CF1-2	001	000101
	CF1-2	010	000101
01	CF2-5	000	000110
	CF2-5	001	000111
	CF2-6	001	000111
	CF2-6	000	001000
	CF2-5	010	001001
	CF2-6	001	001001
	CF2-6	010	001001
10	CF1-1	000	000010
	CF1-1	001	000011
	CF1-3	001	000011
	CF1-2	000	000100
	CF1-3	000	000101
	CF2-5	000	000110
	CF2-5	001	000111
	CF2-7	001	000111
	CF2-6	000	001000
	CF2-7	000	001001
11	CF1-1	000	000010
	CF1-2	000	000011
	CF1-3	000	000100
	CF1-4	000	000101
	CF2-5	000	000110
	CF2-6	000	000111
	CF2-7	000	001000
	CF2-8	000	001001

The 5251 Model 12 keyboard/display address is 000000.

Controller Station Address

The controller station address is in the A part of the SDLC frame (see the index entry *frames*); it allows the host system to address a specific controller. This address is defined by the user and set in the eight rocker switches on the 5251 access panel, or entered from a display station at setup time.

Work Station Address

The work station address is set on the displays and printers to allow the controller to communicate with a specific work station. The work station address is determined by the physical configuration of the user's system. See the *IBM 5250 Planning and Site Preparation Guide*, GA21-9337, for details on setting this address.

ASCII

The 5294 Control Unit supports ASCII configured keyboards but does not support ASCII codes, systems, or work station interfaces.

Aid Codes

The aid code identifies to the host system the function being requested from the keyboard. The aid code is returned via the Read Input or Read MDT command when the operator presses an aid-generating key. See the index entries *display, commands* and *aid-generating keys*.

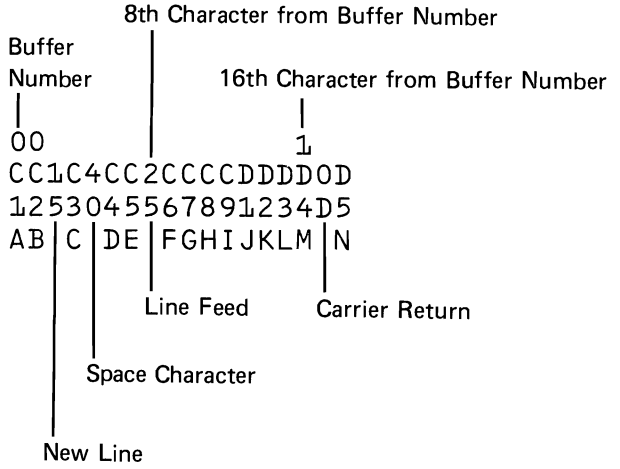
5250 Aid Codes		
Key		**Aid Code Generated (in Hex)**
Command Function Keys	1	31
	2	32
	3	33
	4	34
	5	35
	6	36
	7	37
	8	38
	9	39
	10	3A
	11	3B
	12	3C
	13	B1
	14	B2
	15	B3
	16	B4
	17	B5
	18	B6
	19	B7
	20	B8
	21	B9
	22	BA
	23	BB
	24	BC
Clear		BD
Enter/Rec Adv		F1
Help (not in operator-error mode)		F3
Roll Down (or Page Up)		F4
Roll Up (or Page Down)		F5
Print		F6
Record Backspace		F8
Auto Enter (for Selector Light Pen)		3F

Buffer Print Mode (4224, 5224, and 5225 Printers)

Buffer print mode can be used by the programmer or service representative for problem determination among the printers, controller, and program, and as a software debug tool.

When the printer is operating in buffer print mode, characters and formatting control codes are printed in hexadecimal code with the character representing the code printed below. To aid counting and identification, a hexadecimal count (buffer number) is printed above every sixteenth character and a vertical bar above every eighth character starting from the second character on the left. The second digit on the left column indicates the print buffer used. One line of data prints out as four lines in transparent mode. Formatting control codes are not executed but are treated as data. The default character is printed below the hexadecimal code for the formatting control codes and other unprintable characters.

A sample buffer print mode printout is as follows:



In normal mode, with the SCS control characters executed, the above will print as:

```
AB
C DE
N    FGHIJKLM
```

The 5256 Printer has a similar capability; see the topic *Transparent Mode* in this section.

Procedure for the 4224

The *IBM 4224 Printer Operating Instructions*, GC31-2546, provides a step-by-step procedure in using the buffer print mode for a 4224.

Procedures for the 5224

For the 5224 Printer, buffer print mode is in effect if these procedures are followed: the printer and system are in correct operating condition, the 5224 Attention indicator is blinking, and the Ready indicator is off.

To enter buffer print mode:

1. Load forms at least 375 mm (14.8 inches) wide.
2. Press the Stop switch on the 5224 Printer.
3. Press the Buffer Print switch on the 5224 Printer; the Attention indicator will blink.
4. Press the Start switch on the 5224 Printer; printing in buffer print mode will begin.

To leave buffer print mode, press the Stop switch. For more information about buffer print mode, see the *IBM 5224 Printer Operator's Guide*, GA34-0092.

Procedures for the 5225

For the 5225 Printer, use the following procedures to enter and leave buffer print mode.

To enter buffer print mode:

1. Load forms at least 375 mm (14.8 inches) wide.
2. Press the Stop switch on the 5225.
3. Set the Mode switch on the 5225 to the buffer print position.
4. Press the Start switch on the printer; the Ready light will come on and printing in transparent mode will begin.

To leave buffe. print mode:

1. Set the Mode switch back to the Online position.
2. Press the Stop switch.

For more information about buffer print mode, see the *IBM 5225 Printer Operator's Guide*, GA34-0054.

Note: The 5225 Printer provides a system transparent mode (buffer print transparent mode) in the

SCS control character. See the index entry *printer, code for*.

CD (Change of Direction) Bit

The change of direction bit is bit 2 of byte 2 of the RH. It reverses the normal flow direction and is examined only on RUs with the End Chain indicator on. It is used in the normal flow LU-LU session FM RUs and DFC RUs. See *Protocols and Synchronization for 5250 Implementation of SNA* in Section 1 for more information.

Chaining

The SNA chain carries commands and information between the host system and controller. The length of the chain is not restricted; it can contain multiple RUs. See the index entry *RU*. The first RU is marked first in chain (FIC); the last is marked last in chain (LIC); and all in the middle are marked middle in chain (MIC). The RH that immediately precedes the RU in the SDLC frame contains the information about the position of that RU in the SNA chain (see the index entry *RH*). See also *Protocols and Synchronization for 5250 Implementation of SNA* in Section 1 for a description of how this information is used.

Clock (Synchronous)

The 5251 Model 12 has a clock feature that is offered for external modems that do not provide their own clocking. It is also required when the 1200 bits per second (bps) Integrated Modem feature is installed. The internal clock provides clock speeds of 1200 bps with 600 bps also available for World Trade countries.

Color Alignment (5292 Only)

Color alignment is adjustable with an operator-performed procedure in *select option* mode. (See the index entry *select option mode keys* for information on this procedure.)

Commands

The four types of commands that are described in detail in the following text are: display data stream commands, SDLC commands, SNA commands, and transmission commands.

Display Data Stream Commands

The display commands are in the LU-to-LU flow.

Note: The printer does *not* use Data Stream commands to interface to the host system; it uses an SNA SCS character string or IPDS data stream for the 4224 printer. (The printer does use the Transmission command set that the 5251 Models 2 or 12, or 5294 supplies.) This is referenced by the index entry *control characters, printer*.

Both the display commands and the display responses are found in the SNA RUs. These are routed between the host system and Models 2 and 12, or 5294, in the FM data flow. See Figure 1-13 for a list of the SNA sessions and their contents. The format of the display data stream is:

Escape Character	Command	Associated Data or Parameters	Repeat Sequence or SNA Chain End

The Display commands form two basic categories: the input commands and the output commands.

The following are the commands that the user's output application program uses to control the display:

Input Commands	Output Commands
Read Immediate Read Input Fields Read MDT Fields Read Screen Save	Clear Format Table Clear Unit Clear Unit Alternate Restore Screen Roll Write Error Code Write to Display (See also the index entry *copy to printer feature*.)

For each command, the following text includes function, restrictions, format, and results.

Input Commands

This category consists of immediate and aid-associated Read commands. The immediate commands are those that are executed when the controller receives the command, and the aid-associated commands are those that are queued until the operator presses an aid-generating key such as Enter/Rec Adv. The immediate commands are titled as such; those not labeled as immediate are aid-associated. For details about aid codes, see index entries *aid-generating keys* and *aid codes*.

The host system sends the Read commands to the controller in the LU-LU FM session; when the controller receives the commands, it determines if they are immediate or aid-associated. If they are immediate, they are executed without delay. If they are aid-associated, the controller queues them until it receives an aid code caused by the operator pressing an aid-generating key. These aid-associated commands are held one at a time in a queue until the addressed LU can perform the requested function. When multiple Read commands are sent to a display to be enqueued, only the last one is preserved; the others are overlaid.

Note: When an aid code is serviced, the command is cleared.

Read Immediate (Immediate)

Function: This command sends back the contents of all the input fields on the display.

Restrictions: This command must be the last command in the chain (see *Protocols and Synchronization for 5250 Implementation of SNA* in Section 1), and the controller must have CD (see the index entry *CD*). This command is rejected if the station is in an error, system request, or SS message state.

Note: If the display supports a separate message line, and the message line is selected, the command is rejected only for system request and SS message states. The command is processed with the display in error state.

Format:

ESC	Read Command	LIC or OIC
Hex 04	Hex 72	

Results: The information associated with this command returns to the user in the LU-LU nonexpedited flow. What the user receives when he issues this command depends on the condition of the master MDT bit. See the index entry *MDT bit*.

- If the master MDT bit is not set, the user receives:

  Cursor Address Aid Code

- If the master MDT bit is set, the user receives:

  Cursor Address Aid Code Field Data

The field data consists of the contents of all input fields as they appear on the display unless resequencing has been specified. See the index entry *field control words*. Remember, any attributes contained in a field are treated as data and returned as such. Field boundary attributes are not considered part of the field. All nulls are converted to blanks. If the specified field is a signed numeric field, the last character is not sent; if that same field is negative, the zone position of the next-to-the-last character is changed to hex D.

In each case, the returned cursor address indicates the current location of the cursor and the aid code is hex 00.

Note: Queued Read commands and pending aid codes are not cleared. The format table, display indicators, insert and command modes keying history, and display contents are not affected.

Read Input Fields

Function: This command allows the host system to have the controller send the contents of all input fields defined in the format table.

Restrictions: The operator must press an aid-generating key to execute this command. See the index entry *aid-generating keys*. Also, CD in the RH must be on before the aid byte can be serviced. (See index entry *CD*.) This command is cleared if:

1. The host system issues a session control request (such as Unbind).

2. The host system issues a Clear Unit command and the controller executes it.

3. The host system sends another Read command to the same LU and overlays this command.

4. The Read command is executed.

Format:

ESC	Read	CC	ESC or
Hex 04	Command	(see note)	SNA
	Hex 42		Chain End

Note: This is a 2-byte control character executed after field data read. See the index entry *control characters, display* for details.

Results: The information associated with this command returns to the user in the LU-LU nonexpedited flow. Note that the host system cannot receive this information until the operator presses an aid-generating key. See the index entry *aid-generating keys*. What the user receives when he issues this command depends on the condition of the master MDT bit. See the index entry *MDT bit*.

- If the master MDT bit is not set, the user receives:

  Cursor Address Aid Code

  - Cursor Address: The position of the cursor when the aid-generating key was pressed.
  - Aid Code: The code for the aid-generating key the operator used.

- If the master MDT bit is on, the user receives:

  Cursor Address Aid Code Field Data

  - Cursor Address: The position of the cursor when the aid-generating key is pressed.
  - Aid Code: The code for the aid-generating key the operator used.
  - Field Data: Returned only when one of the following aid-generating keys is used:

    Roll↑ Up
    Roll↓ Down
    Enter/Rec Adv
    Auto Enter
    An unmasked command function key

    When it is returned, the field data consists of the contents of all input fields as they appear on the display unless resequencing has been specified. See the index entry *field control words*.

- If any of the following keys are pressed, the user receives:

  Cursor address
  Clear
  Help
  Print
  Record Backspace in home position

Remember, any attributes contained in a field are treated as data and returned as such. Field attributes are not considered part of the field. All nulls are converted to blanks. All pending aid request bytes are cleared. If the specified field is a signed numeric field, the last character is not sent; if that same field is negative, the zone position of the next-to-the-last character is changed to hex D. Though data is not sent, the CC bytes are processed.

Read MDT Fields

Function: This command allows the host system to ask the controller to send data from only those fields that have been modified. A field is recognized as having been modified if the MDT bit for the field is on. See the index entry *MDT bit*.

Restrictions: The operator must press an aid-generating key to execute this command. See the index entry *aid-generating keys*. In addition, the CD in the RH for the requested LU must be on before any information can be sent back to the host system in response to the command. See the index entry *CD*. The command is cleared if:

1. A session control request (such as Unbind) is issued by the host system.
2. A Clear Unit command is issued.
3. The host system sends another Read command to the same LU and overlays this command.
4. The Read command is serviced.

Format:

ESC Hex 04	Read Command Hex 52	CC (see note)	ESC or SNA Chain End

Note: Two bytes of control characters executed after field data read must be included in this command. These are referenced by the index entry *control characters, display*.

Format of Returned Data

Cursor Address (2 bytes: row, column	Aid Code	SBA Hex 11	Row, Column Address (This address points to the first data character in the field, not the starting attribute.)	Field Data

Results: The contents of each field that has an MDT bit on are returned to the host system in the order that the fields appear in the format table, if one of the following aid-generating keys is used:

Roll↑ Up
Roll↓ Down
Enter/Rec Adv
Unmasked command function keys

If no MDT bits are on or if the operator does not use one of the acceptable aid-generating keys (Clear, Help, Print, Record Backspace), only the cursor and aid code are returned to the host system.

The host system can use field control words to rearrange the sequence in which the fields are returned. See the index entry *field control words* for more details.

If data is returned, the following formatting is done.

If the field is not a transparent data field:

- Trailing nulls are stripped. If the field consists of all nulls, only the SBA, row, and column are returned.
- Leading and embedded nulls are converted to blanks.

If the field is signed numeric, the last character is not sent; if that same field is negative, the zone position of the next-to-the-last character is changed to hex D.

Remember that hex 10 and hex 11 are used as control data; therefore, avoid writing hex 10 and hex 11 to the display as data unless they are written in transparent data fields. See the index entry *field control word* for more information on transparent data fields.

Read Screen (Immediate)

Function: This command causes the contents of the display to go to the host system in the sequence that it appears on the display; for example, row 1 goes first.

Restrictions: This command must be the last command in the SNA chain, and CD must be on. See *Protocols and Synchronization for 5250 Implementation of SNA* in Section 1 and index entry *CD* for more information. The command is rejected when the addressed display is in the prehelp error, posthelp error, system request, or SS message state.

Note: If the display supports a separate message line, and the message line is selected, the command is rejected only for system request and SS message states. The command is processed with the display in error state.

Format:

ESC	Read Command	SNA Chain End
Hex 04	Hex 62	

Results: The content of the entire display, including the attributes, is sent to the host system just as it appears in the regeneration buffer (no formatting or conversion is done). Cursor address and AID are not returned. This command does not clear either pending read commands or aid requests. The keyboard is temporarily locked. The following are unaltered: display indicators, cursor location, modes, keying history, display contents, and format table.

Save (Immediate)

Function: This command allows the host system to save the present display so it can be restored later.

Note: This is accomplished by sending back the data received after a Save operation. See index entry *restore screen command*.

Restrictions: This command must be the last command in the SNA chain and CD must be on. See *Protocols and Synchronization for 5250 Implementation of SNA* in Section 1 and index entry *CD*. The command is rejected if the addressed LU is in either the system request or the SS message state.

Format:

ESC	Save Command	SNA Chain End
Hex 04	Hex 02	

Results: All data required for restoring the display is sent to the host system; it must not be modified by the host system if the result of the Restore command is to have integrity. See index entry *restore screen command*.

On the 5251 Models 2 and 12, approximately 2K bytes are returned to the host system for the 960-character display and approximately 3K bytes for the 1920-character display. On the 5294, the amount of data returned to the host is variable in length, depending on the number and size of the input fields and the actual screen image to be saved. In order to improve response time, the 5294 compresses the screen image, reducing the amount of data that needs to be transmitted to the host and back. This compression is entirely internal to the SAVE/RESTORE code in the 5294 and has nothing to do with SNA support for data compression, which is not supported.

Estimated maximum:	4000 bytes of data for a 24 x 80 display station presentation space
	5200 bytes of data for a 27 x 132 display station presentation space
Estimated typical:	1200 bytes of data for 40 input fields and 50% effective data compression

Read commands and pending aid requests are not cleared when this command is executed. The keyboard is temporarily locked. The display indicators, cursor location, modes (command and insert), keying history, display content, and format table are not affected by this command.

Output Commands

The output commands are Clear, Clear Format Table, Clear Unit, Restore Screen, Roll, Write Error Code, and Write to Display. Some of the commands have associated data and control information (write characters and orders). The control information is not included in this topic; see the index entries *control characters, display* and *orders* for details about these topics. The Write commands are executed immediately.

Clear Format Table

Function: This command clears the format table but does not affect the present display.

Restrictions: The command is rejected if the LU is in an error, system request, or SS message state.

Note: If the display supports a separate message line, and the message line is selected, the command is rejected only for system request and SS message states. The command is processed with the display in error state.

Format:

ESC Hex 04	Clear Format Table Command Hex 50	SNA Chain End or ESC

Results: The following list describes what happens when this command is executed:

- The keyboard is locked.
  - The keyboard clicker is turned off.
  - The Input Inhibited indicator on the display is turned on.
  - The insert mode is cleared (as is the indicator).
  - The command mode is cleared.
- The format table is cleared. The format table header formats like this:

Item	Value
Format ID	Hex 00
First field transmitted to host system	0 (Resequencing is disabled)
Error line	Bottom line of display

- The system insert cursor address is set to row 1, column 1; this clears any previous IC order.
- Any pending aid request is cleared.
- All keying history is cleared.
- The master MDT bit is cleared.
- A blinking cursor caused by waiting for a required field exit key is reset.

Note: Operator-selected reverse image and the Message Waiting indicator are not affected by this command.

Clear Unit

Function: This command clears the display and format table.

Restrictions: The command is rejected if the display is in the SS Message state.

Format:

ESC Hex 04	Clear Command Hex 40	ESC or SNA Chain End

Results: The following describes what happens when this command is executed:

- The keyboard locks.
  - The clicker is turned off.
  - The Input Inhibited indicator is turned on.
  - The error state is cleared.
  - The system request state is cleared.
  - The insert mode is cleared.
  - The command mode is cleared.

- The format table is cleared. Because this is not format level 0, a default header is assumed. See the Clear Format Table command.
- The display is cleared of all characters by nulls being written to the regeneration buffer.
- A nonblinking, nonreverse image with a normal intensity screen attribute is written to the regeneration buffer.
- The cursor position is row 1, column 2.
- The system IC (insert cursor) address is set to row 1, column 1 (clearing any previous insert cursor orders sent by the host system).
- All unserviced aid requests are cleared.
- The history of previous keystrokes is cleared.
- The master MDT bit is cleared.
- If the cursor is blinking, it is reset.
- Pending Read Input or Read MDT commands are cleared.
- If the display supports an alternate presentation space size, the display is reset to 24 x 80 mode.
- The default error line is set either to line 24, or, if supported, to the separate message line.

Note: Operator-selected reverse image and the Message Waiting indicator are not affected by this command.

Clear Unit Alternate

Function: The Clear Unit Alternate command is supported only by the 5294. It performs all the normal Clear Unit functions and also sets the display mode to 132 x 27. Clear Unit is used to set it back to 80 x 24.

Restrictions: This command is rejected when the display is in SS message state. It is also rejected with a 10030101 negative response if the addressed device does not support the alternate display mode and with a 10030105 if the parameter byte has an invalid value.

Format

	Clear Unit	
ESC	Alternate Command	Parameter
Hex 04	Hex 20	see below

Parameter Byte	Meaning
X'00'	Maintain currently defined partition
X'40'	Reset currently defined partition

Note: The distinction between a parameter value of X'00' and X'40' is not significant for the 5294. Both values result in the same action. Other values result in a negative response.

Results: When the Clear Unit Alternate command is executed, the following action takes place:

- The keyboard is locked.
- The keyboard clicker is turned off.
- The Input Inhibited indicator, on the display, is turned on.
- The error state is cleared.
- The system request state is cleared.
- The insert mode is cleared along with the indicators on the display.
- The command mode is cleared.
- The read resequencing is reset.
- All PA/PF keys are set up to return data.
- The default error line becomes the message line.
- The display is cleared of all data by writing nulls to the regeneration buffer.
- The display is set to the 27-row by 132-column presentation screen size.
- An attribute of non-blink, non-reverse image, normal intensity is written into the regeneration buffer at Row 1, Column 1.
- The cursor is placed at Row 1, Column 1.

- The system insert cursor address is set to Row 1, Column 1.
- Any Aid request, not already serviced, is cleared.
- Keystroke processing states are reset.
- The master MDT bit is cleared.
- Blinking cursor is reset.
- The effect of the format table on keyboard shift is cleared.
- Pending Read Input or Read MDT and associated control characters are cleared.

Restore Screen (Immediate)

Function: This command restores the contents of the display by returning data saved in the Save command.

Restrictions: This command is rejected when the station is in a system request or SS message state. To be accepted, the command must be issued to a device that is the same machine type, model, and release as the one that received the Save command.

Format: This is generated via a Save command; therefore, all the operator has to do to execute this command is to return the data received as the result of the Save command.

Results: The following describes what happens when this command is executed:

- These things are restored:
  - Contents of the display.
  - Contents of the format table.
  - State of the keyboard including the insert mode with the indicators and the command mode.
  - Location of the cursor and the way it was displayed.
  - System insert cursor address.
  - State of the master MDT bit.
  - Error code and any explanatory information provided by the host system in the Write Error Code command, if display station was in an error state. The error code and any information are returned via the operator's use of the Help key.
  - Requirements to send LU-LU Lustat when error line is available.
  - Any Read command that was pending at the time.
  - Any aid requests that were outstanding at the time of the Save command.
- Dead key diacritic and hex modes are cleared.
- This data is not restored:
  - Shift and shift indicators
  - State of the Message Waiting indicator
  - Requirement to send SS-LU Lustat when error line is available.
- The following conditions cause a parameter error:
  - Invalid data is detected.
  - The required amount of data is not received.

Note: A Clear Unit command is executed if an error is detected.

Roll

Function: This command allows the lines to be rolled up or down on the display as specified by the size parameter of the command.

Restrictions: The command is rejected if the display is in the prehelp error, posthelp error, system request, or SS message state.

Note: If the display supports a separate message line, and the message line is selected, the command is rejected only for system request and SS message states. The command is processed with the display in error state.

Format:

ESC	Roll	Parameters	ESC or
Hex 04	Command	3 bytes	SNA Chain
	Hex 23	(see note)	End

Note: The following describes the contents of the three parameter bytes:

Byte	Bits	Description
1	0 1-2 3-7	0 = Roll up 1 = Roll down Reserved Number of lines that the designated area is to be rolled
2	0-7	Line number defining the top line of the area that will participate in the roll
3	0-7	Line number defining the bottom line of the area that will participate in the roll

Results: The following describes what happens when this command is executed.

- The display is rolled as designated.
- Lines vacated by the roll are not cleared to nulls.
- The format table is not affected.

  Note: If the display does not conform to the format table, the roll should not be done.

- The lines rolled out of the area are lost (cannot be rolled back onto the screen).
- The state of the keyboard is not affected.
- Pending aid bytes are not affected.
- The following conditions cause parameter errors:
  - A top line of zero
  - A top line greater than or equal to the display length
  - A bottom line of zero
  - A bottom line greater than the display length
  - A top line greater than or equal to the bottom line
  - A roll area greater than the bottom line minus the top line.

Write Error Code

Function: This command allows the host system to force the keyboard into the prehelp error state. See index entry *error states*.

Restrictions: The command is rejected if the display is in the prehelp error, system request, or SS message state.

Note: If the display supports a separate message line, and the message line is selected, the command is rejected only for system request and SS message states. The command is processed with the display in error state.

Data must not exceed 80 characters (1 display line). See Step 9 in the *Results* heading of this topic.

Format:

ESC Hex	Write Error Command Hex 21	IC Order R/C Address Hex 13	Screen Attributes Data	Screen Attributes (see note)	ESC or SNA Chain End
04					

|----------|
These are optional, although at least one of them must be included to make the command valid.

An Insert Cursor (IC) order can appear anywhere within the data. If an IC order is included at a certain display station location, it immediately moves the cursor to that display location without altering the system insert cursor address. All keying history is lost; therefore, field checks such as self check and mandatory fill are inhibited.

If an IC order is not included, the cursor remains where it was at the time of error. See the index entry *IC order*.

Note: The user should include field attributes of his choice, but it is recommended that the leading and trailing attributes be high-intensity blink and nondisplay attributes respectively.

Results: When the operator presses the Help key (prehelp error state only) in response to the error condition, characters from columns 2, 3, 4, and 5 of the error line are returned to the host system in a packed form and sent as a Signal command. These characters form an index code that elicits a user-generated description of the error for the operator. See the index entries *signal command, command and response code* for details.

- The prehelp error state is selected for the keyboard.
- The Input Inhibited indicator is on.
- The keyboard clicker is off.
- The insert mode and insert indicators are cleared.
- The command, dead key diacritic, and hex modes are cleared.
- The cursor is blinking.
- The line in the format table header defined as an error line is saved. See index entry *SOH order*.
- The cursor moves to the location specified by the IC order. If no IC order is given, the cursor does not move.
- All characters (except IC order) found between the command byte and the end of the chain or next ESC are written on the error line. If the data exceeds 80 characters, an error occurs.
- All outstanding aid bytes are cleared.
- When the operator presses Help, the controller places a nonblink high intensity attribute in column 1 of the error line, replacing anything that was previously there.
- The locked state of the keyboard is cleared if the keyboard was locked and the station was not in a posthelp error state; this allows the operator to release the keyboard by pressing the Error Reset key.

The following conditions cause parameter errors:

- Neither an IC order nor data follows the command.
- Invalid IC order.
- More data than 80 bytes is specified.

Write to Display

Function: The Write to Display (WTD) command writes characters and attributes into the display regeneration buffer and creates, adds to, and modifies the format table that is associated with the display.

Restrictions: This command is rejected if the display is in a prehelp error, posthelp error, system request, or SS message state.

If the display supports a separate message line, and the message line is selected, then only system request or SS message state result in a contention state error. If the error line is in use, however, and the Write to Display attempts to redefine the error line (using SOH byte 4), a negative response is generated.

Format:

ESC Hex 04	Write Command Hex 11	CC2 Bytes (See Note 1.)	Orders and Data (See Note 2.)	ESC or SNA Chain End

Notes:

1. CC are the write control characters. See index entry *control characters, display*.
2. The orders are described in detail as referenced by index entry *orders*. Any character that is not an order and not associated with an order is considered data, and is written on the screen at the current display address. The address is then incremented by 1 for each character written. These characters should be hex 00, hex 1C, or above hex 1F, so there is no conflict with the codes reserved for orders.

Results: The display contains exactly what was specified in the control characters and orders:

- The state of the keyboard is not affected by the Write to Display command unless one of the following is specified (in which case the locked state results):
  - An SF order is used to define the input field.
  - An SOH order is present.

- CC byte 1 specifies either clear MDT bits or clear input fields.

- The physical location of the cursor is not affected if the keyboard is in the unlocked state when the Write to Display command is detected, and it remains unlocked after processing the control characters and all orders. For all other conditions, the cursor is moved to one of the following places:

  - The IC order specified by the host system
  - The first nonbypass field
  - Row 1, column 1.

- If the keyboard is in the unlocked state when the Write to Display command is detected, it is possible for the controller to go to the error state between RUs. This results in the command being rejected after being partially processed. This can be avoided by issuing single RU chains when the keyboard is in the unlocked state.

  Note: If initially writing to the display, it is a good practice to issue a Clear Unit command before issuing the Write to Display command to ensure that the format table is not at format level 0. Do not use the Clear Unit command for updating a display.

  The following conditions cause parameter errors:

  - Invalid orders; see the index entry *orders*.
  - No data, orders, or CC follow the command byte.

SDLC Commands and Responses

As described in the heading *Frame-SDLC* in this section, unnumbered and supervisory frames contain commands (and responses) that serve the data link and link level needs of the host system-5250 system communication transfer. Normally, these commands and responses are transparent to the user. They are included in this manual because not all commands and responses available with SDLC are supported by the 5250 system. The following information gives the command and associated response name and tells whether or not it is supported by the 5250 system. The commands and responses are grouped by format type (nonsequenced commands and responses, supervisory format commands and responses, and I frames). Because a user can affect the contents of the XID command, specific bit information about the XID command contents is included in this text.

Unnumbered (Nonsequenced) Commands and Responses

The following commands and responses are supported for all operations:

Commands	Responses	Supported Y = Yes; N = No	Hexadecimal Code	Description
DISC (Disconnect)		Y	53 with P bit	Places the work station in the normal disconnect mode and goes onhook in a switched environment. (See Note 1.)
	UA (NSA) (Unnumbered Acknowledgment/ Nonsequenced Acknowledgment)	Y	73 with F bit	Indicates that the disconnect is complete; the work station is now in a normal disconnect mode (onhook for switched lines).
SNRM (Set Normal Response Mode)		Y	93 with P bit	Places the controller in the normal response mode.
	US (NSA)	Y	73 with F bit	Verifies that the controller is in normal response mode.
Test		Y	F3 with P bit	The user can send a maximum of 256 bytes of data with this.
	Test	Y	F3 with F bit	This returns the data sent with the Test command. (See Note 2.)

Notes:
1. If this command is received when the controller is in normal disconnect mode, the response will be DM.
2. If the data associated with the Test command exceeds 256 bytes, the command is returned with no data.

Commands	Responses	Supported Y = Yes; N = No	Hexadecimal Code	Description
XID (Exchange Station Identifier)		Y	BF with P bit	Requests information about the addressed work station. The controller interrogates byte 16 (LOC) of the XID command. If byte 16 is 7 or less, the controller uses the value; otherwise the default is 7.
	XID	Y	BF with F bit	Returns 20 bytes of information about the work station. See XID in this topic for details.
	FRMR (CMDR) (Frame Reject/ Command Reject)	Y	97 with F bit	This is sent in the normal response mode. It is sent when there is an invalid command, there is data in a command where data is not acceptable, or the Nr count is out of range in either direction (see note).
	Disconnect Mode (DM)	Y	1F with F bit	Indicates that the controller is in normal disconnect mode (see note).
Note: FRMR (CMDR) or DM will never be returned as a response to XID or Test.				

The following commands and responses are supported by the 5251 Model 2 or Model 12 for loop operation only. If they are received when your system is in a loop operation, they will be treated as nonsupported commands.

The 5294 does not support loop operations and will send FRMR and accept CFGR in normal response mode.

Commands	Responses	Supported Y = Yes; N = No	Hexadecimal Code	Description
NSP (UP) (Nonsequenced Poll/ Unnumbered Poll)		Y, if loop operation.	23 without P bit 33 with P bit	Used to solicit information or responses from loop terminals.
CFGR (Configure)		Y, if loop operation.	C7 without P bit D7 with P bit	Used for diagnostic purposes.
	CFGR	Y, if loop operation.	C7 without F bit D7 with F bit	If a data byte is received with the response, the controller has accepted the CFGR command.

The contents of the XID response are as follows:

Byte	Bits	Code (X = Hex and B = Binary)	Meaning
0	0-3 4-7 PU.T1 (FID3).	B'0001' B'0001'	Variable format.
1	0-7	X'14'	XID information field length.
2-5	0-11 6-11 12-15 16-23 24-31	B'000000100000' (5251) B'000001000101' (5294) B'0000' B'00000000' B'--------'	Block number. Specific ID. (See Note 1.)
6-7	0-15	X'0000'	Reserved.
8		X'00'	Configuration flags.
Configuration Code for Secondary Station			
9	 0 0 1 2-3 4-7	 B'1' (5251) B'0' (5294) B'0' B'11' B'0000'	PU characteristics. (See Note 2.) PU can receive FM RUs from SS. Reserved. Reserved. No segments allowed. Reserved.
10-11	 0-15	 X'0105'	Maximum length for receive. (See Note 3.) Maximum length of information field is 261 bytes.
12	 0-3 4-7	 B'0000' B'0000'	SDLC command profiles. Reserved. SNA set. (See Note 4.)

Notes:

1. Bits 24 through 31 contain the controller station address. See the *IBM 5250 Planning and Site Preparation Guide*, GA21-9337, for details on setting this address.
2. This field describes the restrictions, if any, on the PU the user is using.
3. This is a binary count of the maximum number of bytes in the information field. Bit 0 is a flag.
4. Bits 4 through 7 of byte 12 contain the SDLC function profile. Value X'0' defines the SNA link set. The SNA link set is:

Commands	Responses
I-frames	I-frames
RR	RR
RNR	RNR
TEST	TEST
XID	XID
SNRM	NSA (UA)
DISC	DM FRMR (CMDR)

Byte	Bits	Code (X = Hex and B = Binary)	Meaning
13			SDLC function flags.
	0	B'0'	Reserved.
	1	B'0'	Reserved.
	2	B'0'	SIM and RQI (RIM) not supported.
	3-7	B'00000'	Reserved.
14	0-7	X'00'	Reserved.
15	0-7	X'00'	Reserved.
16	0-7	X'03' or X'07'	Maximum out count (see note).
17-19		X'00'	Reserved.

Note: This is the maximum number of consecutive frames the controller is able to accept. It will always be either 3 or 7 for the 5251, and 7 for the 5294.

Supervisory Format Commands and Responses

Commands	Responses	Supported Y = Yes; N = No	Hexadecimal Code	Description
RR (Receiver Ready)		Y	Variable	Host system is ready but has no data to send the controller; it is asking if the controller has data to send. This also acknowledges previously sent data (see note).
	RR (Receive Ready)	Y	Variable	The controller is ready but it has no data to send the host system at this time. This also acknowledges previously sent data.
	RNR (Receiver Not Ready)	Y	Variable	There are no available buffers; therefore, no I frames from the host system can be accepted. This also acknowledges previously sent data.
	I Frame	Y	Variable	This contains the SNA RUs from the controller.
RNR (Receiver Not Ready)		Y	Variable	There are no available buffers; therefore, the host system cannot accept any I frames from the controller (see note).
	RNR (Receiver Not Ready)	Y	Variable	Same meaning as RNR command. This also acknowledges previously sent data.
	RR (Receiver Ready)	Y	Variable	The controller is ready, but it has no data to send at this time. This also acknowledges previously sent data.
Note: FRMR (CMDR) or DM may be sent as a response.				

Nonsupported Commands and Responses

The following commands and responses are not supported by the controller. If these commands are received while the controller is in normal disconnect mode, the response will be DM. If these nonsupported commands are received while the controller is in normal response mode, the response will be FRMR (CMDR).

Command	Response	Description
NSI (UI) (Nonsequenced Information/ Unnumbered Information)		Command contains nonsequenced (unnumbered) information.
	NSI (UI)	Response contains nonsequenced (unnumbered) information.
	SIM (Set Initialization Mode)	Command is dependent on system use; consult your host system documentation.
	RQI (RIM) (Request/ Initialization/Request Initialization Mode)	Initialization needed; expect SIM.
	RQD (RD) (Request Disconnect)	Request to be placed in disconnect mode.
REJ (Reject)	REJ (Reject)	Transmit, starting with frame Nr. Retransmit, starting with frame Nr.

I Frame SDLC Responses

The I frames contain the SNA RUs and all the information and data that the 5250 devices use. The *SNA Commands* and *Display Data Stream Commands* descriptions within this topic give detailed information about the contents of the I frames. The host system can send I frames to a controller that has responded Receiver Ready (RR). The controller can send I frames to the host system when it receives either an I frame with the P (poll of the P/F) bit on or a Receiver Ready command from the host system. Remember, the control field of the SDLC frame contains sequence count information for the I frames; the RU is contained in the information fields of the I frames. See the index entry *frames* for details.

SNA Commands

These are the commands that the host system uses to control the LU. Normally, these commands and responses are supplied by IBM. However, it is possible for the user to affect some of these commands and responses; therefore, the commands and responses available to the user are described in detail in this text. The SNA commands supported by the controllers are:

Actlu	Reqms
Bind	Reqtest
Cancel	Rshutd
Dactlu	Signal
Lustat	Unbind
Recfms	

SNA Session Flow and *Synchronization of 5250 Implementation of SNA* in Section 1 describe the session types and paths these commands take. They also describe typical usage of these commands. The following text describes the individual SNA commands and responses, and details the bit meanings of the commands and responses that the user can affect.

Activate Logical Unit (Actlu)

This command is sent by the host system to the controller on the SS-LU expedited flow; it synchronizes the flow of system request data. When the host system receives acknowledgment of the Actlu by the controller, an SS-LU session is said to be established.

This is the format of the Actlu command:

Byte	Hex Code	Meaning
0	0D	Request code
1	01 02	Cold activation ERP activation
2	01	FMP profile, TSP profile

This is the format of the Actlu response:

Byte	Bit	Code (X = Hex; B = Binary)	Meaning
0		X'0D'	Response code
1		X'01'	Cold activation
2		X'01'	FMP,TSP
3		X'00'	
4		X'84'	Maximum SS RU = 128 bytes
5	0-1 2 3-7	B'10' B'00' B'0' B'1' B'00000'	RUs allowed on SS flow (display station) RUs not allowed on SS flow (printer) LU is able to process RUs LU is unable to process RUs, including Bind **Note:** Lustat is sent informing the SS if the LU changes its available state. (See *Lustat* in this topic.)
6		X'00'	
7		X'00'	
Note: When the LU becomes available, the controller issues a Lustat 0831 command on the SS/LU normal flow.			

The controller sends a negative response (-rsp) to the host system if the Actlu type is not supported. See the index entry *negative responses* for details.

Bind

The Bind request is sent by the host system to the controller on the LU-LU expedited flow. It establishes an LU-LU session between the host system and the requested work station (LU). The controller never sends a Bind request. It returns either a positive or negative Bind response in answer to a Bind request from the host system; the controller returns a negative response when there is an invalid Bind parameter or invalid Bind type, or when the LU is already in session.

If the Bind that the host system sends the controller is supported (negotiable Bind), the Model 2 or Model 12 sends the parameters that it wants the host system to use in the session. The controller does not check the length of a Bind request. It checks only bytes 0, 1, 8, 9, 10, and 25. The Bind request consists of 26 bytes of RU. The meanings of the bytes and bits that are checked by the controller are given in the following table.

Bind Request Contents Checked by Controller

Byte	Bits	Description	Code (X = Hex; B = Binary)
0	0-7	Request code	X'31'
1	0-7	Format	X'00' supported; -rsp if not supported. See the index entry *negative responses.*
8		Pacing from controller to host system	
	0	Stage of pacing from controller to host system	B'0' = 1-stage pacing. B'1' = 2-stage pacing.
	1		B'0'
	2-7	Pacing count to be used when the controller is sending to the host system	B'_____'
9	0-1		B'00'
	2-7	Pacing count to be used when the host system is sending to the Model 2 or Model 12 (see Notes)	B'_____'
10	0-7	Maximum RU size for RUs sent from the Model 2 or Model 12 to the host system	Must be ≥X'85' or -rsp is returned. See the index entry *negative responses.*
25	0-6	Reserved	B'0' = No IPL
	7	IPL	B'1' = Do IPL (5294 only)

Notes:
1. If byte 9 contains either 1 or 2, the controller uses the count supplied in the Bind request. If it is any other value, the controller sets the pacing count to 3 when received for the printer.
2. If bits 2 through 7 of byte 9 are not 0 for the displays, the controller sends a negative response (indicating invalid session parameters) because the display LUs do not allow pacing of received RUs.

When the controller receives the Bind request from the host system, it issues a Bind response. The host system should check the Bind response to verify that it is compatible with the request or that it can support any changed parameters.

The Bind response depends on the type of LU (type 04 or 07) requested. The printer issues one kind of response and the display station another. These are detailed in the following table.

Bind Response for Printer (LU Type 04)				
Byte	**Bits**	**Description**	**Code (X = Hex; B = Binary)**	**Notes**
0	0-7	Code	X'31'	
1	0-3	Format	X'0'	
	4-7	Type	X'0'	Negotiable.
2	0-7	FMP	X'07'	FM profile 7.
3	0-7	TSP	X'07'	TS profile 7.
4		FM usage		Host systems send protocols.
	0	Chaining use	B'1'	Multiple RUs can be used.
	1	RQ mode	B'1'	Delayed RQ may be used.
	2-3	Chain response	B'11'	RQE or RQD.
	4-5	Reserved	B'00'	
	6	Compression	B'0'	No compression
	7	Send end bracket (EB)	B'0'	Bind response receiver will not send end brackets (EB).
5		FM usage		Bind response sender's send protocols.
	0	Chaining use	B'1'	Multiple RU chains can be sent.
	1	RQ mode	B'0'	Immediate request mode.
	2-3	Chain response	B'11'	RQE or RQD.
	4-5	Reserved	B'00'	
	6	Compression	B'0'	No compression.
	7	Send EB	B'0'	Bind response sender will not send EB.
6		FM usage		Common usage.
	0	Reserved	B'0'	
	1	FM headers	B'0'	Not supported.
	2	Brackets	B'0'	Reset in bracket state.
	3	Bracket term rule	B'1'	Rule 1 termination.
	4	Code set	B'0'	No alternate code supported.
			B'1'	Alternate code supported.
	5-7	Reserved	B'000'	

Bind Response for Printer (LU Type 04) (continued)				
Byte	**Bits**	**Description**	**Code (X = Hex; B = Binary)**	**Notes**
7		FM usage		Common usage.
	0-1	FM transaction mode	B'10'	HDX-FF.
	2	Recovery responsibility	B'0'	Host system responsible for ERP.
	3	Contention winner/loser	B'0'	Bind response sender is contention winner.
	4-6	Reserved	B'000'	
	7	HDX-FF reset states	B'1'	Bind sender reset to send.
8		TS usage fields		
	0	Staging indicator for 5251 Model 2 or Model 12 to host system direction	B'__'	Echoed from Bind request.
	1	Reserved	B'0'	
	2-7	Bind request/receivers send pacing count	B'____'	Echoed from Bind request.
9	0-1	Reserved	B'00'	
	2-7	Bind request receivers receive pacing count	B'000011'	(Unless sent by the host system as a 1 or 2.)
10	0-7	Maximum RU sent by Bind request receiver	X'85'	Inbound 256 bytes maximum.
11	0-7	Maximum RU sent by Bind sender	X'85'	Outbound 256 bytes maximum.
12	0	Staging indicator Bind RQ sender-receiver direction	B'__'	Echoed from Bind request.
	1	Reserved	B'0'	
	2-7	Bind RQ sender: send pacing count	B'000011'	
13	0-1	Reserved	B'00'	
	2-7	Bind RQ sender: receive pacing count	B'____'	Echoed from Bind request.

Bind Response for Printer (LU Type 04) (continued)				
Byte	**Bits**	**Description**	**Code (X = Hex; B = Binary)**	**Notes**
14	0 1-7	PS usage format LU type	B'0' B'0000100'	Basic format. LU type 04.
15-18		Bind sender's send capability		
15	 0 1 2-7	Printer data stream profile Base displacement GSD subset	 B'1' B'1' B'000000'	 Base displacement supported. GSD subset supported. Not supported.
16	0-7	Additional media	X'00'	No additional media.
17	 0-3 4-7	Console Console definition Reserved	 B'0000' B'0000'	 No console.
18	 0 1-7	FM/FMH usage field SS FM data FM header bits	 B'0' B'0000000'	 Not supported. No FM headers.
19-22	0-7	Bind receiver's send capability	X'00'	No send capability.
23	 0-3 4-7	Code selection repertoire	 B'1000' B'0000'	 EBCDIC if no alternate code. No alternate code.
24	0-7	General	X'00'	Attended mode assumed.
25	0-7	NCI characteristics	X'00'	No NCI supported.
25	0-6 7		B'0000000' B'0' B'1'	(5294). No IPL. Do IPL.
26-Q		These are not returned and therefore are implied X'00'.		

Bind Response for Display (LU Type 07)				
Byte	**Bits**	**Description**	**Code (X = Hex; B = Binary)**	**Notes**
0	0-7	Code	X'31'	
1	0-3	Format	X'0'	
	4-7	Type	X'0'	Negotiable.
2	0-7	FMP	X'07'	FM profile 7.
3	0-7	TSP	X'07'	TS profile 7.
4		FM usage		Host systems send protocols.
	0	Chaining use	B'1'	Multiple RUs can be sent.
	1	RQ Mode	B'0'	Delayed RQ may not be sent.
	2-3	Chain response	B'11'	RQE or RQD.
	4-5	Reserved	B'00'	
	6	Compression	B'0'	No compression.
	7	Send end brackets (EB)	B'0'	Bind response receiver cannot end bracket.
5		FM usage		Bind response sender's send protocols.
	0	Chaining use	B'1'	Multiple chains can be sent.
	1	RQ mode	B'0'	Immediate request mode.
	2-3	Chain response	B'11'	RQE or RQD.
	4-5	Reserved	B'00'	
	6	Compression	B'0'	No compression.
	7	Send end brackets (EB)	B'0'	Bind response sender will not send end brackets.
6		FM usage		Common.
	0	Reserved	B'0'	
	1	FM headers	B'0'	Not supported.
	2	Brackets	B'0'	Reset in bracket state.
	3	Bracket term rule	B'1'	Rule 1 termination.
	4	Code set	B'0'	No alternate code supported.
			B'1'	Alternate code supported.
	5-7	Reserved	B'000'	

Bind Response for Display (LU Type 07) (continued)				
Byte	**Bits**	**Description**	**Code (X = Hex; B = Binary)**	**Notes**
7		FM usage		Common.
	0-1	FM transaction mode	B'10'	HDX-FF.
	2	Recovery responsibility	B'0'	Host system responsible for ERP.
	3	Contention winner/loser	B'0'	Bind response sender is contention winner.
	4-6	Reserved	B'000'	
	7	HDX-FF reset states	B'1'	Bind sender reset to send.
8		TS usage fields		
	0	Staging indicator for 5251 Model 2 or Model 12 to host system direction	B'__'	Echoed from Bind request.
	1	Reserved	B'0'	
	2-7	Bind request receiver's send pacing count	B'_____'	Echoed from Bind request.
9	0-1	Reserved	B'00'	
	2-7	Bind request receiver: receive pacing count	B'000000'	No pacing supported on display.
10	0-7	Maximum RU sent by Bind request receiver	X'85'	Inbound 256 bytes maximum.
11	0-7	Maximum RU sent by Bind sender	X'85'	Outbound 256 bytes maximum.
12	0	Staging indicator Bind RQ host to 5251 Model 2 or Model 12	B'__'	Echoed from Bind request.
	1	Reserved	B'0'	
	2-7	Bind request sender's send pacing count	B'000000'	

Bind Response for Display (LU Type 07) (continued)				
Byte	**Bits**	**Description**	**Code (X = Hex; B = Binary)**	**Notes**
13	0-1 2-7	Reserved Pacing count	B'00' B'XXXXXX'	Same as Bind request.
14	0 1-7	PS usage format LU type	B'0' B'0000111'	 LU type 07.
15-23		Reserved	X'00'	
24	 0 1-7	 Reserved Screen Size	 B'0' B'0000010' B'0000011'	 Character display with 24 rows. Character display with 12 rows.
25	0-7	Reserved for 5251	Reserved	X'00'
25	0-6 7	IPL for 5294 IPL bit	B'0000000' B'0' B'1'	 No IPL. IPL.
26-Q			These are not returned; therefore, they have the implied value X'00'.	

The following describes transmission subsystem profile (TSP) and function management profile (FMP) as referred to in the Bind command and responses, and as implemented by the controller:

- *TSP:* The controller supports TSP-7, which has these characteristics:
  - Allows bidirectional pacing on the normal flow
  - Does not allow SDT, CLEAR, RQR, and STSN
  - Allows for the specification of the maximum RU size for FM data in the TS usage field in the Bind request.
- *FMP-7*
  - Allows multiple RU chains
  - Uses HDX-FF FM transaction mode
  - Supports these DFC functions: Cancel, Lustat, Rshutd, and Signal.

Cancel

The controller sends this command to the host system on LU/LU normal flow when it is sending chains and it encounters an error that can affect the integrity of the data. The host system sends this command to the controller any time it wishes to prematurely end a chain; for example, the host system may send this in response to a negative response received from the controller. The effect of the command is the cessation of all RU chaining. The format of the command is hex 83. The positive response to an RQD request for this command is also hex 83.

When the host system issues the Cancel command to the printer, the controller purges the print buffers and issues a positive response.

See *Protocols and Synchronization for 5250 Implementation of SNA* in Section 1 and index entry *negative responses* for additional details.

Deactivate Logical Unit (Dactlu)

This command is sent by the host system to the controller and to the printer on the SS-LU expedited flow. The Dactlu command terminates the SS-LU and LU-LU session when received by the controller.

The code is:

Command byte request code = hex 0E; response code hex 0E.

Logical Unit Status (Lustat)

This command is sent by the controller to report (1) the correction of a previously reported unavailable status of a 5250 component (hex 0001 on the SS/LU normal or LU/LU normal), or (2) that an unavailable condition for the LU has occurred (hex 0831 on the SS/LU normal). In addition, Lustat 0002 is also sent by the printer when it receives CD in the LIC or OIC of an RU.

The format for the controller's Lustat is:

Hexadecimal Code	Meaning	Flow
00020200	There is no data to send (printer only).	LU/LU normal
00010000	LU was unavailable, but is available now.	LU/LU normal SS/LU normal
0000yyzz	No-op used to report error conditions. (See the legend below.)	LU/LU normal
08310000	LU not available.	SS/LU normal

Legend:

yy = 01 This reports a parameter error found during a read operation.
zz = Error code for the error causing the Lustat.
03 = Resequencing error

02 This reports a parameter error found during the processing of a feature field.
zz = Error code for the error causing the Lustat.
86 = Feature requested not installed
87 = Self-check field greater than 33 bytes specified
88 = Self-check modulus specified but not supported

Any Lustat issued by the host system is unexpected; the controller will supply a positive response. The controller must have the CD on to send the Lustat on the LU/LU normal flow.

Record Formatted Maintenance Statistics (Recfms)

This command is concerned with the error log. Recfms can be either a solicited or an unsolicited command. This command can only be sent by the controller on the SS/PU normal flow.

Solicited Recfms: When there is no overflow condition and the host system wants the error log, the host system sends the Reqms command to the controller. This requests immediate sending of the error log to the host system. The controller immediately sends the error log contents via the Recfms command. (See the index entries *errors, error log*.)

Unsolicited Recfms: When an overflow condition exists, the controller immediately sends the Recfms command to the host system. It does this by prefixing the Recfms command to the error log data.

Note: Remember that the error log is cleared when unsolicited Recfms or solicited Recfms are used and Reqms byte 7 bit 0 = 1.

If byte 7 of the Reqms command has bit 0 = 0, the error log is not cleared. If the host system does not have a buffer allocated to collect the contents of the error log, valuable information for diagnostic maintenance could be lost.

The format of the Recfms command is:

Byte	Bit	Hex Code	Description
0		41	Network services (physical services)
1		03	Maintenance code
2		84	Request code
3-4			Reserved
5-6			Set to 0
7	0 1-7		0 = log overflow 1 = sent in reply to Reqms B'0000100'
8-13			XID data
14		FF	Log segment
15-255			Error statistics

The response format consists of bytes 0 through 2 in this chart.

Request Maintenance Statistics (Reqms)

This command is concerned with the error log and can only be received by the 5294 during SS/PU normal flow.

The format of the Reqms command is:

Byte	Bit	Hex Code		Description
0		41		Network services (physical services)
1		03		Maintenance services
2		04		Request code
3-4				Reserved
5-6				Set to 0
7	0	84 04	B'1' = 'B'0 =	Reset log after sending it No reset log after sending it
	1-7			Type data 1 (5294) or 4

Request Test Procedure (Reqtest)

Whenever the operator keys the test request sequence (see the index entry *test request keys*), the controller sends the following Reqtest command to the host system:

Byte	Hex Code	Description
0	01	Network services
1	03	Maintenance services
2	80	Request code (test)
3	00	Network name 1
4	00	Network name 2
5	00	Procedure name
6	00	Requester ID
7	00	Password
8	00	User field

Normally, the host system sends back a test menu in response to this command. This menu allows the operator to determine which tests to use. The Reqtest command is sent in the SS-LU normal flow as formatted, FM, nonexpedited data with RQD specified.

Note: The controller does not support receiving this command from the host system.

Request Shutdown (Rshutd)

Because the controller has sensed a hardware error, it sends the Rshutd command to terminate the LU-LU session. This command is sent on the LU/LU expedited flow; it is followed by Lustat hex 08310000 to indicate that this LU is not available. The host system should respond to this command by sending an Unbind command. The error log contains explanatory information (See the index entry *errors, error log.*) The user can access this information by using the Reqms command. See the index entry *reqms command*. The controller does not support receiving an Rshutd command from the host system. The command code is hex C2.

Signal

The Signal command is an expedited means of alerting session partners of an occurrence or request that needs attention. This command is sent on the LU/LU expedited flow. Some examples of such occurrences or requests follow:

- The receiving partner wishes to send data. The operator presses the Attn key and the controller issues a Signal command to the host system.
- Intervention is required for the printer. For example, the printer has no forms left for printing. The controller sends the host system a Signal command.
- A previous condition that required intervention has been cleared. For example, forms have been loaded into the printer. The 5251 controller sends the host system a Signal command.
- The operator requires assistance in an error state, so the operator presses the Help key. The controller sends the host system a Signal command.
- The Message Waiting indicator needs to be turned on or off. The host system sends the controller a Signal command.

The format for the Signal command is:

Byte	Hex Code	Description
0	C9	Command code
1-4	00 01 00 01	Request to send (Attn key pressed on the display station).
	00 03 02 xx	Printer intervention required (for **xx** descriptions, see the following charts).
	00 00 00 02	Component now available (operator has cleared the error on the printer).
	00 00 00 01	Signal operator (turns on the Message Waiting indicator and sounds the Audible Alarm).
	00 00 00 05	Resets the Message Waiting indicator.
	00 02 yy yy	Signal help code. **yyyy** is 4 digits of packed decimal code indicating either (1) operator error or (2) information sent by a previous Write Error Code command. See index entry *operator error codes*.

5224/5225 Printer		
xx	**Description**	**Logged?**
26	Graphic check	No
30	Reserved	
31	Control and sense card	Yes
32	Actuator carrier servo card	Yes
34	Driver/servo card/motor	Yes
35	Overcurrent	Yes
36	Emitters	Yes
37	Reserved	
38	Actuator carrier speed	Yes
39	Undetermined	Yes
50	End of forms	No
51	Not ready	No
80	Reserved	
81	High voltage	Yes
82	Reserved	
83	DOT image generator	Yes
84	Wire latch card	Yes
85	Pedestal	Yes
86	Actuator group jumpers	Yes
87	Timers	Yes
88	Ribbon jam	Yes
89	Ribbon card	Yes

5256 Printer		
xx	**Description**	**Logged?**
26	Graphic error	No
30	Printer mechanism not ready	Yes
31	Wire check	Yes
32	Invalid status	Yes
33	Fast speed check	Yes
34	Emitter sequence check	Yes
35	No emitters	Yes
36	Overrun error	Yes
37	Forms stop	Yes
38	Forms position lost	Yes
39	No status byte after error flagged	Yes
50	End of forms	No
51	Printer not ready and not available	No

Unbind

The host system sends this command to the controller on the LU-LU expedited flow; this command terminates the LU-LU session. The controller accepts and executes any valid Unbind command when the LU is in an LU-LU session. The result of this command is that all LU-LU session parameters and SNA states are reset. The controller sends the host system a positive response and hex 32 to indicate to the host system that the command execution is complete.

The format of the Unbind command is:

Byte 0 = Unbind code (hex 32)
Byte 1 = Status (See note.)

Note: Any status code is acceptable here.

Transmission Commands

The controller implements the transmission protocol and command set to drive the attached LUs. These are transparent to the user; therefore, this text does not include details about transmission commands or responses.

Common Carrier Services

Communications services are provided throughout the U.S.A. and in other countries by privately owned (but government regulated) companies. In other countries, the services may be provided by the government and are usually referred to as post telegraph telephones (PTTs).

Domestic Services

Nonswitched Voice Grade Communication Lines (3002 Channel Equivalent) and Nonswitched Metallic Lines

These lines may operate at speeds up to and including 19.2K bps using IBM- or OEM-supplied modems. The actual operating speed is determined by the modem used and the line type and quality available.

- IBM 1200, 2400, or 4800 bps integrated modems for the 5251 Models 2 or 12 and IBM 3863, 3864, 3865, and 3872 external modems operate on a Type 3002 basic channel. See note.
- IBM 3874 (4800 bps) modems operate on a Type 3002 channel with C-1 conditioning.
- IBM 3875 (7200 bps) modems operate on a Type 3002 channel with C-2 conditioning.
- OEM modems that are compatible with the 5251 Models 2 and 12 may operate at speeds of up to 9600 bps on a 3002 channel with conditioning as required by the modem. The 5294 Control Unit operates from 2400 bps to 19.2K bps.

Note: In some cases, the IBM 3865 may require a Type 3002 channel with D-1 conditioning for the Model 1 and D-2 conditioning for the Model 2. Check with your modem supplier for details.

X.21 Public Data Networks

These lines operate at speeds of 2400 to 48,000 bps and are connected to the 5294 Control Unit with the X.21 Adapter feature. These lines can be circuit switched or nonswitched.

Common Carrier Switched Telephone Network

These lines may operate at speeds of up to 9600 bps. The line speed is determined by the modems and the network used.

AT&T's Private Line Data-Phone Digital Service[1]

These lines operate at 2400, 4800, or 9600 bps and connect to a system or 5251 Models 2 or 12, and up to 56,000 bps for the 5294 via an AT&T Channel Service Unit or Data Service Unit.

World Trade Common Carrier Services

Nonswitched Voice Grade Communication Lines

These lines operate at speeds of up to and including 9600 bps. However, most post telegraph telephones (PTTs) do not provide services equivalent to the 3002 channel, with its various types of conditioning which is available in the United States. The type of line used depends on the modem chosen and is either a *Normal Quality Line* designated Type M.1040 (for international service) or a *Special Quality Line* Type M.102 (for international service Type M.1020).

The selection of modems and operating speeds may be limited by PTT rules and regulations or by line types available.

Common Carrier Switched Telephone Network

These lines operate at speeds of up to 4800 bps for the 5251 Models 2 or 12 and up to 9600 bps for the 5294, and use IBM, OEM, or PTT modems. PTT modems are mandatory in some countries.

The selection of modems and/or operating speeds or

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1 Trademark of the American Telephone & Telegraph Co.

network types may be limited by PTT rules and regulations or by line types available.

5294 Communications Features

The 5294 Control Unit must have one of the following communications features installed to operate on a communications network.

- EIA/CCITT Interface Adapter
- XLCA Adapter
- Digital Interface Adapter.

The configuration and other communications controls for these features are described in the *IBM 5294 Setup Procedures* manual. All of the communications features for the 5294 can be field installed by service personnel. The following topics briefly discuss the communications features for the 5294. Detailed information on the 5294 communications is contained in this section, organized alphabetically by topic.

EIA/CCITT Interface Adapter

This feature is required to connect the 5294 Control Unit to external data circuit-terminating equipment (DCE). The adapter interfaces to a synchronous DCE which complies with the electrical/physical criteria of RS232C and CCITT Recommendations V.24/V.28 (This adapter is also used for X.21 bis DCE). With this adapter, the 5294 supports communications speeds of 2400 bps through 19.2K bps. For countries other than the U.S.A., a Primary/Secondary Line Speed switch is provided to enable half-speed operations.

XLCA Adapter

The XLCA Adapter feature allows the 5294 to attach to the following:

- X.21 Public Data Network
- X.25 Packet Switching Network.

This adapter provides interface circuits and electrical characteristics described in CCITT Recommendation X.24/X.27 (V.11) and operates as described in CCITT Recommendation X.21. With this adapter, the 5294 can operate from 2400 bps up to 48,000 bps.

Digital Data Service Adapter (DDSA)

The DDSA allows the 5294 to attach to the AT&T Private Line Data-Phone Digital Service Network. The adapter enables connection to the AT&T Channel Service Unit or equivalent. With this adapter, the 5294 can operate up to 56,000 bps.

Communications Network Errors

If a network error occurs while a display station is being used, the keyboard locks and a 4-digit error code is displayed. The error codes and a brief description of each error are contained in the following list. The type of network the error applies to is shown in the right column (Y = yes, N = no). For complete instructions on recovery and problem determination, see the *Operator's Guide* for the appropriate device.

Error Code	Meaning	SDLC Switched	SDLC Nonswitched	X.25	X.21 Switched
0040	The modem/DCE is not ready when expected to be ready.	Y	Y	Y	Y
0041	The 'received' line was idle for 15 contiguous bit times.	N	N	Y	N
0042	A failure occurred in the receive clock signal during a receive operation.	Y	Y	Y	Y
0043	The modem/DCE is ready when expected to be not ready.	N	Y	N	N
0044	The 30-second time out ended with no valid data received. The controller will terminate the call.	N	Y	N	Y
0045	The network will not activate. Either a disconnect mode (DM) or a disconnect signal (DISC) was received during link setup procedures.	N	N	Y	N
0046	The 5294 received an invalid X.25 frame.	N	N	Y	N
0047	The 5294 received an unexpected disconnect mode (DM) or a disconnect (DISC) signal.	N	N	Y	N
0050	Either the clear to send line was inactive while the request to send line was active, or the clear to send line was active while the request to send line was inactive.	Y	Y	Y	N
0051	The transmit clock failed during a transmit operation.	Y	Y	Y	Y
0052	The transmit buffer failed to clear either before or during a transmit operation.	Y	Y	Y	Y
0053	No acknowledgment of a transmission was received before the T1 timer expired after the tenth retry attempt.	N	N	Y	N
0054	The received SDLC X.21 or X.25 command was was not valid.	Y	Y	Y	Y
0055	The communications cable was unplugged and plugged back in, or the DCE was powered off then back on, or the X.21 attachment feature detected an error.	N	N	N	Y

Control Characters

This topic includes two types of control characters (CC): control characters for the display and control characters for the printer. The display control characters are used in some of the display LU-LU commands to allow the user to determine the characteristics of the display. The printer control characters, which are an SNA subset called standard character string (SCS), are in the printer output data stream; they allow the user to determine the format of the printed output. Although both are called control characters, they share no function and have no relationship.

Display

The display CCs are always used as 2-byte (2-CC) fields. They appear in the Write to Display, Read MDT Fields, and Read Input Fields commands in the display's output data stream (see the index entry *display, commands*). These characters select the specific operations for the display station to perform. Byte 1 is always processed first. When the CCs are used with the Write to Display command, the first CC is processed immediately while the second CC is not processed until all the other information associated with the command has been processed. The following gives the format and bit information for these 2 bytes:

First Byte

Bits 0-2	Reset Pending Aid; Lock Keyboard	Clear Master MDT; Reset MDT Flags in Nonbypass Fields	Clear Master MDT; Reset MDT Flags in All Fields	Null Nonbypass Fields with MDT On	Null All Nonbypass Fields
000					
001	X				
010	X	X			
011	X		X		
100	X			X	
101	X	X			X
110	X	X		X	
111	X		X		X

Notes:
1. Bits 3 through 7 are reserved and should be set to 0.
2. If there are no bypass fields with MDT flags on, then the master MDT will be cleared.

Second Byte

Bit	Code	Meaning
0		Reserved.
1		Reserved.
2	0	No action.
	1	Reset blinking cursor (Note 1).
3	0	No action.
	1	Set blinking cursor (Note 1).
4	0	No action.
	1	Unlock the keyboard and reset any pending aid bytes (Note 2).
5	0	No action.
	1	Sound alarm.
6	0	No action.
	1	Set Message Waiting indicator off (Note 3).
7	0	No action.
	1	Set Message Waiting indicator on (Note 3).

Notes:

1. If bits 2 and 3 are both on, the cursor blinks. For the 5292 Color Display Station, bits 2 and 3 will be effective only if the operator does not use the blink cursor function. See the index entry *select option mode keys*.
2. If the keyboard is already unlocked, this bit is ignored; otherwise, it:
   a. Unlocks the keyboard.
   b. Turns the keyboard clicker on.
   c. Turns the Input Inhibited indicator off.
   d. Moves the cursor to the address given in the last IC order (see the index entry *IC order*) or defaults to the first position of the first nonbypass input field if no IC order has been given. If there is no nonbypass field, it defaults to row 1, column 1.
   e. Clears all unserviced aid requests.
3. If bits 6 and 7 are both on, the Message Waiting indicator is set on.

Printer

The SNA subset support for the 5219, 5224, 5225, and 5256 printers is accomplished through standard character string (SCS) control characters. The user codes these control characters in the printer output data stream. SCS control character codes (00-3F) not recognized by the printer set invalid SCS control character status. See the index entry *data streams. Printer Data Stream Example* in Section 1 shows a sample printer data stream. The following chart describes the general functions provided by the printer control characters. A detailed description of each control character follows the chart.

The IBM 4224 Printer does not support SCS codes, but does support IPDS codes. Refer to the *IBM 4224 Printer Product* and *Programming Description*, GC31-2551, for more details.

Function to Perform	SCS Control Character and Code	Description
Define the next print position	PP (34xxnn)	Identifies the next print position, either horizontal or vertical, as defined by **xx**.
Horizontal: absolute	34COnn	Horizontally moves the print position to the position defined by **nn.**
Relative	34C8nn	Horizontally moves the print position **nn** print positions away from the present print position.
Vertical: absolute	34C4nn	Vertically moves the paper to the line specified by **nn**.
Relative	344Cnn	Vertically moves the paper **nn** lines from its present position.
Maximum print position	Fmt (2Bxxnn___)	Defines either the maximum horizontal or vertical print postion as specified by **xx**.
Horizontal	2BC1nnhh	Sets the maximum horizontal print position where **nn** = the number of bytes in the string and **hh** = the maximum horizontal print position.
Vertical	2BC2nnvv	Sets the maximum vertical print position where **nn** = the number of bytes in the string and **vv** = the maximum vertical print position.
Define the unprintable Character	SGEA (2BCnngguu)	Sets the unprintable character option and defines the default character where **nn** = the number of bytes in the string, **gg** = the default graphic, and **uu** = the print option. See the index entry *SGEA CC*.

Function to Perform	SCS Control Character and Code	Description
Move the paper	NL (15) IRS (1E) LF (25) FF (OC)	Logically moves the print position to the first position of the next line. Same as NL. Logically moves the print position vertically to the same horizontal print position of the next line. Moves the print position to the first position of the next logical page.
Move the print position	CR (OD)	Logically moves the print position to the first position of the same line.
No operation	NUL (00)	No-op.
Stop printing and alert operator	BEL (2F)	Turns off the Ready indicator and turns on the Attn indicator, sounds the Audible Alarm (if installed), and stops printing.
Transparent (5224 and 5225)	TRN (35nn)	Permits the codes normally used as control characters to be used as printable characters. The parameter frame **nn** specifies the number of frames that follow the 35-command frame.
Set Character Density (5224 and 5225)	SCD (2BD20429P1P2)	Sets the character density to 10 or 15 characters per inch as specified by the P1 and P2 parameter frames.
Set CGCS through Local ID (5224 and 5225)	SCL (2BD10381P1)	Loads 1 of 16 graphic character sets specified in the P1 parameter frame.
Load Alternate Characters (5224 and 5225)	LAC (2BFEnn01 EEI1I1e)	Allows user-designed fonts or characters to be loaded for printing.
Set Line Density (5224 and 5225)	SLD (2BC6nnLD)	Selects vertical line density of 6 or 8 lines per inch or other densities in multiples of 1/72 of an inch.

BEL

Function: This control character stops printing, sounds the Audible Alarm, if installed, and turns on the Attention indicator.

Code: Hex 2F

Results: When the printer microprocessor detects this control character, it:

- Allows all preceding data to be printed and all preceding control characters to be executed
- Turns the Ready indicator off
- Turns the Attention indicator on
- Sounds the audible alarm, if installed
- Stops printing
- Stops formatting
- Returns an unavailable status to the 5251 Model 2 or Model 12.

Carrier Return (CR)

Function: This control character performs a carrier return to the first print position on the same line.

Code: Hex 0D

Results: The horizontal print position logically moves to the first print position on the same line. If it already is at the first print position, no operation occurs.

Forms Feed (FF)

Function: This control character moves the paper to the next logical page as specified by the Set Vertical Format control character (see *Fmt* in this topic).

Default: 1 logical page = 1 logical line.

Code: Hex 0C

Results: The print position moves to the first logical print line and first logical print position of the next logical page.

Format (Fmt)

Function: This control character defines data formatting for a specified length (provided in the parameter).

Default: Logical line length = 132 character positions; logical page length = 1 line.

Code and Format:

Code	Set Type	Associated Parameters
Hex 2B	Start of formatted data stream. Must include: SHF, SVF, or SGEA	Length of formatted data stream.

Results: The following chart shows the various set types and their associated parameters.

Set Types Available for Use with the Format (Fmt) Printer Control Character			
Set Type	**Format**	**Values of Parameters**	**Description of Set Type**
SHF (Set Horizontal Format)	2BC1nnhh	nn = Number of bytes in the SHF string. hh = Maximum horizontal print position (greater than or equal to 1 and less than or equal to 132); the default is 132. If a 00 is sent, the printer substitutes its largest maximum print position which is 132 for the 5256 and the 10 character per inch density of the 5225, and substitutes 198 for the 15 characters per inch density of the 5225.	Sets the maximum print position (MPP), which is the value of the print line length.
SVF (Set Vertical Format)	2BC2nnvv	nn = Number of bytes in the SVF string. vv = Maximum number of lines on a page greater than or equal to 1 and less than or equal to 255. The default is a page length of one line.	Sets the maximum print line (MPL) on the logical page; it overrides the physical device logical page.

Set Types Available for Use with the Format (Fmt) Printer Control Character (continued)

Set Type	Format	Values of Parameters				Description of Set Type		
SGEA (Set Graphic Error Action)	2BC8nnggxx	nn =	Number of bytes in the SGEA string.					
		Input Hex Data Stream[2]				**5256 Results**		
		SGEA Code	**SCS Count nn**	**Default Graphic**	**Unprintable Character Option uu**	**Default Graphic**	**Unprintable Character Option**	**Error Status**
		2BC8	00	–	–	Hyphen	01	Invalid SCS parameter
		2BC8	01	–	–	Hyphen	01	
		2BC8	02	gg	–	gg[1]	01	
		2BC8	03	gg	00, 01, 02	gg[1]	01	
		2BC8	03	gg	03 or 04	gg[1]	03	
		2BC8	03	gg	05-ff	gg[1]	01	Invalid SCS parameter
		2BC8	04	gg		Hyphen	01	Invalid SCS parameter
		[1]If **GG** is unprintable, including characters in the EBCDIC control code quadrant, a hyphen is printed. [2]The first 2 characters (the first byte) in the hex data stream are control characters; if unspecified ones are used, an error code 28 results. The characters to the right of the control characters are control parameters; if unspecified ones are used, an error code 29 results.						
		gg = Unprintable character option. **Note:** On early production 5256 printers, options 02 and 04 will allow printing of the International Extension characters. See Figure 2-3. 01 = No stop, no status. 02 = Defaults to 01. 03 = Stop, hard error status. Unit not available 04 = Defaults to 03. The default for **xx** is 01.				Sets the way the printer will respond when it encounters an unacceptable symbol in the data stream. **Note:** **nn** must be at least 1 and not greater than 3 for the SGEA set type.		

The following chart shows the characteristics of the SHF and SVF set types:

Valid Values for the SHF and SVF Set Types			
Set Type Code	**Parameters**	**Results (MPL and MPP)**	**Error**
SHF 2BC1nnhh	nn = 00	MPP = 132	Invalid SCS parameter
	nn = 01	MPP = 132	None
	nn = 02 hh = 00	MPP = 132 MPP = 198*	None
	nn = 02 hh = 1-84	MPP = 1-132 as specified	None
	hh = 85-C6	MPP = 133-198 as specified*	
	nn = 02 hh = 85-FF	MPP = 132	Invalid SCS parameter
	nn = 03FF	MPP = 132	Invalid SCS parameter
SVF 2BCnnvv	nn = 00	MPL = 1	Invalid SCS parameter
	nn = 01	MPL = 1	None
	nn = 02 vv = 00	MPL = 1	None
	nn = 03-FF	MPL = 1	Invalid SCS parameter

*A maximum print position of greater than 132 is only possible on the 5224 or 5225 printer when a print density of 15 characters per inch has been set prior to the execution of this command.

Interchange Record Separator (IRS)

Function: This control character does the same thing that NL does.

Code: Hex 1E

Line Feed (LF)

Function: This control character moves the paper one line without altering the print position.

Code: Hex 25

Results: Moves the paper logically to the same print position on the following line. If you use this control character on the last line of a page, it will move the print position to the first line of the next page.

New Line (NL)

Function: This control character moves the paper to the next line.

Code: Hex 15

Results: The print position moves to the first print position on the next line if it is not coded on the last line of the page. If you code this on the last line, it moves the paper to the first print position on the first line of the next page.

NUL

Function: No-op

Code: Hex 00

Results: No characters are printed and no functions are performed.

Print Position (PP)

Function: This control character moves the logical print position as determined by the associated parameters.

Restrictions: The absolute parameters must be equal to or less than the page length. (See the following explanation.) If the absolute horizontal parameter is less than the current print position, the printer microprocessor treats it as a separate line and inserts a CR control character in the printer data stream. If the absolute vertical parameter is less than the current line number, the microprocessor treats it as a new page. If both are equal, no operation is performed. Relative values must indicate a move to but not past the end of the line or page. A value of 0 is not valid, and no operation is performed.

Code and Format:

Hex 34	Function Parameter (hex) (See Note 1.)	Value Parameter (decimal) (See Note 2.)

The results are determined by the parameters as described in the following notes:

Notes:

1. The following chart shows the types of moves available and indicates what the PP CC accomplishes for each type:

Function	Function Parameter (Hex)	Value Parameter (Decimal)
Absolute horizontal move	C0	Numeric value of horizontal position (less than or equal to the end of the line).
Absolute vertical move	C4	Numeric value of vertical position (less than or equal to the end of page).
Relative horizontal move	C8	Numeric value or horizontal movement from the present position (less than or equal to the end of the line).
Relative vertical move	4C	Numeric value of vertical movement from the present position (less than or equal to the end of the page).

2. The following chart shows the relationships of the parameters:

Parameter Relationships		
Function	**Value Parameter (nn)**	**Results**
Absolute horizontal move (hex 34C0nn)	00 00 < nn ≤ 132 (10 cpi) 00 < nn ≤ 198 (15 cpi) nn > maxPP	No-op; the current print position is unchanged; no error. The print position becomes the value of **nn**. Error; invalid SCS parameter.
Absolute vertical move (hex 34C4nn)	00 current PP ≤ nn ≤ max PP 0 < nn < current PP nn > max PP	No-op; the current print position is unchanged; no error. The print position becomes the value of **nn** and remains on the same logical page. The print position becomes the value of **nn** and goes to the next logical page. Error; invalid SCS parameter.
Relative horizontal move (hex 34C8nn)	00 nn + current PP ≤ max PP nn + current PP > maxPP	No-op; the current print position is unchanged; no error. The new print position is equal to the current print position plus the value of **nn**. Error; invalid SCS parameter.
Relative vertical move (hex 344Cnn)	00 nn + current PP ≤ max PP nn + current PP > max PP	No-op; the current print position is unchanged; no error. The print position becomes the value of the current print position plus the value of **nn**. Error; invalid SCS parameter.
Set Horizontal Format 2B(C1nnhh)	(nn) 01,02 (hh) hh = max PP Hex 01 ≤ hh ≤ hex C6 00 hh > C6	Total number of frames following the command (including the count frame) is defined. The maximum print position is set at a value between 1 and 198. No-op, the default value of hex 84 (132) is supplied. Error; invalid SCS parameter.
Set Vertical Format 2B(C2nnvv)	(nn) (vv) 1 ≤ vv ≤ 255 00	Number of frames to end of SVF string (including the count frame) is defined. Sets the value of the maximum number of print lines per page. The function retains the default value of one line.

Parameter Relationships		
Function	**Value Parameter (nn)**	**Results**
SGEA (Set Graphic Error Action) 2B(C8nnggxx)	(nn) 01, 02, 03 (gg) (uu) If SGEA has not been sent, the default is: hex 01 (no stop, no status) Hyphen in place of any unprintable character.	Number of frames to the end of the SGEA string (including the count frame) is defined. Substitutes a designated graphic character for any unprintable characters encountered. If the graphic character selected is also unprintable or if no character is designated, the default character is a hyphen. Determines error and status action resulting from an unprintable character as follows: Hex 01 = no stop, no status Hex 00 = default to hex 01 Hex 02 = default to hex 01 Hex 03 = stop, hard error status Hex 04 = default to hex 03
TRN (Transparent)[1] (35nn)	(nn) $01 \leq nn \leq 255$ 00 Use of the codes hex 00 through hex 3F requires that print images for those values have been loaded into the 5224 or 5225 print buffers by the using system. If no image was loaded for a given code, the 5224 or 5225 inserts a blank.	Permits codes normally used as control characters to be used as printable characters. Number of frames of transparent data to follow (not including count frame) is defined. No-op; following data is treated as normal data.
SCD (Set Character Distance)[1] 2B(D20429P1P2)	(on) P2 = 0A (10 cpi) 0F (15 cpi) 00 (no-op) FF (default to 10 cpi) P2 = 0A, 0F, 00, or FF	Defines the number of characters per inch to be printed. Error; invalid SCS parameter.
SCL (Set CGSC through Local ID)[1] 2B(D10381P1)	(P1) P1 = FF or $00 \leq p1 \leq 0F$	Selects 1 of 16 predetermined character sets used to print data. These character sets are designated by a Code (P1). FF sets printer to default (jumper setting) character set.
LAC (Load Alternate Character(s)) (2BFEnn01EEI1I18)[1]	(nn) = 10x +2 $nn \leq 252$ EE = code point where character is to be placed. I1 through I18 = 9 bytes making up the character.	Allows loading of from 1 to 25 character images into the alternate character buffer.
SLD (Set Line Density) 2BC6nnLD)	nn = count byte LD = number of 1/72 inch forms movement per line	Allows 6 or 8 lines per inch.
[1]Applies to the 5224 and 5225 Printers only.		

Copy to Printer Feature

This feature allows the user to print the contents of the display using any printer that is attached via a cluster feature. When the feature is installed, the host system sends the Copy to Printer command to the controller in the following format:

ESC Character Hex 04	Copy to Printer Command Hex 16	Printer LSID (See the index entry *addresses*.)	Maximum Number of Lines on Page (See Note.)	SNA Chain End

Note: The default for this is the same number of print lines per page as there are lines in a display. If 00 is specified, the default is to the display size.

The Copy to Printer command must be LIC or OIC on the RU, or followed by null RUs.

The operator should ensure that the printer is positioned at the first print position on a new page when issuing this command. The format of the data stream as it is created and sent by the controller to the printer is the printer control character with the horizontal control set to the display line length, and the vertical controls set to the maximum print line. (See the index entry *control characters, printer* for specific details about the types of characters that control these formats.)

The results of using the Copy to Printer feature are:

- All nondisplay fields are printed as blanks.
- All null characters are printed as blanks.
- All screen attributes are printed as blanks.
- All dup characters are printed as an overstruck asterisk.
- Blank lines on the display are translated to new lines at the printer.
- A form-feed control CC is appended to the end of the data stream to position the printer at the top of the next page.

The terminal returns a positive response when it completes this command. The operator can cancel this command from either the keyboard or the printer. To cancel the operation from the keyboard, the operator first presses a shift key and then the Print key. This terminates the operation without alerting the host system that an abnormal termination has occurred (normal +rsp). To terminate the operation from the printer, the operator sets the Status switch to the Cancel position. The controller then sends a negative response to the host system, indicating that an abnormal termination has occurred. The following conditions result in the terminal responding to the command with a negative response:

- Another command is outstanding for the printer.
- The printer is involved in an LU-LU session.
- There is an error condition.
- Status switch is set to Cancel on the printer.
- An incorrect LSID has been specified.
- An RU error exists.
- Intervention is required to make the printer ready.

Note: See the index entry *negative responses*.

Data Streams

The data streams consist of all the information required by the controller to drive the attached work stations (LUs), and all of the response information that was furnished by the LUs and sent to the host system by the controller. The 5250 display and printer data streams reside in the SNA RUs which are embedded in the I part of the SDLC I frames. See the index entries *frames* and *RU* for details about these subjects. If you are not familiar with SNA, please read the information under *Protocols and Synchronization for 5250 Implementation of SNA* in Section 1 of this manual.

Display

The display data stream is on the normal FMD LU-LU flow in SNA RUs; it contains (1) commands, data, orders, and parameters that the host system uses to control the display and (2) data and status information that the 5251 Model 2 or Model 12 sends the host system in response to the host system's requests. See the index entries *display, commands,* and *orders*. The general format of the output display data stream is:

ESC Command Hex 04	Associated Parameter	ESC or SNA Chain End

The general format of the data stream that the 5251 Model 2 or Model 12 sends to the host system for the display is:

Cursor Address (2 bytes)	Aid Code Field Data

Note: See the index entries *aid codes* and *input commands*.

Printer

The data stream for the printer contains a mixture of output data to be printed and control characters that direct the printer to format the data as the user has specified. See the index entry *control characters, printer* for details about these topics. The printer data stream comes in the normal FMD LU-LU flow path in SNA RUs. The format for the printer data stream looks like this:

CC Data CC Data CC Data

The host system writes information to the printer by issuing the printer data stream. There are no printer commands. The Copy to Printer feature is executed by issuing a command to the display. See the index entry *copy to printer feature* for details.

Digital Data Service Adapter

This special feature allows the 5251 Model 2 or Mode 12 and the 5294 to attach to AT&T's Private Line Data Phone Digital Service (or equivalent) through the use of an AT&T Channel Service Unit (or equivalent). The data rates are 2400, 4800, or 9600 bps for the 5251 Model 2 or Model 12 and up to 56,000 for the 5294.

The 5251 Model 2 or Model 12 can also be directly attached to some systems using the Digital Data Service Adapter (DDSA) feature. The host system must be equipped with a communications adapter and a DDSA feature. To determine if a 5251 Model 2 or Model 12 can be directly attached to your system, contact your IBM sales representative. The 5294 cannot be directly attached.

EBCDIC Character Sets

Figure 2-1 applies to the 5251 Models 1, 2, 11, or 12, the 5252, the 5291, and the 5292 display stations equipped with the 96-Character EBCDIC character set. This character set is standard on all display stations and contains all characters of the ASCII character set, but not necessarily in the same positions. Hexadecimal combinations for which no characters are shown may have unpredictable results that vary with the level of the machine. Figure 2-2 shows the Katakana character set. Figure 2-3 shows the character sets for major countries.

Also available is the Multinational character set. This character set allows you to generate any EBCDIC character that is not available on your keyboard but is needed for input and displaying. For more information about the Multinational character set, see *Multinational Character Set* in this section.

Note: Unless otherwise specified, characters in the following character sets are printed as displayed.

The character that has a heavy line surrounding it is printable only on early production 5256 printers when option 02 or option 04 of the Set Graphic Error Action has been set.

The Set Graphic Error Action control character (see the index entry *CC, printer*) can be set to do one of the following when an unprintable character is encountered:

01: Continue printing without an error; a default character will be substituted for any unprintable characters.

02: Defaults to 01.

03: Finish printing the current line, supplying a default character for the unprintable character(s), and post an error.

04: Defaults to 03.

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Sp	&	-						Note	Note	Note	0
1							/		a	j	Note		A	J		1
2									b	k	s		B	K	S	2
3									c	l	t		C	L	T	3
4									d	m	u		D	M	U	4
5									e	n	v		E	N	V	5
6									f	o	w		F	O	W	6
7									g	p	x		G	P	X	7
8									h	q	y		H	Q	Y	8
9								Note	i	r	z		I	R	Z	9
A					Note	Note	Note	:								
B					.	Note	,	Note								
C		*			Note	*	%	Note								
D					(	)	_	'								
E					+	;	>	=								
F					Note	Note	?	"								

Note: Variable; see the appropriate chart for the specific characters for your country.

Figure 2-1. EBCDIC Character Sets (96-Character EBCDIC Character Set)

Figure 2-2 shows the Katakana character set.

The character that has a heavy line surrounding it is not printable and cannot be entered from the keyboard, but will be displayed if the corresponding hexadecimal code is received as data from the host system.

Katakana

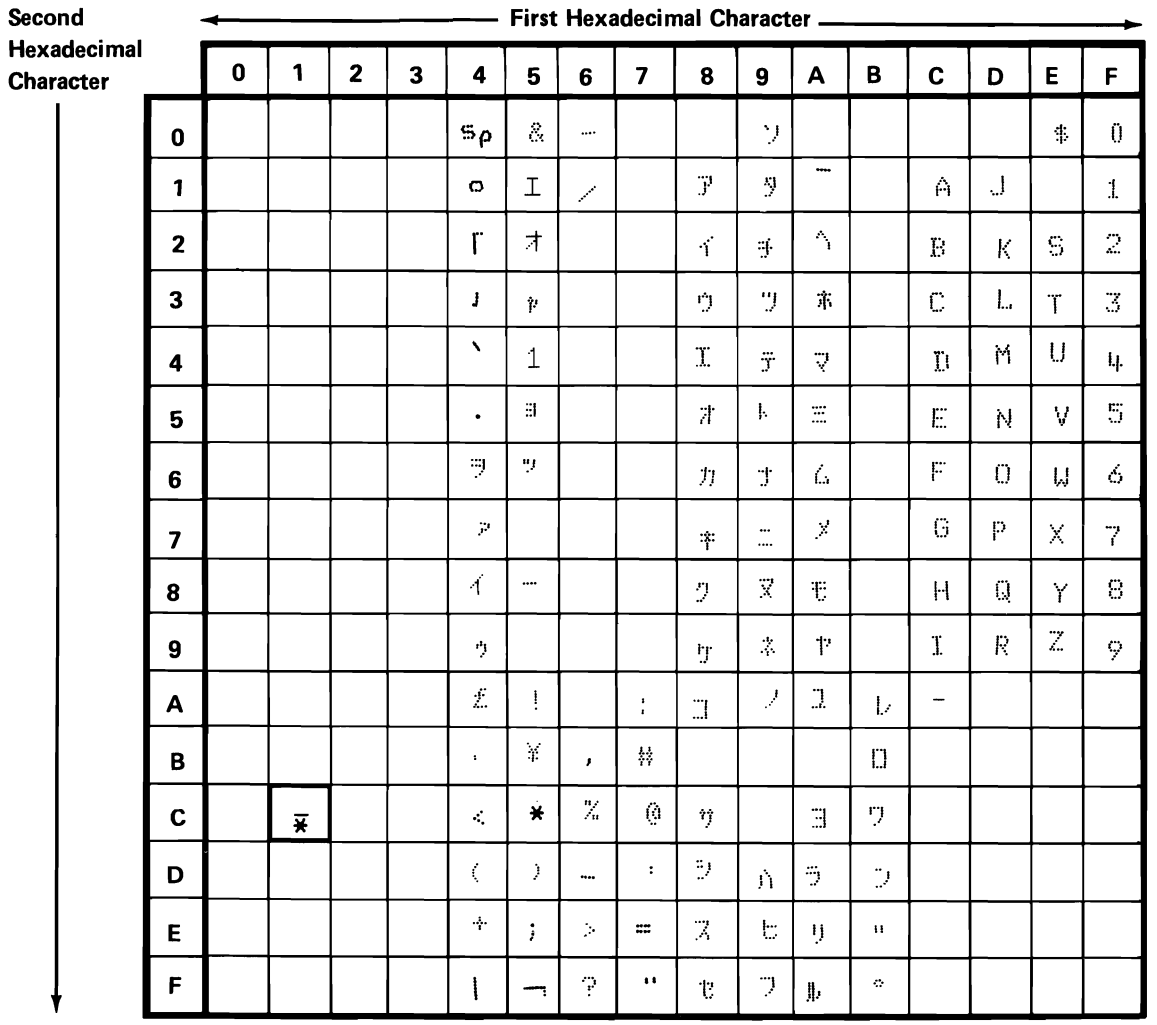


Figure 2-2. EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

Austria/Germany

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	°	µ	ç	ä	ü	Ö	0
1					Required Space	è	/	É	a	j	ß	£	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					{	ë	[	Ë	c	l	t	Pt	C	L	T	3
4					à	è	À	È	d	m	u	ƒ	D	M	U	4
5					á	í	Á	Í	e	n	v	@	E	N	V	5
6					ã	î	Ã	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					ç	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	~	Ñ	`	i	r	z	¾	I	R	Z	9
A					Ä	Ü	ö	:	«	a	¡	¬	-	Note	2	3
B					.	$	,	#	»	o	¿	|	ô	û	Ô	Û
C		*			<	*	%	§	ð	æ	Ð	Note	¦	}	\	]
D					(	)	—	'	Note	ƅ	Note	¨	ò	ù	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	´	ó	ú	Ó	Ú
F					!	^	?	"	±	¤	®	¯	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 4214, 5262, 4214, 4224, and 4210	ý	ı		|
5251, Models 1, 2 11, 12, and 5252	5256	⩽	↑	≠	⩾

Figure 2-3 (Part 1 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

Belgium

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	°	µ	ç	é	è	ç	0
1					Required Space	{	/	É	a	j	¨	£	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	C	L	T	3
4					@	}	À	È	d	m	u	*f*	D	M	U	4
5					á	í	Á	Í	e	n	v	§	E	N	V	5
6					ã	î	Ã	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					\	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	`	i	r	z	¾	I	R	Z	9
A					[	]	ù	:	«	a	¡	¬	-	Note	2	3
B					.	$	,	#	»	o	¿	|	ô	û	Ô	Û
C		*			<	*	%	à	ð	æ	Ð	Note	ö	ü	Ö	Ü
D					(	)	–	'	Note	♭	Note	~	ò	¦	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	'	ó	ú	Ó	Ú
F					!	^	?	"	±	¤	®	¯	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	¯	¬	|
5251, Models 1, 2 11, 12, and 5252	5256	≤	↑	≠	≥

Figure 2-3 (Part 2 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

Canadian French

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	°	µ	ç	é	è	♭	0
1					Required Space	è	/	É	a	j	¨	£	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	C	L	T	3
4					à	è	À	È	d	m	u	ƒ	D	M	U	4
5					á	í	Á	Í	e	n	v	§	E	N	V	5
6					ã	î	Ã	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					ç	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	`	i	r	z	¾	I	R	Z	9
A					à	'	ù	:	«	a	¡	¬	-	Note	2	3
B					.	$	,	#	»	o	¿	|	ô	û	Ô	Û
C		*			<	*	%	@	ð	æ	Ð	Note	ö	ü	Ö	Ü
D					(	)	–	'	Note	♭	Note	' '	ò	ù	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	'	ó	ú	Ó	Ú
F					!	^	?	"	±	¤	®	¯	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

		Character			
Display Station	Printer ↓	8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	ı	¨	|
5251, Models 1, 2 11, 12, and 5252	5256	≤	↑	≠	≥

Figure 2-3 (Part 3 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

Denmark/Norway

First Hexadecimal Character →

Second Hexadecimal Character ↓	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	¦	@	°	µ	ç	æ	å	\	0
1					Required Space	è	/	É	a	j	ü	£	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	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	î	Ã	Î	f	o	w	¶	F	O	W	6
7					}	ï	$	Ï	g	p	x	¼	G	P	X	7
8					ç	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	`	i	r	z	¾	I	R	Z	9
A					#	¤	ø	:	«	a	¡	¬	-	Note	2	3
B					.	Å	,	Æ	»	o	¿	|	ô	û	Ô	Û
C		*			<	*	%	Ø	ð	{	Ð	Note	ö	~	Ö	Ü
D					(	)	—	'	Note	½	Note	' '	ò	ù	Ò	Ù
E					+	;	>	=	Þ	[	þ	'	ó	ú	Ó	Ú
F					!	^	?	"	±	]	®	¯	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	¨	—	|
5251, Models 1, 2 11, 12, and 5252	5256	≤	↑	≠	≥
3180 and 3198					

Figure 2-3 (Part 4 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

Finland/Sweden

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	°	µ	ç	ä	å	É	0
1					Required Space	`	/	\	a	j	ü	£	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					{	ë	#	Ë	c	l	t	Pt	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	î	Ã	Î	f	o	w	¶	F	O	W	6
7					{	ï	$	Ï	g	p	x	¼	G	P	X	7
8					ç	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	é	i	r	z	¾	I	R	Z	9
A					§	¤	ö	:	«	a	¡	¬	-	Note	2	3
B					.	Å	,	Ä	»	o	¿	|	ô	û	Ô	Û
C		*			<	*	%	Ö	ð	æ	Ð	Note	¦	~	@	Ü
D					(	)	–	'	Note	ь	Note	,,	ò	ù	Ò	Ù
E					+	;	>	=	·	Þ	Æ	þ	'	ó	ú	Ó	Ú
F					!	^	?	"	±	]	®	¯	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	Ý	¯	|
5251, Models 1, 2 11, 12, and 5252	5256	⩽	↑	≠	⩾

Figure 2-3 (Part 5 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

France

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	[	`	ç	è	è	ç	0
1					Required Space	{	/	É	a	j	¨	#	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	C	L	T	3
4					@	}	À	È	d	m	u	*f*	D	M	U	4
5					á	í	Á	Í	e	n	v	]	E	N	V	5
6					ã	î	Ã	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					\	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	µ	i	r	z	¾	I	R	Z	9
A					°	§	ù	:	«	a	¡	¬	-	Note	2	3
B					.	$	,	£	»	o	¿	|	ô	û	Ô	Û
C		*			<	*	%	à	ð	æ	Ð	Note	ö	ü	Ö	Ü
D					(	)	–	'	Note	♭	Note	~	ò	¦	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	'	ó	ú	Ó	Ú
F					!	^	?	"	±	¤	®	=	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	´	¯	|
5251, Models 1, 2 11, 12, and 5252	5256	⩽	↑	≠	⩾

Figure 2-3 (Part 6 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

Italy

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	[	µ	ç	à	è	ç	0
1					Required Space	]	/	É	a	j	ì	#	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	C	L	T	3
4					{	}	À	È	d	m	u	ƒ	D	M	U	4
5					á	í	Á	Í	e	n	v	@	E	N	V	5
6					ã	î	Ã	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					\	~	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	ù	i	r	z	¾	I	R	Z	9
A					°	è	ò	:	«	a	¡	¬	-	Note	2	3
B					.	$	,	£	»	o	¿	|	ô	û	Ô	Û
C		*			<	*	%	§	ð	æ	Ð	Note	ö	ü	Ö	Ü
D					(	)	_	'	Note	ъ	Note	,,	¦	`	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	'	ó	ú	Ó	Ú
F					!	^	?	"	±	¤	®	¯	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	´ ı	¨	|
5251, Models 1, 2 11, 12, and 5252	5256	⩽	↑	≠	⩾

Figure 2-3 (Part 7 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

Portugal

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	°	µ	ç	ã	'	Ç	0
1					Required Space	è	/	É	a	j	ç	£	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	C	L	T	3
4					à	è	À	È	d	m	u	ƒ	D	M	U	4
5					á	í	Á	Í	e	n	v	§	E	N	V	5
6					{	î	#	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					~	ì	\	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	`	i	r	z	¾	I	R	Z	9
A					[	]	õ	:	«	a	¡	¬	-	Note 1	2	3
B					.	$	,	Ã	»	o	¿	|	ô	û	Ô	Û
C		*			Note 2	*	%	Õ	ð	æ	Ð	Note 1	ö	ü	Ö	Ü
D					(	)	–	'	Note 1	ƅ	Note 1	,,	ò	ù	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	}	ó	ú	Ó	Ú
F					!	^	?	"	±	¤	®	=	¦	ÿ	@	

Notes:

1. Dependent on the display station/printer you are using, see the following table:
2. For 3180 or 3196 a "<". For all others, a "Ç".

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	↓		|
5251, Models 1, 2 11, 12, and 5252	5256	⩽	↑	≠	⩾

Figure 2-3 (Part 8 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

Spanish Speaking/Spain

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	°	µ	ç	{	}	\	0
1					Required Space	è	/	É	a	j	¨	£	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	C	L	T	3
4					à	è	À	È	d	m	u	ƒ	D	M	U	4
5					á	í	Á	Í	e	n	v	§	E	N	V	5
6					ã	î	Ã	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					ç	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					¦	ß	#	`	i	r	z	¾	I	R	Z	9
A					[	]	ñ	:	«	ª	¡	^	-	Note	2	3
B					.	$	,	Ñ	»	º	¿	!	ô	û	Ô	Û
C		*			<	*	%	@	ð	æ	Ð	Note	ö	ü	Ö	Ü
D					(	)	–	'	Note	½	Note	~	ò	ù	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	'	ó	ú	Ó	Ú
F					|	¬	?	"	±	¤	®	¯	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	Ý	¯	|
5251, Models 1, 2 11, 12, and 5252	5256	≤	↑	≠	≥

Figure 2-3 (Part 9 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

United Kingdom

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	°	μ	ç	{	}	\	0
1					Required Space	è	/	É	a	j	—	[	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	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	î	Ã	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					ç	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	`	i	r	z	¾	I	R	Z	9
A					$	!	¦	:	«	a	¡	^	-	Note	2	3
B					.	£	,	#	»	o	¿	]	ô	û	Ô	Û
C		*			<	*	%	@	ð	æ	Đ	Note	ö	ü	Ö	Ü
D					(	)	–	'	Note	ь	Note	,,	ò	ù	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	'	ó	ú	Ó	Ú
F					|	¬	?	"	±	¤	®	=	õ	ÿ	Õ	

Note:

Dependent on the display station/printer you are using, see the following table:

Display Station	Printer ↓	Character 8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	ı		|
5251, Models 1, 2 11, 12, and 5252	5256	≤	↑	≠	≥

Figure 2-3 (Part 10 of 11). EBCDIC Character Set

The characters with a heavy line surrounding them are unprintable and will be represented as specified by the set Graphic Error Action control character or, if unspecified, by a hyphen.

U.S., Canada, Netherlands

First Hexadecimal Character →

Second Hexadecimal Character ↓

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0					Space	&	-	ø	Ø	°	µ	^	′	}	\	0
1					Required Space	è	/	É	a	j	~	£	A	J	Num Space	1
2					â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3					ä	ë	Ä	Ë	c	l	t	Pt	C	L	T	3
4					à	è	À	È	d	m	u	ƒ	D	M	U	4
5					á	í	Á	Í	e	n	v	§	E	N	V	5
6					ã	î	Ã	Î	f	o	w	¶	F	O	W	6
7					å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8					ç	ì	Ç	Ì	h	q	y	½	H	Q	Y	8
9					ñ	ß	Ñ	`	i	r	z	¾	I	R	Z	9
A					ç	!	¦	:	«	a	¡	[	-	Note 1	2	3
B					.	$	,	#	»	o	¿	]	ô	û	Ô	Û
C		*			<	*	%	@	ð	æ	Ð	Note 1	ö	ü	Ö	Ü
D					(	)	–	'	Note 1	ь	Note 1	,,	ò	ù	Ò	Ù
E					+	;	>	=	Þ	Æ	þ	′	ó	ú	Ó	Ú
F					|	¬	?	"	±	¤	®	¯	õ	ÿ	Õ	

Notes:

1. Dependent on the display station/printer you are using, see the following table:
2. Netherlands is supported only for the 5294 with the Enhanced Keyboard Feature installed.

		Character			
Display Station	Printer ↓	8D	AD	BC	DA
5292, 3179, 3180, and 3196	5224, 5225, 5262, 4214, 4224, and 4210	ý	´	¨	|
5251, Models 1, 2 11, 12, and 5252	5256	⩽	↑	≠	⩾

Figure 2-3 (Part 11 of 11). EBCDIC Character Set

EIA/CCITT Adapter

This special feature allows the user to attach a controller to an external modem. The modem that it attaches to, however, must have (1) an interface that meets the *EIA Standard RS232C* and *100 Series Interchange Circuits* requirements defined in the *CCITT Internal Recommendations*, Volume 24, and (2) electrical characteristics that are compatible with the electrical requirements of the *EIA Standard RS232C* and conform to the CCITT recommendations in Volume 28. This feature is restricted to a maximum speed of 9600 bps.

Error Log

The error log is a buffer that is 16 bytes long for the 5251 Models 2 and 12 and an additional 64 bytes long for each installed cluster feature. On the 5294, the error log buffer is 128 bytes with 121-byte data area plus pointers that indicate which entries are valid and which have been sent to the host system. The log contains information about errors that have occurred (both software errors and errors sent from a signal). Hardware errors may be logged but not sent via a signal, because the unit was not in session. See the index entries *errors, codes* and *negative responses*.

The format of the error log entries is:

L,LSID,xxyy,S0,S1,S2,S3,S4

L is the number of bytes in the entry.

LSID is the local session identification address (See the index entries *addresses* and *LSID*.)

xxyy is either the error code or the user bytes of the negative response that describe the condition causing the error. **xx** is the device type and **yy** is the error type.

S0, S1, S2, S3, and **S4**, if present, are predefined and used only as diagnostic maintenance information.

The error log exists only in the controller. The remainder of the 5250 work stations are dependent on the controller or on a host system for error logging.

Note: If the host system does not have a buffer area for the error log, its contents are lost when transmitted and valuable information necessary to diagnose error-related problems is lost.

Protocols and Synchronization for 5250 Implementation of SNA in Section 1 and index entries *reqms command* and *recfms command* describe how to access this error log.

Field Control Word (FCW)

Field control words (each 2 bytes) are sent by the user's program to the controller via the Write to Display command. Field control words are optional and if coded, they should follow the field format word of the SF order. See the index entry *SF order*. Any field control word encountered during the modification of an existing format table entry is ignored. A field control word of hex FFXX will not be accepted by the LU.

The types of field control words are (1) Magnetic Stripe Reader, (2) resequencing, (3) Selector Light Pen, and (4) Self-Check. The Magnetic Stripe Reader control words allow the reading of numeric encoded information from a magnetic stripe. The resequencing control words alter the sequence of sending information; they do not alter the sequence of information on the display. The Selector Light Pen control words permit attachment of a light pen. The Self-Check control words determine the validity of the data that is sent.

Magnetic Stripe Reader Feature

The Magnetic Stripe Reader (MSR) feature provides the capability of reading numeric encoded information from a magnetic stripe. The Magnetic Stripe Reader card may be encoded with up to 128 numeric characters, including control characters. The following requirements must be met when specifying a field for MSR input:

- A field control word must be defined for the field only if operator ID (OID) secure data is to be entered into this field.
  - Hex 8101 is for an MSR OID secured field. When the MSR OID data is read into the field, the OID code is converted to a colon which appears in position 1 of the field to indicate secured data.
  - Hex 8103 allows both the Magnetic Stripe Reader and the Selector Light Pen to enter data.
- The MSR data must be entered with the keyboard unlocked or after the System Request key is pressed, otherwise the data is lost and no error will appear to inform the operator of the situation. If the OID is encoded on the card, it can only be entered in response to the OID display provided by the host system.
- MSR data can be entered into an I/O field.
- Data will be entered starting at the cursor position; the operator must position the cursor within a field.
- Data entered from the card must satisfy the requirements of any mandatory fill, check digit, signed numeric, numeric-only, alpha-only, and auto-enter specifications for the field into which MSR data is entered or the appropriate operator error will be posted.
- There can be only one field on each magnetic stripe card. This field can range from 1 to 125 characters in length for the 5251 and 5252 displays.
- No data overflow is allowed. Magnetic stripe data must all fit within the field or an operator error 0034 will be displayed.
- The field starting attribute (nondisplay) must be supplied using the SF order.

Resequencing

Resequencing allows the controller to send the input fields to the host system in any specified order. Resequencing is accomplished by chaining input fields together via field control words (FCW) specifying resequencing. The format of the resequencing FCW is as follows:

Bits	Binary Description
0-1	10
2-7	000000
8-15	The normal sequence position of the next field to be returned to the host system. (The first field on the screen is number 1; the field numbers progress sequentially, left to right and top to bottom.)

The first field to be sent to the host system is identified in the start of header (SOH) by its number. If the first field identifier in the SOH is set to zero, resequencing will not occur (that is, all resequencing FCWs will be ignored; fields will be sent to the host system in the order defined in the format table). The last field to be sent to the host system must have a field control word defined as follows:

Bits	Binary Description
0-1	10
2-7	000000
8-15	11111111

Notes:

1. A closed resequencing loop will result in an endless transmission of data, terminated only by a negative response, Unbind, or Dactlu from the host system. See the index entries *SNA, commands* and *negative responses*.
2. It is not a requirement to have a resequencing FCW for each field. An FCW pointing to the next sequential field will be assumed if no resequencing FCW is specified. (The last field in the format table must have a resequencing FCW.)

See the index entry *SOH order* for more information.

Selector Light Pen Feature

The Selector Light Pen feature is a pen-like device that permits the operator to select fields of data from the display screen for system input. The ease with which the operator can select and designate the correct light pen field is affected by the format, content, intensity, and spacing of the light pen fields upon the screen. The following requirements must be met when specifying a field for the selector light pen:

- A field control word must be defined for the field:
  - Hex 8102 is for a selector light pen tip switch allowed field.
  - Hex 8103 allows both magnetic stripe/slot reader and selector light pen to enter data.
- Light pen fields on the same line should be separated by at least four characters.
- The light pen field should be formatted as follows:

  @?b*bxx...x@

  @ - The leading attribute should be high intensity. The trailing attribute should be normal intensity.

  ? - A designator character (?) in the first position of the field indicates filed selection or reselection. This character should change from ? to > after selection and back to ? after reselection.

  b - A blank should separate the designator character from the rest of the field.

  * - A target character (asterisk) may be inserted into the field format. This character enhances the pen's ability to detect the field and the pen should be aimed at this target character during the selection process.

  xx...x - These character combinations indicate a variable length name or description of the selectable field. (The name should be at least 2 characters long.)

Self-Check Feature

The Self-Check feature on the controllers provides additional integrity for the data entry. All field types can be specified for self-checking. The following requirements must be met when specifying a field for self checking:

- A field control word must be defined for the field:
  - Hex B1A0 is for Modulus 10 checking.
  - Hex B140 is for Modulus 11 checking.
- Field lengths for checking are restricted to 33 positions. For signed numeric fields, only 32 positions can contain digits. The sign is not checked. If more than 33 characters are given, a Lustat parameter error results.
- The Self-Check feature must be installed or a Lustat parameter error results when self check is specified for the field and the operator tries to leave the field.

The Self-Check feature resolves fields and conditions in the following ways:

- The feature converts nonnumeric characters, including nulls and blanks, by using the 4 low-order bits from their EBCDIC representation, when the low-order bits are in the range 0-9. For example:
  - A in EBCDIC is C1; therefore A = 1.
  - R in EBCDIC is D9; therefore R = 9.

  All other characters with the 4 low-order bits in the range of hex A through F are replaced by 0. For example: % is EBCDIC 6C; therefore % = 0.

  Null and blank characters are also converted to 0. All high-order nulls, zeros, and blanks in a field are converted to 0 and do not affect the value of the check number.
- An all-null field checks correctly. This kind of field can result when an operator has unsuccessfully tried to enter digits into a field and checking fails, so the controller allows the operator to exit the field from the first position by using the Field Exit key.

- A duplication character (hex 1C) resulting from the operator using the Dup key automatically causes the field to pass this test.
- Checking errors result in the controller issuing a 0015 error code and placing the cursor at the first position of the field containing the error.

Field Format Word (FFW)

Field format words (each 2 bytes long) are sent by the host system in the SF order to the controller to be placed in the format table. They allow the programmer to control the type of fields on the display. The index entry *fields* references the details for the types of fields that are supported and their characteristics. See the index entries *SF order* and *format table* for additional information. The following describes the meanings of the field format word bits:

Byte	Bit	Code	Description
1	0-1	01	
	2		Bypass.
		0	This is not a bypass field.
		1	This is a bypass field.
	3		Dup enable.
		0	Duplication is not allowed in this field.
		1	Duplication is allowed in this field.
	4		Modified data tag (MDT).
		0	This field has not been modified.
		1	This field has been modified. **Note:** This bit may be turned on by the host system before being sent to the display.
	5-7		Field shift/edit specifications.
		000	Alphabetic shift.
		001	Alphabetic only.
		010	Numeric shift.
		011	Numeric only.
		100	Katakana shift.
		101	Digits only (5294).
		110	I/O (magnetic stripe reader, selector light pen input only).
		111	Signed numeric.
2	0		Auto enter.
		0	No auto enter.
		1	Auto enter.
	1		Field exit required (FER).
		0	Field exit key is not required.
		1	Field exit key is required.
	2		Monocase.
		0	Accept lowercase letters.
		1	Translate operator-entered letters to uppercase.
	3		Reserved.
	4		Mandatory enter.
		0	This is not a mandatory enter field.
		1	This is a mandatory enter field.
	5-7		Right adjust/mandatory fill (MF).
		000	No adjust specified.
		001	Reserved.
		010	Reserved.
		011	Reserved.
		100	Reserved.
		101	Right adjust, zero fill.
		110	Right adjust, blank fill.
		111	Mandatory fill.

No checks are made against the field format word when the host system writes to the display; therefore, the user can initialize the field the user wants. The host system can turn on the master MDT bit by placing in the display data stream a field format word with bit 4 on. When there is a Read MDT command, the field is sent back to the host system as if the operator had modified it.

Fields

The following table identifies the types of fields available and their characteristics. The display fields are defined by the field format word. The information in parentheses immediately following the field name gives the byte and bit identifiers of the field in the field format word. See the index entry *field format word* for specific bit information.

Field Type	Description
Alphabetic only (byte 1, bits 5-7 = 001)	Accepts only characters A-Z (both uppercase and lowercase plus the , . - and blank symbols). Other characters cause operator errors. Some special characters for World Trade countries are also acceptable.
Alphabetic shift (byte 1, bits 5-7 = 000)	Accepts all characters. The shift keys are acknowledged. The characters on the lower symbol of each key are valid.
Auto enter (byte 2, bit 0)	Sends the contents of all fields except Read MDT fields to the host system when the operator either enters the last character into the last position of the field or enters one of the field exit keys. (The only Read MDT fields sent are those that have been modified.)
Bypass (byte 1, bit 2)	Entries are not allowed in this field. If the operator tries to enter something into this field, an error results.
Dup enable (byte 1, bit 3)	The controller repeats hex 1C from the cursor position to the end of the field when the operator presses the Dup key; this shows on the display as an overstruck asterisk.
Field exit required (byte 2, bit 1)	Requires the operator to exit the field with a nondata key. When the operator has entered the last character, the cursor remains under the character and blinks, indicating that a Field Exit key is required.
I/O (byte 1, bits 5-7 = 110)	Rejects any data keys from the keyboard. The operator can move the cursor in and out of the field as in a nonbypass field. Any entered data results in an error. Data from a magnetic stripe reader or selector light pen can be entered into an I/O field without causing an error.
Katakana shift (byte 1, bits 5-7 = 100)	This is the same as the alphabetic shift except the keyboard is Katakana and is placed in Katakana shift.
Mandatory enter (MD) (byte 2, bit 4)	Requires the operator to enter something in the file before the controller allows the Enter key to be active. The controller recognizes the state of these fields by checking the MDT bit for the field. If the operator tries to bypass the field using a Field +, Field -, or Field Exit key, an error occurs.
Digits only (byte 1, bits 5-7 = 101)	Allows digits 0-9 only from keyboard. Also allows the DUP key if the DUP enabled bit in the FFW is on (5294 only).

<table>
<tr><th>Field Type</th><th>Description</th></tr>
<tr><td>Mandatory fill (MF) (byte 2, bits 5-7 = 111)</td><td>Requires that once the operator has entered data into the field, he must completely fill the field before exiting. Any attempt to leave an unfilled field causes an error. The operator can use the Dup key to fill the field. If the field is nulled when the operator exits from the first position using the Field Exit or Erase Input key and the MDT bit is on, the null fields can be set back to the host system in response to a red command.</td></tr>
<tr><td>Monocase (byte 2, bit 2)</td><td>Regardless of the shift state, the keyboard enters only the uppercase characters A-Z in the field. In addition, the following characters on the specified World Trade typewriter keyboard will be translated to uppercase.

<table>
<tr><td>Austria/Germany</td><td>ü ä ö</td></tr>
<tr><td>Brazil</td><td>ã ç é õ</td></tr>
<tr><td>Denmark</td><td>å æ ø</td></tr>
<tr><td>Finland</td><td>å ä ö é</td></tr>
<tr><td>Norway</td><td>å æ ø</td></tr>
<tr><td>Portugal</td><td>ã ç õ</td></tr>
<tr><td>Spain</td><td>ñ</td></tr>
<tr><td>Spanish Speaking</td><td>ñ</td></tr>
<tr><td>Sweden</td><td>å ä é ö</td></tr>
</table>

For the remaining World Trade typewriter-like and all data entry keyboards, the lowercase special characters are keyed and displayed as is.</td></tr>
<tr><td>Numeric only (byte 1, bits 5-7 = 011)</td><td>Accepts only characters 0-9 and the symbols + , . - and blank. Any other character causes an operator error. The unit position carries the sign digit for the field. Use either the Field +, the Field -, or the Field Exit key to exit this field. If you use the Field - key to exit the field, the controller changes the zone of the low=order digit to hex D, unless it is one of the symbols (+ - , . or blank); in this case, an error results.</td></tr>
<tr><td>Numeric shift (byte 1, bits 5-7 = 010)</td><td>Accepts all characters.</td></tr>
<tr><td>Right adjust (byte 2, bits 5-7; 101 = 110-blank)</td><td>Fills all left-most unoccupied positions of a field with the specified character; characters are right-adjust and spaces are blank-filled or zero-filled. The user must specify this as either blank or 0. The fill character will appear on the display.</td></tr>
<tr><td>Signed numeric (byte 1, bits 5-7 = 111)</td><td>Allows only characters 0-9. An attempt to enter any other character causes an error. The field must be at least 2 bytes long. Reserves the rightmost position for the sign display (- for negative and null for positive). The operator cannot key a digit into the last position; an error results if this attempt is made. Use either the Field +, the Field -, or the Field Exit key to exit this field. If you use the Field - key to exit this field, the controller right adjusts the field and places a negative sign in the rightmost position. If you use Field +, the controller right adjusts the field and blanks the rightmost position. The rightmost sign position is not sent to the host system in response to either the Read MDT or Read Input commands. The rightmost character is affected in the following way before it is sent to the host system: If it is a negative sign, the zone of the low-order digit is set to hex D. If it is positive, the low-order digit is not changed.</td></tr>
</table>

Format Level 0

Format level 0 is the condition of the format table at power-on and reset time. It has the following characteristics:

1. There is one input field that goes from row 1, column 2 to the last row, column 80.

2. The field is normal entry; no Field Exit key is required; there are no mandatory enter, no auto-record advance, no right adjust, and no mandatory fill field requirements.

3. The error line is on row 1.

4. Alphabetic shift is in effect.

5. No field control words are specified.

6. Uppercase and lowercase output is allowed.

See also the index entry *power-on state*.

Format Table

A format table contains the format information for the displays. There is one format table for each display. The Write to Display command from the host system builds the format tables. The entries in the tables define the characteristics of the field. Specifically, the format tables contain entries that describe (1) each input field that is returned to the system by all read commands (except Read Screen) and (2) each field that is modified from the keyboard (see the index entry *MDT bit*).

The format table contains the field control and field format words. It has room for a maximum of 127 fields if there are no field control words and no SOH order (see the index entry *SOH order*). The field length, field format, and field control words are sent by the host to the controller in the Write and Display command in the display data stream. The controller then stores these in the current format table. At power-on time, the format table is at format level 0. See these index entries for details: *field control word, field format word, format level 0*, and *display, commands*.

Frame - SDLC

The frame is the SDLC format used to convey commands and information between the host system and the controller. The SDLC frame is the organizational unit required to send information between the host system and the controller using remote attachment. The frame is what the host system and controller use to send requests for service, commands, data, and responses to each other. To be valid, the frame must be bounded by flags, and must be a minimum of 32 consecutive bits in length, or any greater length divisible by 8. The frame has a fixed format. This format is as shown:

	F	A	C	I	FCS	F
Bytes:	1	1	1	Determined by physical limitations required for accuracy. The I field is an optional field. It is where the SNA RUs reside. The I field is associated with an information frame and is restricted to a maximum of 261 bytes for the 5251 Model 2 or 12. See the index entry *SDLC, commands and responses*	2	1

The first **F** is a flag; **A** is the address of the referenced controller; **C** contains commands, responses, and information about the frame type (and commands and responses for the data link and link level types of formats); **FCS** performs transmission checking; and the last **F** is another flag. The following text explains each of the fields in more detail.

Flag Sequence (F)

All frames start and end with the bit sequence 01111110. An ending flag for one frame can also be the beginning flag for the next, or a single ending 0 can be shared to couple the ending flag sequence of one frame with the beginning flag sequence of another. The communications adapter hardware checks for the flag sequence.

Station Address Field (A)

This is the first 8-bit sequence following the flag; it contains the controller station address which identifies the secondary station (controller) that is involved in the transmission. See the index entry *station address* for details.

Control Field (C)

The control field is one byte long; it contains (1) commands and responses, (2) the poll bit for the host system, (3) the final bit for the controller, and (4) the sequence numbers for some commands and responses. See the index entries *SDLC, commands and responses* and *P/F bit* for detailed information.

The control field supports three frame types; they are: information, nonsequenced, and supervisory. Of those three frame types, only the information (I) frame contains data for the LUs. The other frames are for SDLC link-level control. The control field for each frame type is different. Do not confuse the I control field with the information field. It is the information field of the information frame that contains the RUs that the I frames support. The information format of the control field only identifies the information frame. The I format has this configuration:

Information (I) Format:

```
0 1 2 |3   | 4 5 6|7
| Nr  |PF | Ns   |0
```

The I frames are used to transfer information. They are the only frames that contain **Ns** bits.

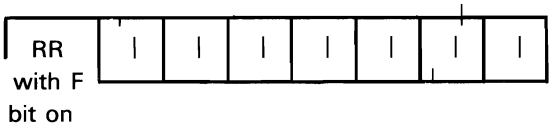
Nr = Station-receive sequence count; 3 bits for error detection and recovery.

Ns = Station-send sequence count; 3 bits to number information frames as they are sent.

P/F = Poll/final bit. The poll bit is in frames sent by the host system, and the final bit is in the frames sent by the controller.

The controller cannot send a response to the host system until it receives a frame with the poll bit on. When the controller responds to a command from the host, it will send no more than seven consecutive I-frames. The transmission of the I-frames will be followed by either a ready to receive (RR) or a receive not ready (RNR) response and the F bit of this last frame will be on. This indicates to the host system that the controller has finished.

In this example, the frames are traveling ———>



Information Field (I)

This field contains such things as the RUs (LU data streams), status, controls, and SNA responses and commands. The I field of an information frame consists of 2 bytes of TH followed by 3 bytes of RH and finally followed by up to 256 bytes of RU. The maximum length of this field is 261 bytes (including the SNA header information, which is 5 bytes long, and the RU, which can be a maximum of 256 bytes long). See the index entries *RU; RH; TH;* and *SNA, commands* for specific information about the contents of the I-field.

```
| TH  RH --      RU       -- |
|-------------------| part of SDLC frame--------------------
```

Flag Uniqueness

The frame can consist of any sequence of bits. If there are five consecutive 1s, the controller inserts a 0 when transmitting and deletes a 0 when receiving to indicate that the bit sequence has been checked. This prevents data from being misinterpreted as a flag.

Frame Check Sequence (FCS)

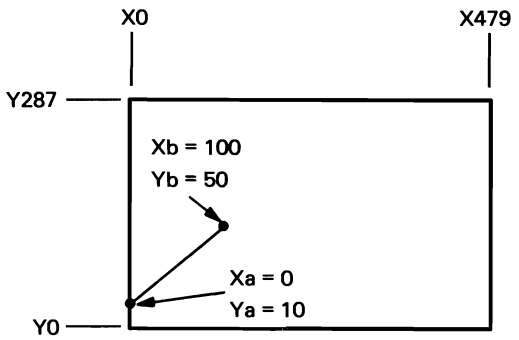
This field is 16 bits long. It is used for detecting transmission errors. Any frame that contains an FCS error is discarded.

Graphics Introduction

Graphics on the 5250 Information Display System is implemented by using the 5292 Color Display Station Model 2. The 5292 Model 2 also has three standard interfaces for I/O features. The three interfaces are:

- IEEE-488 digital interface for plotters
- Video interface for video film camera or video monitor
- Parallel printer interface.

The 5292 Color Display Station Model 2 can display alphanumeric (A/N) and graphic images, such as pie charts and line drawings using flexible line styles and line widths. The displays can be in seven (plus black, which cannot be changed) colors selected from a palette of 512. The graphic images are displayed by selecting the color and a combination of addressable dots (PELs or picture elements) on the display screen. The PELs are addressed by X and Y coordinates as shown below.



5292 Graphics orders in the data stream allow the programmer to draw a line between X and Y coordinates (vector graphics), fill areas with color, and vary line style and width.

5292 Select Options

The 5292 Color Display Station Model 2 has options available from the keyboard during online select option mode to control graphics. These options are activated by pressing certain key sequences. The select options available are:

- Erase graphics display: Selecting this option erases the graphics buffer, which clears the graphic display.
- Terminate graphics processing: Selecting this option discontinues graphics mode and terminates graphics processing.
- Graphics display-on/off: Selecting this option turns the graphics display on and off.
- Screen copy: Selecting this option copies from 1 to 20 copies of the screen to an output printer device.

More information on select options is contained in the *5292 Color Display Station Models 1 and 2 Operator's Guide*, GA21-9416.

Graphic Display Indicators

There are two additional indicators on the 5292 display that pertain to graphic displays.

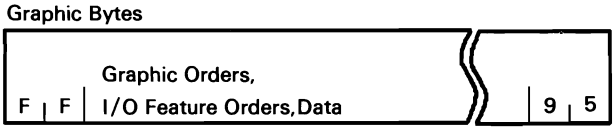
- Graphic Display-On indicator: When graphics display is on, a blue **G** appears on the indicator line of the display.
- Graphics Mode indicator: This is the same indicator as the input-inhibited indicator on the Model 1 except that the indicator is blue for graphics mode or screen copy. When the Graphics Mode indicator is on, the keyboard on the 5292 Model 2 is locked.
- Screen copy count: This is a blue number on the lower right that indicates the number of copies to be produced.

More information on 5292 Model 2 Display indicators is contained in the *5292 Color Display Station Models 1 and 2 Operator's Guide*, GA21-9416.

Graphic and I/O Feature Orders

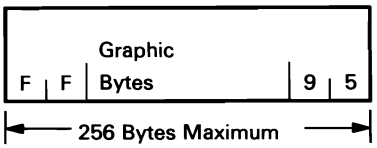
Graphic bytes consist of Graphic orders, I/O Feature orders, and data associated with the orders. The graphic bytes in a graphics data stream must begin with hex FF (Begin Graphics order) and end with hex 95 (End Graphics order) as shown below.

Graphic Bytes



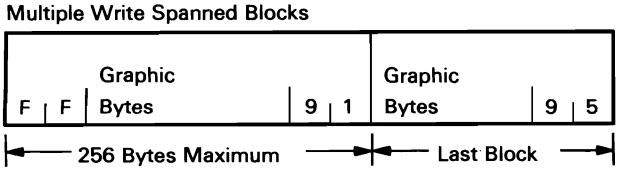
Graphic bytes are sent to the 5292 Model 2 in write blocks. A graphic write block has a maximum length of 256 bytes and a minimum length of 11 bytes. Graphic blocks may be sent to the 5292 Model 2 by single blocks, where each graphic write block begins and ends graphic mode as shown below.

Single Write Block



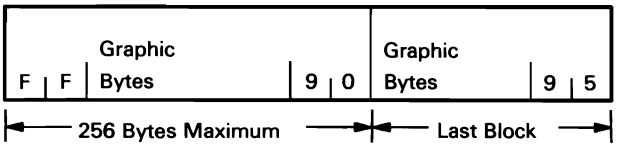
If a group of blocks is sent, graphic data for certain orders may span blocks. For orders where data can span blocks, the data can be split by using the More-Data-to-Come order (hex 91) as shown below. A detailed description of each Graphic order and whether data can span blocks for that order is contained in Section 2 of this manual.

Multiple Write Spanned Blocks



A group of graphic write blocks can also be sent by using the End Graphics Block order (hex 90) to specify the end of a graphics write block without ending graphics mode as shown below.

Multiple Write Nonspanned Blocks

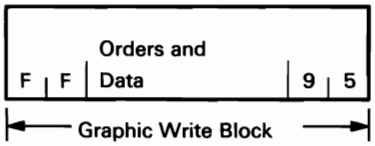


Pacing

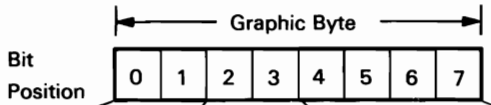
Pacing is the method used by the host system to send graphics data streams to the display station independent of the display station busy status. Pacing is necessary because some graphic operations, especially to the I/O interfaces, take several seconds to complete. This would exceed the work station controller time-out unless a way is provided to release the work station controller before graphic data is fully processed. Pacing is accomplished on the 5292 Model 2 by resetting busy as soon as a graphics block is received. When the graphics block is fully processed, a graphics aid key is returned to the host to indicate the display station is ready to process another graphics block. More details on pacing are contained later in this section.

Graphic and I/O Feature Orders

The data stream that defines the graphic displays and I/O feature operations is sent from the host using normal 5250 Write commands. The graphic and I/O feature data streams are made up of a combination of orders and data as shown below.



The 8 bits that make up a graphic byte have the following format:



Bits 0 and 1	Bits 2 and 3	Bits 4 through 7
00 Invalid		
01 Graphic Data	Bits 2 through 7 contain data to be used with a previous order.	
10 Graphic Order	00 Read Order 01 Control Order 10 Draw Order 11 Set Order	Bits 4 through 7 identify a specific order.
11 I/O Feature Order	00 I/O Printer Control Order 01 I/O IEEE Set Order 10 I/O IEEE Local Command Order 11 Reserved	

There are two control orders that have a special meaning and must begin with the first byte in a graphics write block as shown below.

Byte 1	Byte 2	Order	Function
Hex FF		Begin Graphics Order	This order turns on graphics mode and identifies the following bytes as graphic bytes.
Hex FF	Hex FF	System Graphics Reset	This order terminates graphics processing, ends graphic mode, and returns a graphic AID key code to the host (See *Pacing* in this chapter.).

The Graphic and I/O Feature orders are described in detail in the following sequence:

1. Graphic Control orders
2. Graphic Set orders
3. Graphic Draw orders
4. Graphic Read orders
5. I/O Feature: Printer orders
6. I/O Feature: IEEE Interface orders.

Graphic Control Orders

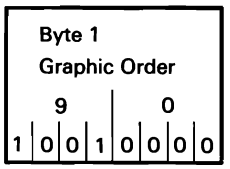
Graphic Control orders control the processing of graphic data streams. Control orders have no data associated with the order. The following chart summarizes the control orders, and a detailed description of each order follows the chart.

Order	Graphic Byte	Data Bytes Used with This Order	End of Data Required	Block Spanning Allowed	Description of Data
End Graphics Block	90	0	No	No	No data for these orders.
More Data to Come	91	0	No	No	
End of Data	92	0	No	No	
Graphics Display On	93	0	No	No	
Graphics Display Off	94	0	No	No	
End Graphics	95	0	No	No	
Suppress Pacing Response	96	0	No	No	

End Graphics Block Order

Function: The End Graphics Block order tells the 5292 Model 2 to ignore the remaining bytes in the current graphics write block, and to prepare to receive the next graphics write block.

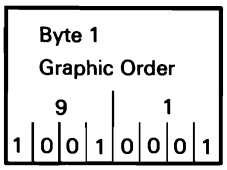
Format:



More-Data-to-Come Order

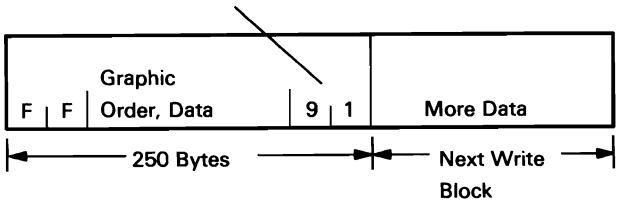
Function: The More-Data-to-Come order tells the 5292 Model 2 that the next write block will contain more data for the current order. This order is valid for variable length data orders only.

Format:



Example: The following graphic data stream shows a Graphic order where the data associated with the order spans write blocks. The More-Data-to-Come (MDTC) order tells the system that the next write block contains more data.

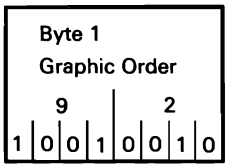
The MDTC order tells the system that this is the end of this write block and the next write block contains more data.



End-of-Data Order

Function: The End-of-Data order tells the 5292 Model 2 that this is the end of the data associated with the previous order. This order is valid only for variable length data orders and must be preceded with at least 1 data byte. This order ends the previous order.

Format:

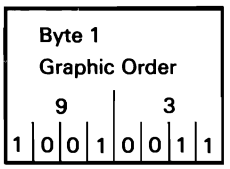


Graphics Display-On Order

Function: The Graphics Display-On order turns on the 5292 Model 2 graphic display. This allows the display station to display data from the graphics buffer. Graphics display on is indicated at the 5292 Model 2 by a blue **G** on the left side of the status line.

When the graphics display is turned on at the 5292 Model 2, reduced line spacing will be in effect.

Format:

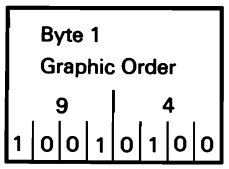


Graphics Display-Off Order

Function: The Graphics Display-Off order turns off the graphics display at the 5292 Model 2. Graphics Display-Off is indicated at the 5292 Model 2 by the blue **G** on the status line going off.

When the graphics display is turned off at the 5292 Model 2, the reduce line space reverts to the status that was in effect when graphics display was turned on.

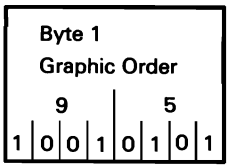
Format:



End Graphics Order

Function: The End Graphics order ends graphics mode. The 5292 Model 2 cannot accept Graphic orders, I/O Feature orders, or graphic data until graphics mode is started again by a graphics data stream with the first byte of hex FF. The blue Input inhibited indicator on the status line of the 5292 is turned off.

Format:

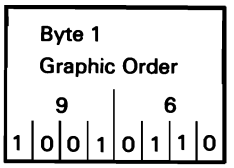


Suppress Pacing Response Order

Function: The Suppress Pacing Response order specifies that no graphics aid key code will be returned to the system following completion of current graphic block processing.

CAUTION
When this order is used, the normal pacing function is altered and the programmer must provide proper pacing control.

Format:



Graphic Set Orders

The Graphic Set orders are used to set up graphics display attributes such as color, line style, and line width to be used by subsequent Draw orders. The values specified in the Set orders remain in effect for subsequent Draw orders until another Set order changes the value. The following list summarizes the Graphic Set orders, and a detailed description of each Set order follows.

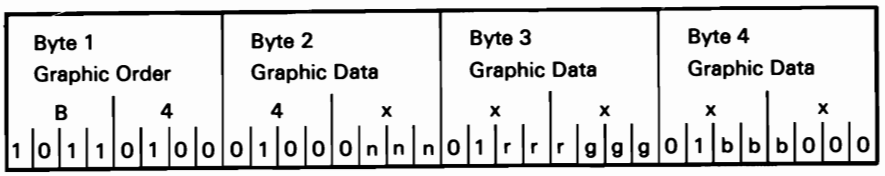
Order	Graphic Byte	Data Bytes Used with This Order	End of Data Required	Block Spanning Allowed	Description of Data
Set Color Table	B4	Var	Yes	Yes	Table index/value
Set Color	B0	1	No	No	Color index
Set Style	B1	4	No	No	Line style
Set Style Offset	B2	1	No	No	Line style offset
Set Function	B3	1	No	No	Function type
Set Marker	B5	1	No	No	Marker type
Set Line Weight	B6	1	No	No	Line weight
Set Fill Mode	B7	2	No	No	Fill control information

Set Color Table Order

Function: The Set Color Table order allows the programmer to choose seven display colors (plus black, which cannot be changed) from a palette of 512. The color table contains 3 intensity bits for each of the primary colors (red, green, and blue). The intensity bits for each of the primary colors can be set by using the Set Color Table order to achieve the desired tint or shade for each of the seven color indexes. A value of 7 indicates maximum intensity for a primary color. The color table is initialized to the following values. Multiple color indexes can be changed per order.

3 Bit Color Index	Initial Value rrr	ggg	bbb	Color
000	0 0 0	0 0 0	0 0 0	Black (This color index cannot be changed.)
001	1 1 1	0 0 0	0 0 0	Red
010	0 0 0	1 1 1	0 0 0	Green
011	0 0 0	0 0 0	1 1 1	Blue
100	1 1 1	0 0 0	1 1 1	Pink
101	1 1 1	1 1 1	0 0 0	Yellow
110	0 0 0	1 1 1	1 1 1	Turquoise
111	1 1 1	1 1 1	1 1 1	White

Format:



Byte 1 = This is the Graphic order for the set color table.

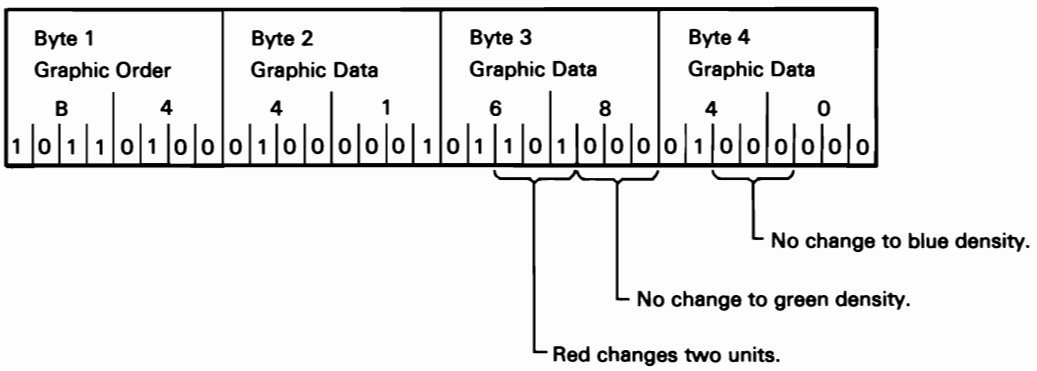
Byte 2 = The binary value of the **nnn** bits is the color index you want to set.

Byte 3 = The **rrr** bits control the red intensity. The **ggg** bits control the green intensity.

Byte 4 = The **bbb** bits control the blue intensity.

More color changes can follow until an end of data is encountered.

Example: The following Graphic order will reduce the color index 1 red intensity two increments from its default value of seven.



Set Color Order

Function: The Set Color order specifies the color to be used on subsequent Draw orders.

Default: The default color index is 7.

Format:

Byte 1 Graphic Order								Byte 2 Graphic Data							
B				0				4				0-7			
1	0	1	1	0	0	0	0	0	1	0	0	0	a	a	a

The binary value of bits **aaa** specifies the color index (0 through 7) to be used for subsequent Draw orders.

Example: The following Graphic order and data byte will set the display color to color index 1 for subsequent Draw orders:

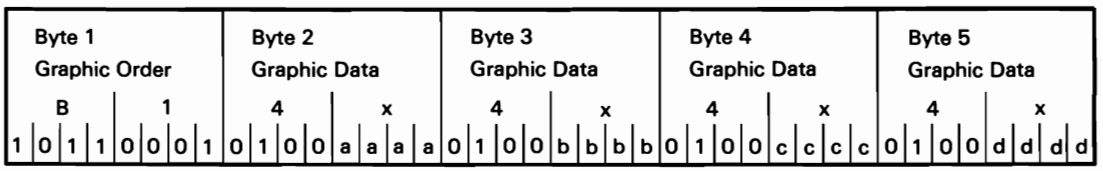
Byte 1 Graphic Order								Byte 2 Graphic Data							
B				0				4				1			
1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1

Set Style Order

Function: The Set Style order specifies the line style to be used for subsequent Draw orders. You can specify a solid line or a dotted line with variable visible lengths and variable unchanged PELs between the visible PELs.

Default: The default value is hex F0F0, which is a solid line.

Format:



Byte 1 = This is the Graphic order for the set line style.

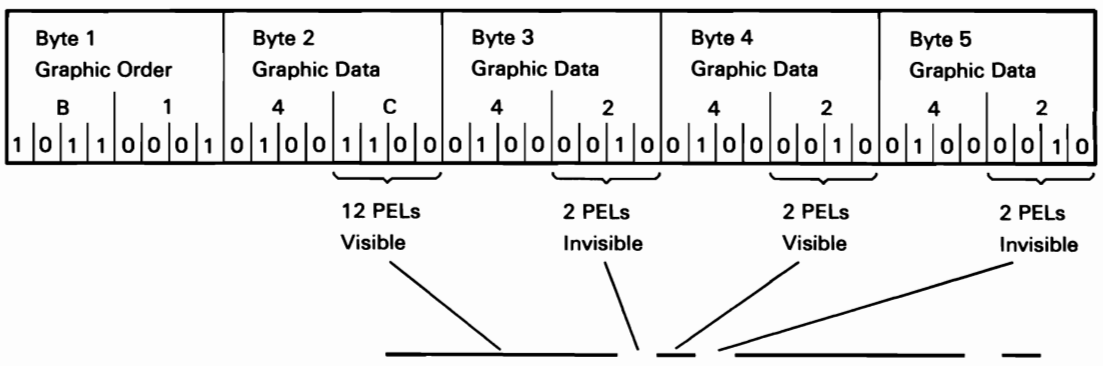
Byte 2 = The binary value of the **aaaa** bits is the length (number of PELs) of the first visible segment of the line style.

Byte 3 = The binary value of the **bbbb** bits is the number of unchanged PELs that follow the first visible segment.

Byte 4 = The binary value of the **cccc** bits is the length of the second visible segment of the line.

Byte 5 = The binary value of the **dddd** bits is the number of unchanged PELs that follow the second visible segment.

Example: The following Graphic order and graphic data will set the line style shown below on a blank background.

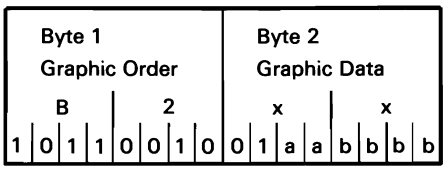


Set Style Offset Order

Function: This order specifies which of the four length values you want to start with when using the line style specified in a previous Set Style order. You can select one of the four lengths specified in the previous Set Style order and also specify an override length for the value selected.

Default: The default value is hex 00, and causes the line to start as it was specified in the previous Set Style order.

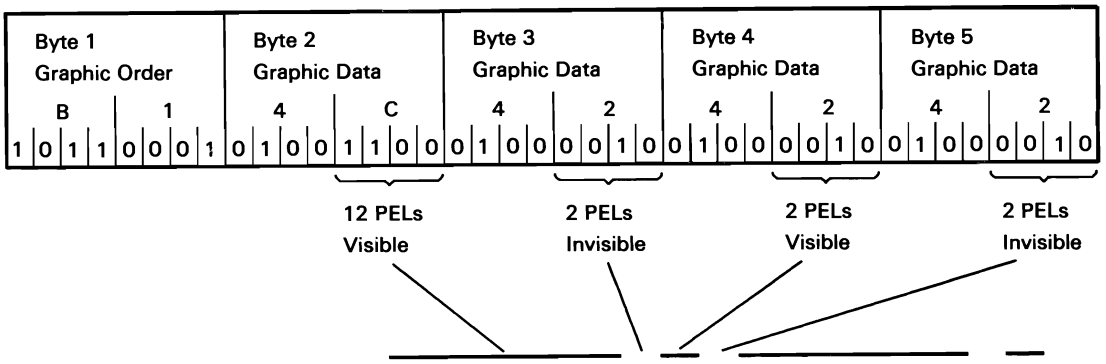
Format:



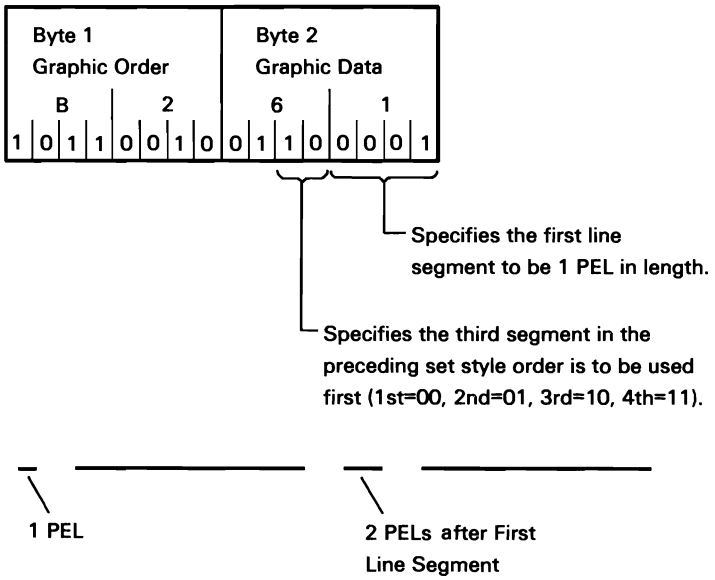
Byte 1 = This is the Graphic order for the set style offset.

Byte 2 = The binary value of the **aa** bits represents the first, second, third, or fourth segment length that was specified in the preceding Set Style order. This segment will be used for the first line segment on subsequent Draw orders.

Example: The following Set Style order was issued previously for the following line style.



The following Set Style Offset order and data specifies the first line segment to be drawn by subsequent Draw orders to be 1 PEL in length.

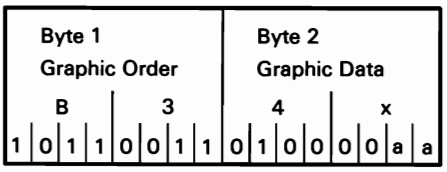


Set Function Order

Function: The Set Function order determines how subsequent Draw orders will be combined with the existing picture. This order allows you to specify whether you draw over an existing picture (replace), or combine the existing picture color with the color you are drawing to display a different color.

Default: The default value hex 11 specifies replace, which will result in the color you are drawing replacing any existing color.

Format:



Byte 1 = This is the Graphic order for the set function.

Byte 2 = The binary values of the **aa** bits have the following meaning:

00 = Reserved.

01 = OR: If you specify this value, the color you are drawing will be combined with the existing color using OR logic.

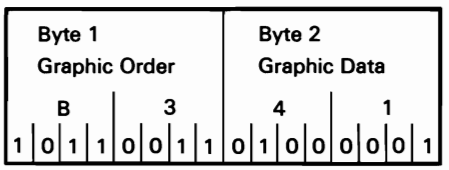
10 = XOR (exclusive OR): If you specify this value, the color you are drawing will be combined with the existing color using exclusive OR logic.

11 = Replace: This is the default and specifies that the color you are drawing will replace the existing color.

Example: If you are drawing a red line and encounter an existing white PEL, the resulting color-assuming default colors will be:

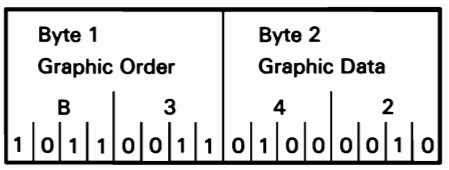
OR
001 (Red)
111 (White)
111 Resulting Color (White)

Order Used



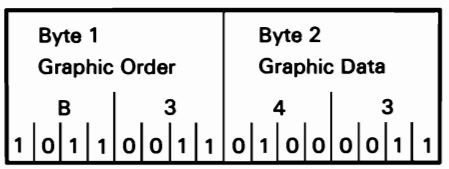
XOR
001
111
110 Resulting Color (Turquoise)

Order Used



Replace
001
111
001 Resulting Color (Red)

Order Used

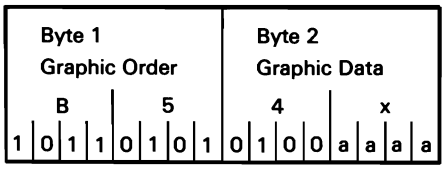


Set Marker Order

Function: The Set Marker order establishes the type of marker that will be drawn for subsequent Write Polymarker orders.

Default: The default value for this order is 0000 which will be a solid 5 X 5 box.

Format:



Byte 1 = This is the Graphic order for the set market order.

Byte 2 = The **aaaa** bits define the type of marker to be drawn. The values for the **aaaa** bits result in the following markers:

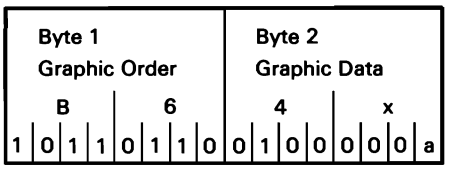
aaaa bits	**Description**	**Marker**
0000	Solid 5 x 5 box (default)	■
0001	Solid 3 x 3 box	■
0010	Empty 5 x 5 box	□
0011	5 x 5 plus sign	+
0100	5 x 5 cross	×
0101	Solid 5 x 5 diamond	◆
0110	Hollow 5 x 5 diamond	◇
0111	3 segment asterisk	✳
1000	4 segment asterisk	✳

Set Line Weight Order

Function: The Set Line Weight order determines which line width will be used for subsequent Draw Polyline orders. The values that can be specified on this command are single line width (normal) or double line width.

Default: The default value is 0, which results in single line width (normal).

Format:



Byte 1 = This is the Graphic order for the set line weight.

Byte 2 = The **a** bit determines if the line weight will be single weight or double weight as follows:

a bit = 0 Single width
a bit = 1 Double width

Set Fill Mode Order

Function: The Set Fill Mode order establishes the fill and reference line information that will be used for subsequent Fill Polygon and Define Shield Area orders.

Default: The default values are:

aa bits	00	The interior style will follow a vertical reference line.
bb bits	00	Draw a solid boundary line and fill with current style.
cccccc	000000	The reference line will not be shifted.

Format:

Byte 1 Graphic Order								Byte 2 Graphic Data								Byte 3 Graphic Data							
B							7	4							x	x							x
1	0	1	1	0	1	1	1	0	1	0	0	a	a	b	b	0	1	c	c	c	c	c	c

Byte 1 = This is the Graphic order for the set fill mode.

Byte 2 = The **aa** bits determine the reference line to be used for a Fill Polygon order as follows:

aa bits 00 The interior style will follow a vertical reference line.

aa bits 01 The interior style will follow the polygon edge.

aa bits 10 The interior style will follow a +45 degree from vertical reference line.

aa bits 11 The interior style will follow a - 45 degree from vertical reference line.

The **bb** bits determine the fill mode to be used for subsequent Draw orders as follows:

bb bits 00 This mode will draw a solid boundary line and fill the polygon with the style specified in the Set Style order.

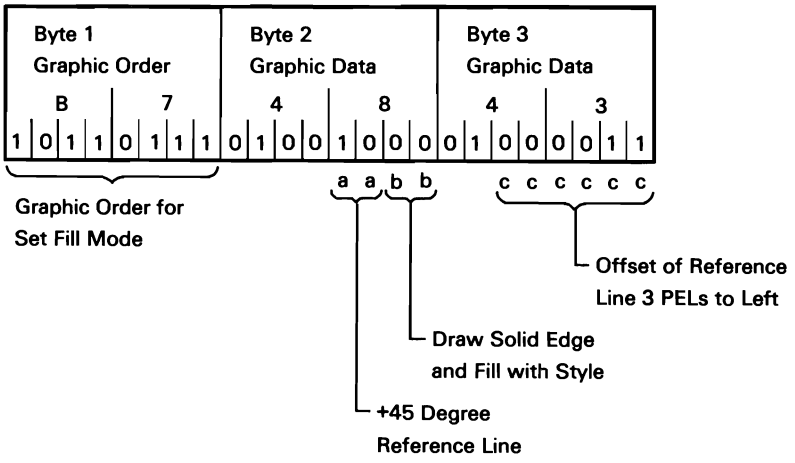
bb bits 10 This mode will draw a solid boundary line only.

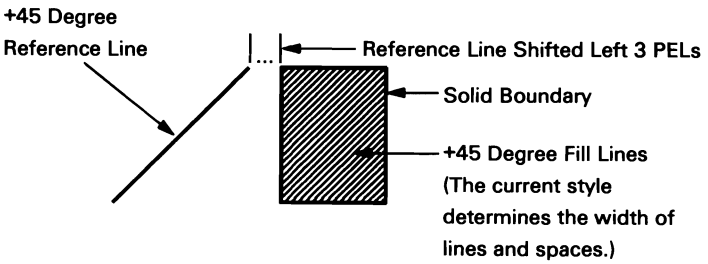
bb bits 10 This mode will fill the interior of the polygon with the style specified in the Set Style order.

bb bits 11 This mode will draw the boundary only with the style specified in the Set Style order.

Byte 3 = The **cccccc** bits specify the amount the reference line is to be shifted. The value of the **cccccc** bits is the number of PELs that the reference line is to be moved left.

Example: The following Graphic order and graphic data will result in setting the fill mode to cause a solid boundary line and polygon fill that will follow a +45 degree reference line that is offset 3 PELs to the left. The fill will occur when a Fill Polygon order is issued. The style for the fill lines will be defined by a previous Set Style order.





Graphic Draw Orders

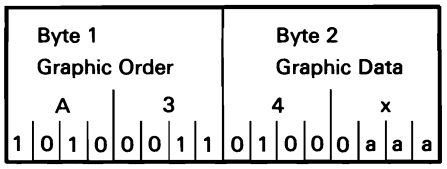
Graphic Draw orders are the group of orders that draw the images on the display screen. The line weight, line style, color, and fill modes are defined in previous Graphic Set orders. The following chart is a summary of the Graphic Draw orders. A detailed description of each order follows the chart.

Order	Graphic Byte	Data Bytes Used with This Order	End of Data Required	Block Spanning Allowed	Description of Data
Write Background	A3	1	No	No	Background color
Draw Polyline	A0	Var	Yes	Yes	X and Y coordinates
Draw Scanline	A1	Var	Yes	Yes	X and Y PEL pattern
Write Polymarker	A4	Var	Yes	Yes	X and Y coordinates
Fill Polygon	A5	Var	Yes	Yes	X and Y coordinates
Define Shield Area	A6	Var	Yes	Yes	X and Y coordinates

Write Background Order

Function: The Write Background order writes the entire background on the screen to the color specified in the data byte. The line style and function are determined by the current line style and function.

Format:



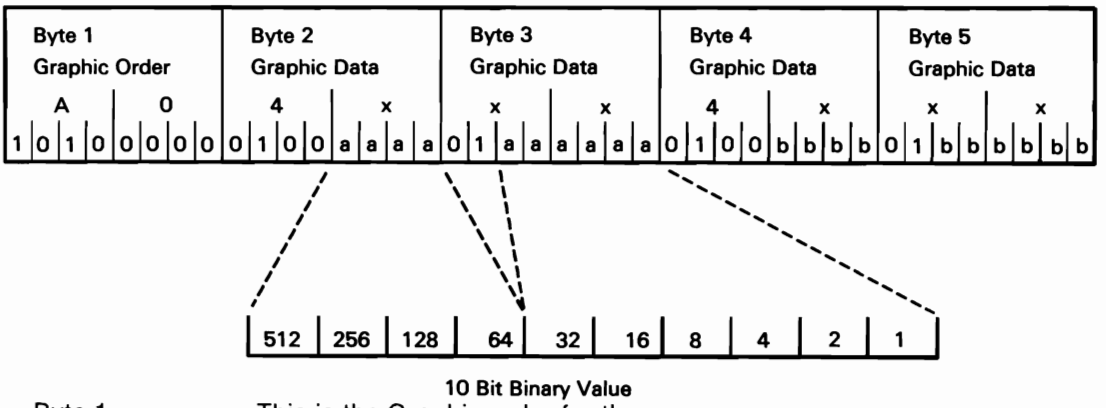
Byte 1 = This is the Graphic order for the write background.

Byte 2 = The binary value of the **aaa** bits is the color index that the order will use when it writes the background.

Draw Polyline Order

Function: The Draw Polyline order connects X and Y coordinates defined in the graphic data bytes that follow the Draw Polyline order. The current line style, color, width, and function are used. Each X and Y coordinate is defined in 4 graphic bytes that follow the order. This order will connect all coordinates specified in the graphic data bytes until an End-of-Data order is encountered.

Format:



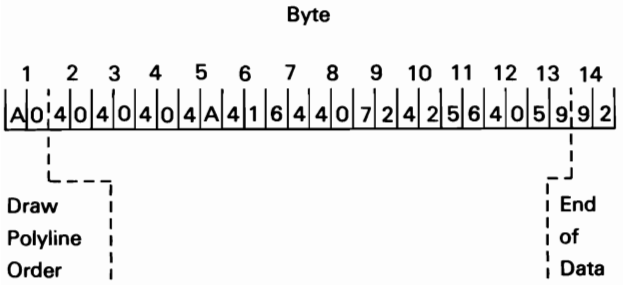
Byte 1 = This is the Graphic order for the draw polyline.

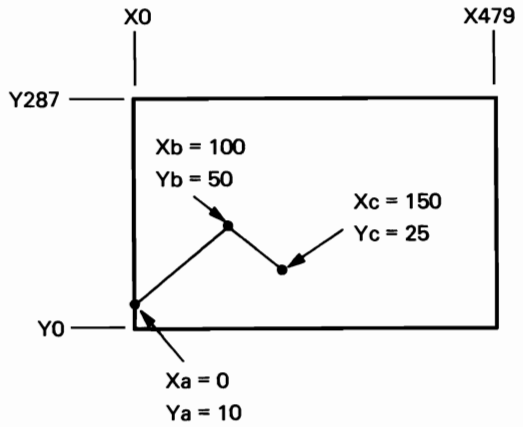
Bytes 2 and 3 = The binary value of the **a** bits is the X coordinate of the first point (0 through 479).

Bytes 4 and 5 = The binary value of the **b** bits is the Y coordinate of the first point (0 through 287).

More X and Y coordinates can follow until an End-of-Data order is encountered. If there are more X and Y coordinates than will fit in a write block, use the More-Data-to-Come order described earlier in this chapter.

Example: The following Draw Polyline order will draw the polyline shown below:

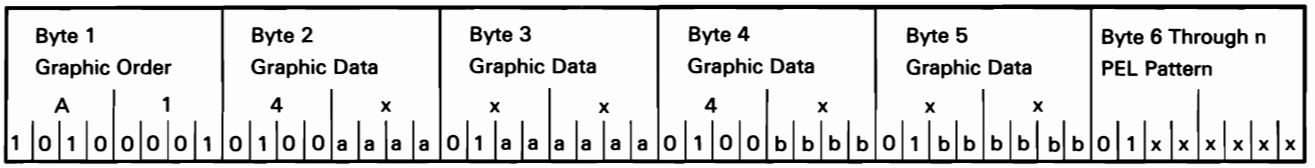




Draw Scanline Order

Function: The Draw Scanline order allows the programmer to set individual PELs on a specified scan line. The scan lines are numbered starting at the bottom of the screen with scanline 0 to the top of the screen with scanline 287. The Draw Scanline order is followed by graphic data bytes that specify where the X and Y coordinates start, and these are followed by graphic data bytes that indicate which PELs to set. The PELs are either set to the current color using current function or left alone.

Format:



Byte 1 = This is the Graphic order for the draw scanline.

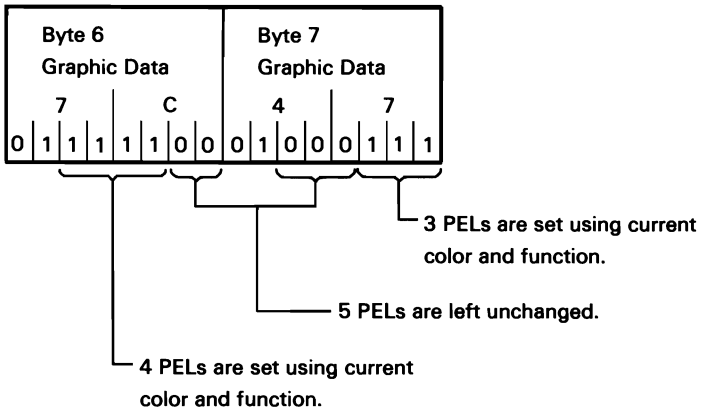
Bytes 2 and 3 = The binary value of the **a** bits is the X coordinate of the first point (0 through 479).

Bytes 4 and 5 = The binary value of the **b** bits is the Y coordinate of the first point (0 through 287).

Bytes 6 thru n = The bit pattern of bytes 6 thru n determines which PELs will be set and which PELs will be left as is. If the bit is: 1 = set the PEL using current color and function; 0 = do not change the PEL.

More scan line pattern bytes can follow until an end of data is encountered. If there is more data than will fit in a write block, use the More-Data-to-Come order described earlier in this chapter.

Example: The following example bytes 6 and 7 will result in the following scanline pattern being drawn at the coordinates defined in bytes 2 through 5.



Write Polymarker Order

Function: The Write Polymarker order will write the polymarker defined in the previous Set Marker order at the coordinates specified in the graphic data bytes of the Write Polymarker order.

Format:

Byte 1 Graphic Order								Byte 2 Graphic Data								Byte 3 Graphic Data								Byte 4 Graphic Data								Byte 5 Graphic Data							
A				4				4				x				x				x				4				x				x				x			
1	0	1	0	0	1	0	0	0	1	0	0	a	a	a	a	0	1	a	a	a	a	a	a	0	1	0	0	b	b	b	b	0	1	b	b	b	b	b	b

Byte 1 = This is the Graphic order for the draw polymarker.

Bytes 2 and 3 = The binary value of the **a** bits is the X coordinate.

Bytes 4 and 5 = The binary value of the **b** bits is the Y coordinate.

More X and Y coordinates can follow until an end of data is encountered. If there is more data than will fit into a write block, use the More-Data-to-Come order described earlier in this chapter.

Fill Polygon Order

Function: The Fill Polygon order constructs a polygon from the X and Y coordinates in the graphic data bytes and fills the polygon, using fill mode and reference line as defined in the previous Set Fill Mode order. The last vertex is combined with the first vertex to form the last edge.

Restrictions:

1. The edges of polygons can touch but not cross.

2. The maximum number of nonhorizontal shield area and fill area edges is 128.

Format:

Byte 1 Graphic Order								Byte 2 Graphic Data								Byte 3 Graphic Data								Byte 4 Graphic Data								Byte 5 Graphic Data							
A				5				4				x				x				x				4				x				x				x			
1	0	1	0	1	0	0	1	0	1	0	0	a	a	a	a	0	1	a	a	a	a	a	a	0	1	0	0	b	b	b	b	0	1	b	b	b	b	b	b

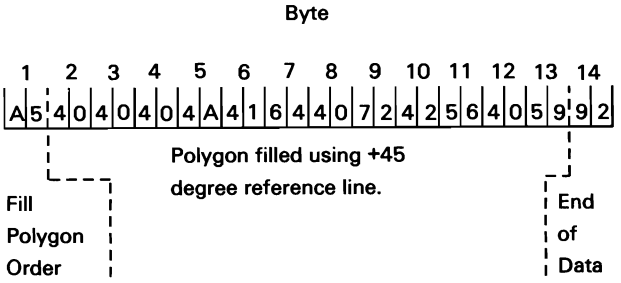
Byte 1 = This is the Graphic order for the fill polygon.

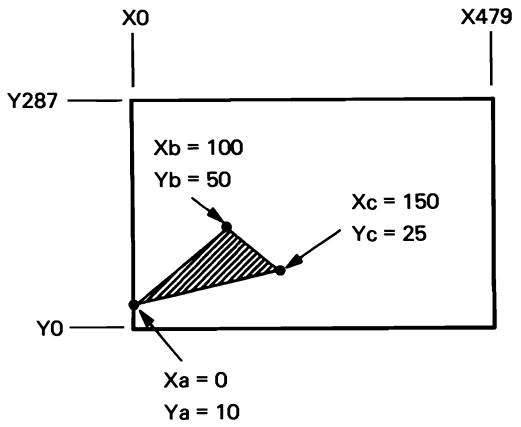
Bytes 2 and 3 = The binary value of the **a** bits is the X coordinate of the first point (0 through 479).

Bytes 4 and 5 = The binary value of the **b** bits is the Y coordinate of the first point (0 through 287).

More X and Y coordinates can follow until an End of Data order is encountered. If there is more data than will fit in a write block, use the More-Data-to-Come order described earlier in this chapter.

Example: The following Fill Polygon order will draw the polygon shown below and fill the polygon using the fill mode and reference line from the previous Set Fill mode, Set Style, and Set Function orders. In this example, the fill mode and reference line had been set to draw solid boundary and fill with +45 degree lines.





Define Shield Area Order

Function: The Define Shield Area order allows the programmer to define an area that will be shielded from the next Fill Polygon order. The shield area is defined in the graphic data bytes that follow the order. The Fill Polygon order does not have to immediately follow the Define Shield Area order; however, the next Fill Polygon order deletes previously defined shield areas after they have been processed. Shield areas may be defined within shield areas, and the result will be reverse shielding (no shield).

Restrictions:

1. The edges of polygons can touch but not cross.

2. The maximum number of nonhorizontal shield area and fill area edges is 128.

Format:

Byte 1 Graphic Order								Byte 2 Graphic Data								Byte 3 Graphic Data								Byte 4 Graphic Data								Byte 5 Graphic Data							
A				6				4				x				x				x				4				x				x				x			
1	0	1	0	0	1	1	0	0	1	0	0	a	a	a	a	0	1	a	a	a	a	a	a	0	1	0	0	b	b	b	b	0	1	b	b	b	b	b	b

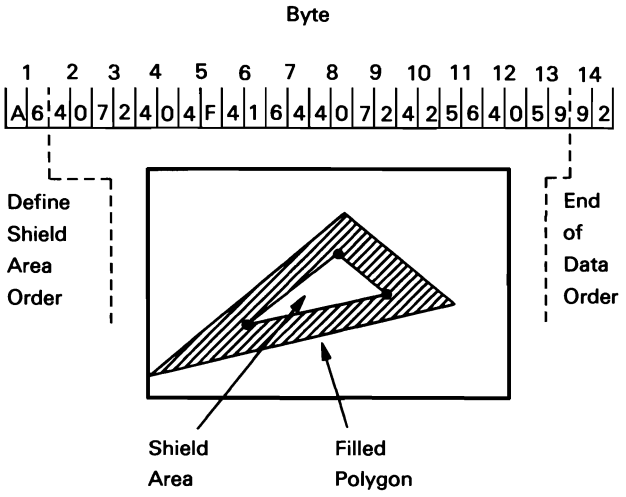
Byte 1 = This is the Graphic order for the define shield area.

Bytes 2 and 3 = The binary value of the **a** bits is the X coordinate of the first point (0 through 479).

Bytes 4 and 5 = The binary value of the **b** bits is the Y coordinate of the first point (0 through 287).

More X and Y coordinates can follow until an End of Data order is encountered. If the data will not fit a write block, use the More-Data-to-Come order described earlier in this chapter.

Example: The following Define Shield Area order will draw the shield area shown below. After the shield area is defined, a polygon can be drawn around the shield and filled; the shield area will be unaffected by the fill.



Read Orders

Graphic Read orders allow graphic data to be written to the A/N display buffer so it can be read by the host, using normal 5250 Read commands.

Order	Graphic Byte	Data Bytes Used with This Order	End of Data Required	Block Spanning Allowed	Description of Data
Read Status Order	80	2	No	No	Buffer offset

Read Status Order

Function: The Read Status order writes 20 bytes of graphic status information to the A/N display buffer address specified by the 2 graphic bytes that follow the order.

Format:

Byte 1 Graphic Order								Byte 2 Graphic Data								Byte 3 Graphic Data							
8							0	x							x	x							x
1	0	0	0	0	0	0	0	0	1	a	a	a	a	a	a	0	1	a	a	a	a	a	a

Byte 1 = This is the Graphic order for the read status.

Bytes 2 and 3 = The binary value of the **a** bits is the offset on the A/N display screen where the status data will be written. This value can be 0 through 1919. The binary value of 0 represents row 1, column 1 on the A/N display screen.

The 20 data bytes written to the A/N buffer on the read status order have the following format:

Position	Status Data Description
1,2	Two-byte error code of the last graphic error detected. These codes are described later in this section under error handling.
3,4	(5292 Model 2 identification).
5	Printer type.
6,7	If error pending, these 2 bytes are the offset into the graphics write block where the error was detected.
8 - 20	Reserved.

I/O Feature Printer Orders

Printer orders control the printing of graphics information and control the color tables for A/N and graphics information for the screen copy function. The programmer can use Printer orders to:

- Pass data received from the host directly to the printer interface.
- Pass display screen data to the printer interface for screen copy.
- Load the Printer Color Mix Table for A/N Screen Copy.
- Load the Printer Color Mix Table for Graphics Screen Copy.
- Set the duration of the printer error time-out.

The following chart summarizes the I/O Feature Printer orders. A detailed description of each order follows the chart.

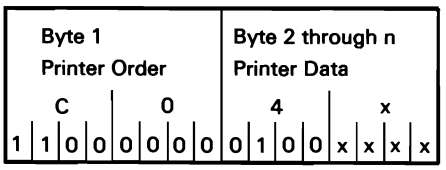
Order	Graphic Byte	Data Bytes Used with This Order	End of Data Required	Block Spanning Allowed	Description of Data
Printer Data Follows	C0	Var	Yes	Yes	Printer data
Screen Copy	C1	0	No	No	
Load A/N Color Mix Table	C2	Var	Yes	Yes	Table index value
Load Graphics Mix Table	C3	Var	Yes	Yes	Table index value
Set Printer Time-out	C4	1	No	No	Time-out value

The following paragraphs describe the printer orders.

Printer Data Follows Order

Function: This order allows printer data that can be variable in length to be passed to the printer interface from the host. Printer data is described later in this chapter.

Format:



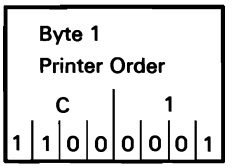
Byte 1 = This is the Printer order for the printer data that follows.

Data that follows this order will be processed as printer data until an end of data is encountered. If the data spans write blocks, use the More-Data-to-Come order described earlier in this chapter.

Screen Copy Order (This order is supported under a printer RPQ only.)

Function: The Screen Copy order causes the printer to provide hard copy output from the A/N buffer and the graphic bit map.

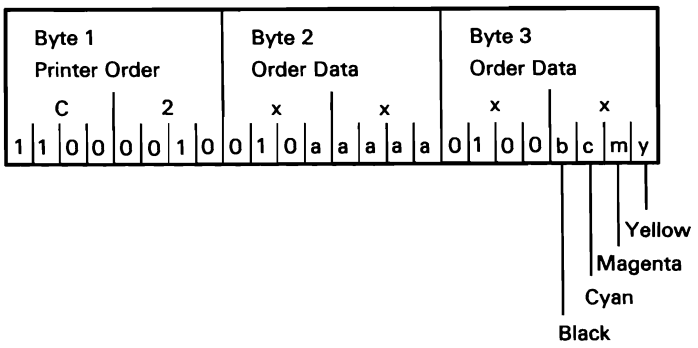
Format:



Load Printer A/N Color Mix Table Order

Function: The Load Printer A/N Color Mix Table order for screen copy maps the A/N display attributes into 16 possible colors. These colors are created by the printer, mixing black, cyan, magenta, and yellow. This order allows the default table to be changed by the host.

Format:



Byte 1 = This is the Printer order for Load Printer A/N Color Mix Table.

Byte 2 = The binary value of the **a** bits is the color index to be changed.

Byte 3 = The **bcmy** bits are the new **bcmy** values to be used.

Data associated with this order will be processed as color table changes until an end of data is encountered. If the data spans blocks, use the More-Data-to-Come order described earlier in this chapter.

The following chart summarizes the default values for the Printer A/N Color Mix Table.

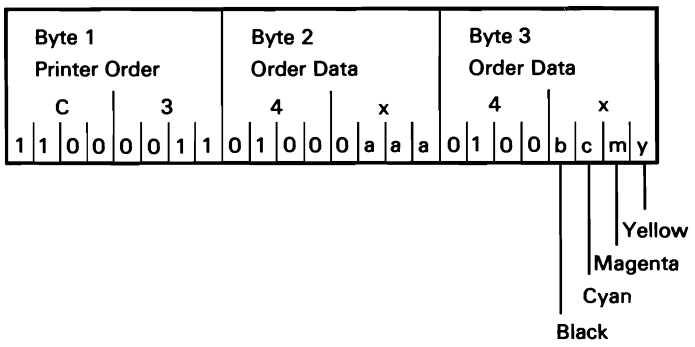
Color Index	A/N Attribute	Default Value (BCMY)	Color Printed
0	20	1000	Black
1	21	1000	Black
2	22	0101	Green
3	23	0101	Green
4	24	1000	Black
5	25	1000	Black
6	26	0101	Green
7[1]	27	0000	None
8	28	0010	Magenta
9	29	0010	Magenta
10	2A	0010	Magenta
11	2B	0010	Magenta
12	2C	0010	Magenta
13	2D	0010	Magenta
14	2E	0010	Magenta
15[1]	2F	0000	None
16	30	0100	Cyan
17	31	0100	Cyan
18	32	0001	Yellow
19	33	0001	Yellow
20	34	0100	Cyan
21	35	0100	Cyan
22	36	0001	Yellow
23[1]	37	0000	None
24	38	0011	Orange
25	39	0011	Orange
26	3A	0110	Violet
27	3B	0110	Violet
28	3C	0011	Orange
29	3D	0011	Orange
30	3E	0110	Violet
31[1]	3F	0000	None

[1]Cannot be changed by host.

Load Printer Graphics Color Mix Table Order

Function: The Load Printer Graphics Color Mix Table order for screen copy maps the color index number used for creating the display to 16 possible colors. These colors are created by the printer mixing of black, cyan, magenta, and yellow. This order allows the default table to be changed by the host.

Format:



Byte 1 = This is the Printer order for Load Printer Graphics Color Mix Table.

Byte 2 = The binary value of the **aaa** bits is the color index number to be used.

Byte 3 = The **bcmy** are the new **bcmy** values to be used.

The data associated with this order will be processed as table values until an end of data is encountered. If the data spans blocks, use the More-Data-to-Come order described earlier in this chapter.

The following chart summarizes the default values for the Printer Graphics Color Mix Table.

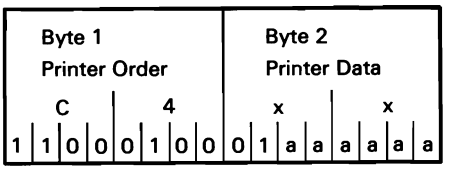
Color Index	Default Value (BCMY)	Color Printed
0	0000	None
1	0010	Magenta
2	0101	Green
3	0110	Violet
4	0011	Orange
5	0001	Yellow
6	0100	Cyan
7	1000	Black

Set Printer Time-out Order

Function: The Set Printer Time-Out order allows the programmer to vary the time-out value for a P1, P2, or P4 printer error. The time-out is the amount of time between the detection of a P1 or P2 error and the moment when processing is halted and the error is reported to the host. This time-out period also determines the maximum time the printer can be busy before processing is halted and a P4 error is reported to the host. The data byte associated with this order specifies the number of time units for the time-out. One time unit is 5.5 seconds.

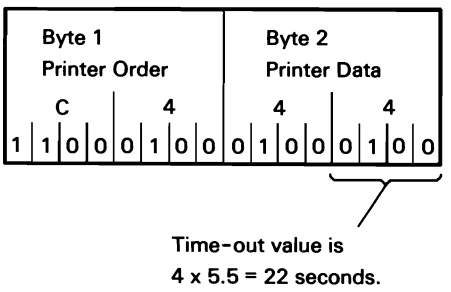
Default: The default value for this order is hex 03 (3 X 5.5 seconds).

Format:



Byte 1 = This is the Set Printer Time-Out order
Byte 2 = The **a** bits are the binary value of the units of time. The maximum time-out value is 5 minutes and 45 seconds (63 X 5.5).

Example: The following Printer order and data byte will set the time-out value to 22 seconds.



I/O Feature IEEE-488 Interface Orders

The IEEE-488 interface feature provides for two order types. The Set orders allow static information to be established, and the Local Command orders allow the dynamic commands to be processed.

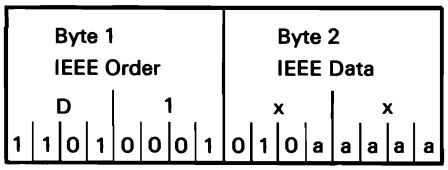
Order	Graphic Byte	Data Bytes Used with This Order	End of Data Required	Block Spanning Allowed	Description of Data
Set Address	D1	1	No	No	IEEE address
Set Talker Time Out	D2	2	No	No	Time-out value
Set EOI Mode	D3	1	No	No	EOI mode
IEEE Data Follows	E0	Var	Yes	Yes	Pass through data
Go to Standby	E2	0	No	No	
Remote Enable	E3	0	No	No	
Remote Disable	E4	0	No	No	
Interface Clear	E5	0	No	No	

The description of the IEEE-488 orders in this section assumes a working knowledge of the IEEE-488 standards.

Set Address Order

Function: The Set Address order sets the 5292 Model 2 IEEE address.

Format:

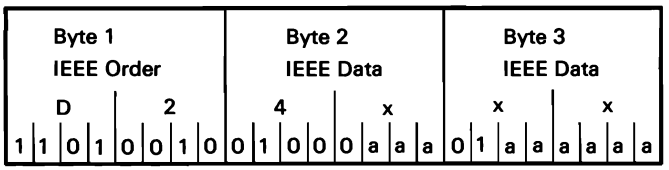


Byte 1 = This is the IEEE order for the set address
Byte 2 = The **a** bits are the binary value of the 5292 Model 2 address (0-30).

Set Talker Time-out Order

Function: The Set Talker Time-Out order sets the talker time-out to the specified number of seconds.

Format:



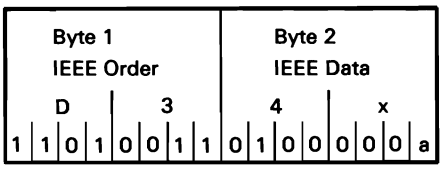
Byte 1 = This is the IEEE order for the set talker time-out.

Bytes 2 and 3 = The **a** bits are the binary value in seconds (0 to 511) to be used for a talker time-out (0 = no time-out).

Set EOI-Mode Order

Function: The Set EOI-Mode order sets the end or identify mode on or off.

Format:

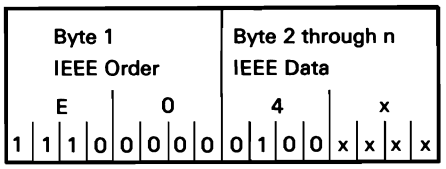


Byte 1 = This is the IEEE order for set EOI mode.
Byte 2 = The **a** bit value is
1 = EOI mode on
0 = EOI mode off.

IEEE Data Follows Order

Function: The IEEE Data Follows order causes the direct pass through of IEEE data. IEEE data is described later in this chapter. Data following this order will be passed through until an end of data is encountered. If the data spans blocks, use the More-Data-to-Come order described earlier in this chapter.

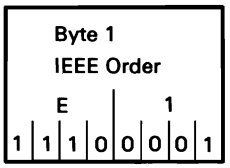
Format:



Take Control Asynchronously Order

Function: This order causes the 5292 Model 2 to send the ATN line TRUE (Take Control Asynchronously) on the IEEE-488 bus.

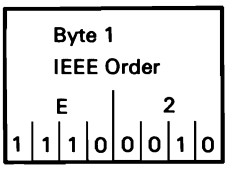
Format:



Go-To-Standby Order

Function: This order causes the 5292 Model 2 to send the ATN line FALSE (Go-to-Standby) on the IEEE-488 bus.

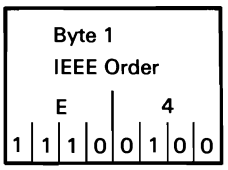
Format:



Remote Enable Order

Function: This order causes the 5292 Model 2 to send the Remote Enable Auxiliary command on the IEEE-488 bus.

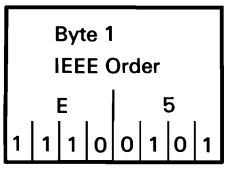
Format:



Remote Disable Order

Function: This order causes the 5292 Model 2 to send the Remote Disable Auxiliary command on the IEEE-488 bus.

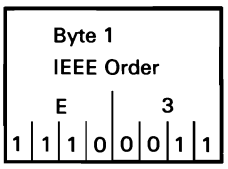
Format:



Interface Clear Order

Function: This order causes the 5292 Model 2 to send the Interface Clear Auxiliary command on the IEEE-488 bus.

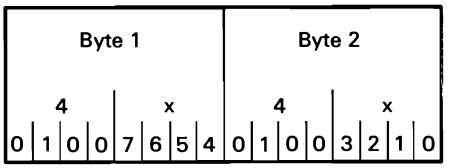
Format:



Printer and IEEE Data

Data associated with the Printer Data Follows order and the IEEE Data Follows order must be sent to the 5292 Model 2 in pairs. Data for one order may span graphic write blocks by using the graphics More-Data-to-Come order.

Format:



Bytes 1 and 2 = The bits 0 through 7 represent the data. Note that bit 7 is the most significant bit.

Printer and IEEE data will be processed until an end of data is encountered.

Error Handling

When an online error is detected during graphics processing, the error can be classified as either recoverable or nonrecoverable. The action taken by the 5292 Model 2 is somewhat different for these two types of errors. The following topics describe the events for each type of error.

Recoverable Errors

The following graphic error is recoverable: G5

The following events take place when a recoverable type error is detected.

1. The 2-digit error code is displayed on the status line of the 5292 Model 2 Display.
2. The alarm will sound for approximately 400 milliseconds.
3. Graphics processing will continue with the next byte in the graphics write block.
4. The graphics Aid key code Cmd-9 will be sent to the host when the graphics write block has completed processing.

Non-Recoverable Errors

The following graphic errors are nonrecoverable:

G1	P1	E1
G2	P2	E2
G3	P3	E3
G4	P4	E4
	P5	E5

The following events take place when a nonrecoverable error is detected when processing a graphic write block:

1. The 2-digit error code is displayed on the status line of the 5292 Model 2 Display.
2. The alarm will sound for approximately 400 milliseconds.
3. Graphics block processing will be terminated.
4. Graphics mode will be terminated.
5. The graphics Aid key code Cmd-10 will be sent to the host.

Printer Soft Error

There are two printer errors, P1 and P2, that allow you to take corrective action before the error becomes nonrecoverable. The time allowed to take corrective action can be changed by using the Set Printer Time-Out order; the default is 16.5 seconds. The following events take place when a P1 or P2 error is detected:

1. The 2-digit error code appears on the status line.
2. The alarm sounds.
3. The 5292 Model 2 will wait for the error to be corrected for the amount of time specified in the time-out period.
4. If the error is not corrected during the time-out period, graphics processing is terminated and the graphics Aid key code Cmd-10 is sent to the host.

Two-Digit Graphic Error Codes

Two-digit graphic error codes that further define a graphic error are displayed on the status line of the 5292 Model 2 Display Screen, and also are available to the programmer by using the Read Status Graphic order. The 2-digit codes are summarized in the following chart.

Two-Digit Code	Error	Possible Cause
G1	Invalid graphic byte	Invalid data byte format. MDTC order received with no preceding data. Data byte detected when expecting an order.
G2	Undefined order	Order code received which is not supported.
G3	Invalid graphic set order data	Set color table index = 0. Set marker > 8.
G4	Fill polygon error	The number of nonhorizontal fill edges > 128.
G5	Marker outside display boundaries	Center coordinate will not allow entire marker to be drawn.
P1	Printer not ready	No paper in printer. Printer is not powered on. Printer is not attached.
P2	Printer not selected	Printer is offline.
P3	General printer error	Printer hardware error.
P4	Time-out error	Printer remains busy for longer than the time-out period (default = 1615 seconds).
P5	Invalid printer control order data	Load Printer A/N Color Mix Table index = 7, 15, 23, or 31.
E1	IEEE bus error	IEEE device is not powered on. IEEE device is not attached. No interface message was received which assigned a listen address. No address match between a powered on IEEE device and an assigned listen address.
E2	Talker error	No interface message was received which assigned a listen address.
E3	Invalid IEEE address set	Set address = 31.
E4	Time-out error	No interface clear order was received after powering on. No interface clear order was received following an E1 order.
E5	Listen mode attempted	Interface message was received which assigned a 5292 Model 2 to listen.

Pacing

The 5292 Model 2 uses pacing to prevent long running graphic operation from tying up the work station controller or causing a work station controller time out. Pacing is accomplished by resetting busy when a graphic write block is received at the 5292 Model 2 and sending graphic Aid key codes when a write block has completed processing. The following paragraphs contain a description of pacing and the graphic Aid key codes used to accomplish pacing.

Pacing Description

The pacing described below frees up the work station controller and prevents transmission of the next graphics write block until the current graphics write block has been processed.

1. Data is sent from the host system using normal 5250 Write commands. Other 5250 commands have no relation to graphics processing.

2. The first byte in a write block, being hex FF, turns on graphics mode, and the following bytes for that write block will be saved in the graphics buffer. The maximum length of a graphic write block is 256 bytes and the minimum length is 11 bytes. If the graphics mode is off and the first byte is not hex FF, the data will be written to the appropriate address of the alphanumeric buffer. Graphics and alphanumeric data may not be mixed within a single write block. The 5292 Model 2 continues processing write blocks as graphic blocks while in graphics mode until the End of Graphics Mode order is received or a non-recoverable error is detected.

3. After receiving and saving a graphics write block, busy is immediately reset by the 5292 Model 2 to avoid a work station controller time out. A graphics block will be processed only during idle time and may be interrupted by another 5250 command from the host. When the graphics block has completed processing, a graphic Aid key code is sent to the host system to indicate the status of the processing.

4. The host must not send another graphics block until a graphics Aid key is received from the terminal. If a write block is received at the 5292 Model 2 while a previous graphic block is being processed, the write block is assumed to be alphanumeric.

5. Local keyboard select options will be processed as normal while in graphics mode; otherwise, the keyboard is locked.

6. System graphics reset (first two bytes of a write block hex FFFF) can be used by the programmer to put the 5292 Model 2 into a known condition. System graphics reset terminates graphics processing, ends graphic mode, and returns a graphic Aid key code (Cmd-8) to the host.

Graphic Aid Key Codes

Graphic Aid key codes are sent to the host system to indicate the completion status of graphic processing. Unless suppressed by the Suppress Pacing Response order, a Graphic Aid key code is sent to the host for every graphic write block that is received by the 5292 Model 2. A summary of the Graphic Aid key codes and a description of the status is shown below.

Graphic Aid Key	Scan Codes Sent (Hex)	Description of Status
Cmd-12/24	6F 3C	Graphics block processing completed successfully with no errors.
Cmd-11/23	6F 3B	Graphics processing and graphics mode terminated at the 5292 Model 2 by the operator using local keyboard select option.
Cmd-10/22	6F 3A	Graphics block processing and graphics mode terminated following detection of an error.
Cmd-9/21	6F 39	Graphics block processing continued and completed successfully after detecting an error.
Cmd-8[1]/20	6F 38	Graphics processing and graphics mode terminated after receiving a system graphics reset from the host.
Cmd-7/19 through Cmd-1/13	6F 37 6F 31	Reserved.
[1]Cmd 8 is never suppressed.		

I/O Feature Information

The 5292 Model 2 has connectors for three I/O features on the back of the machine. The I/O features supported are:

- IEEE-488 digital interface for plotters.
- Video interface for video film camera or video monitor.
- Parallel printer interface.

The implementation of each I/O feature is discussed in the following paragraphs.

IEEE-488 Digital Interface for Plotters

The plotter implementation on the 5292 Model 2 conforms to ANSI/IEEE-488 1978 specifications. Connection of the IEEE bus is by way of the parallel port connector on the back of the 5292.

The IEEE-488 functions implemented on the 5292 Model 2 are:

- Source handshake (SH1).
- Acceptor handshake (AH0).
- Talker (T4).
- Listener (L0).
- Service request (SR0).
- Remote local (RL0).
- Parallel poll (PP0).
- Device clear (DC0).
- Device trigger (DT0).
- Controller (C1 through C4, C28).
- Electrical interface (E1).

Video Interface

The 5292 Model 2 video implementation provides the following signals at the video connector.

Video Outputs

There are three color-coded noncomposite video outputs at the connector (red, green, and blue) and one composite SYNC output.

Color	Voltages (into 75 ohm load)
Red	1.1 plus or minus 36% volts P-P
Green	1.1 plus or minus 36% volts P-P
Blue	1.1 plus or minus 36% volts P-P
Sync	0.9 plus or minus 8% volts P-P negative going

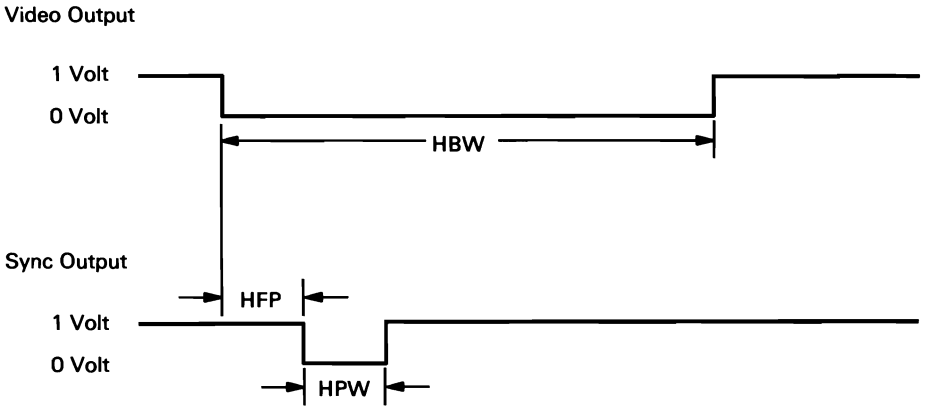
Synchronizing Rates

Horizontal scan frequency: 15,724 KHz
Vertical trace frequency: 2:1 interface

1. Field frequency: 93.32 Hz

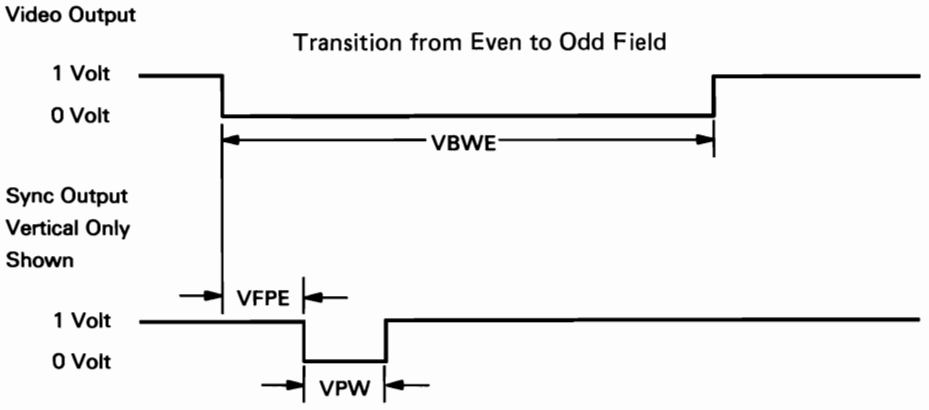
2. Frame frequency: 46.66 Hz

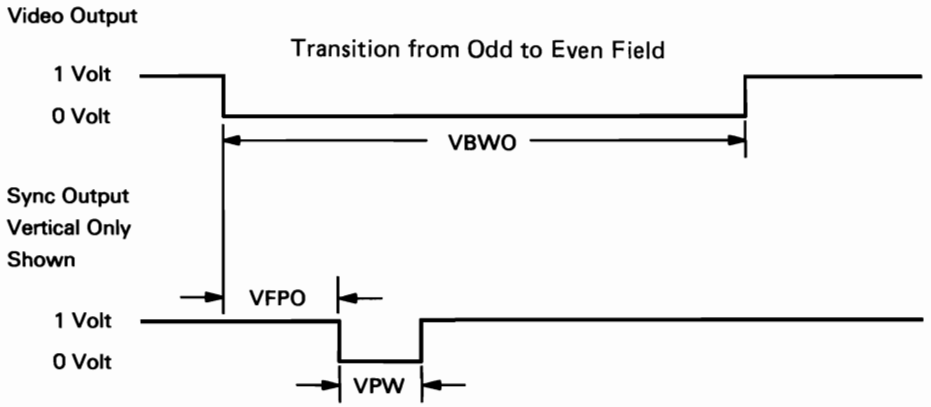
Sync Timing Horizontal Blanking Internal



HBW	Horizontal blanking width = 12.7 microseconds
HFP	Horizontal front porch = 1.7 microseconds
HPW	Horizontal sync pulse width = 5.1 microseconds

Sync Timing Vertical Blanking Internal





VBWE	Vertical blanking width, even field = 1.52 milliseconds
VBWO	Vertical blanking width, odd field = 1.58 milliseconds
VFPE	Vertical front porch, even field = 633 microseconds
VFPO	Vertical front porch, odd field = 665 microseconds
VPW	Vertical sync pulse width = 190 microseconds

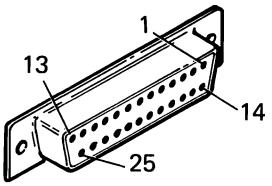
Parallel Printer Interface

The parallel printer interface connector on the back of the 5292 Model 2 can be used to connect a graphics printer. The following paragraphs describe the interface in the following sequence:

1. Signal names
2. Signal timings
3. 5292 processing order for handshake
4. Printer commands.

Signal Names

The connector is a D-type 25-pin receptacle (DB-258 Amphenol) shown below:



The pin numbers and signal names are shown in the following chart. The names in parentheses are the 5292 names of the printer signal.

Pin Number	Signal Name
1	-Strobe
2	D0
3	D1
4	D2
5	D3
6	D4
7	D5
8	D6
9	D7
10	-Acknowledge
11	+Busy
12	+P.E. (+paper out)
13	+Select (+enabled)
14	-Autofeed (not connected)
15	-Error (+online)
16	-Reset
17	Select input (not connected)
18	Ground (not connected)
19	Ground
20	Ground
21	Ground
22	Ground
23	Ground
24	Ground
25	Ground

Signal Name Definitions

- D0 through D7: These are the data lines to the printer (unidirectional). D0 is the least significant bit and D7 is the most significant bit.

- -Strobe: This is a control signal to the printer (unidirectional) that indicates when valid data is available on the data lines. This control tells the printer to input a data byte.

- +Busy: This is a control signal from the printer (unidirectional) that indicates that the printer is performing an internal task and cannot receive a -strobe.

- -Acknowledge: This is a control signal from the printer (unidirectional) that indicates that the previous data byte received via a -strobe pulse was successful and another data byte can now be received.

- +Paperout: This is a control signal from the printer (unidirectional) that indicates the printer is out of paper and cannot continue to print.

- -Error (+online): This is a control signal from the printer (unidirectional) that indicates a printer error condition exists and the printer is not online.

- +Select (+enabled): This is a control signal from the printer (unidirectional) that indicates the printer will execute all printer commands. This condition is necessary to print data sent to the printer.

- -Reset: This is a control signal sent to the printer (unidirectional) that indicates the printer will be initialized to power on condition.

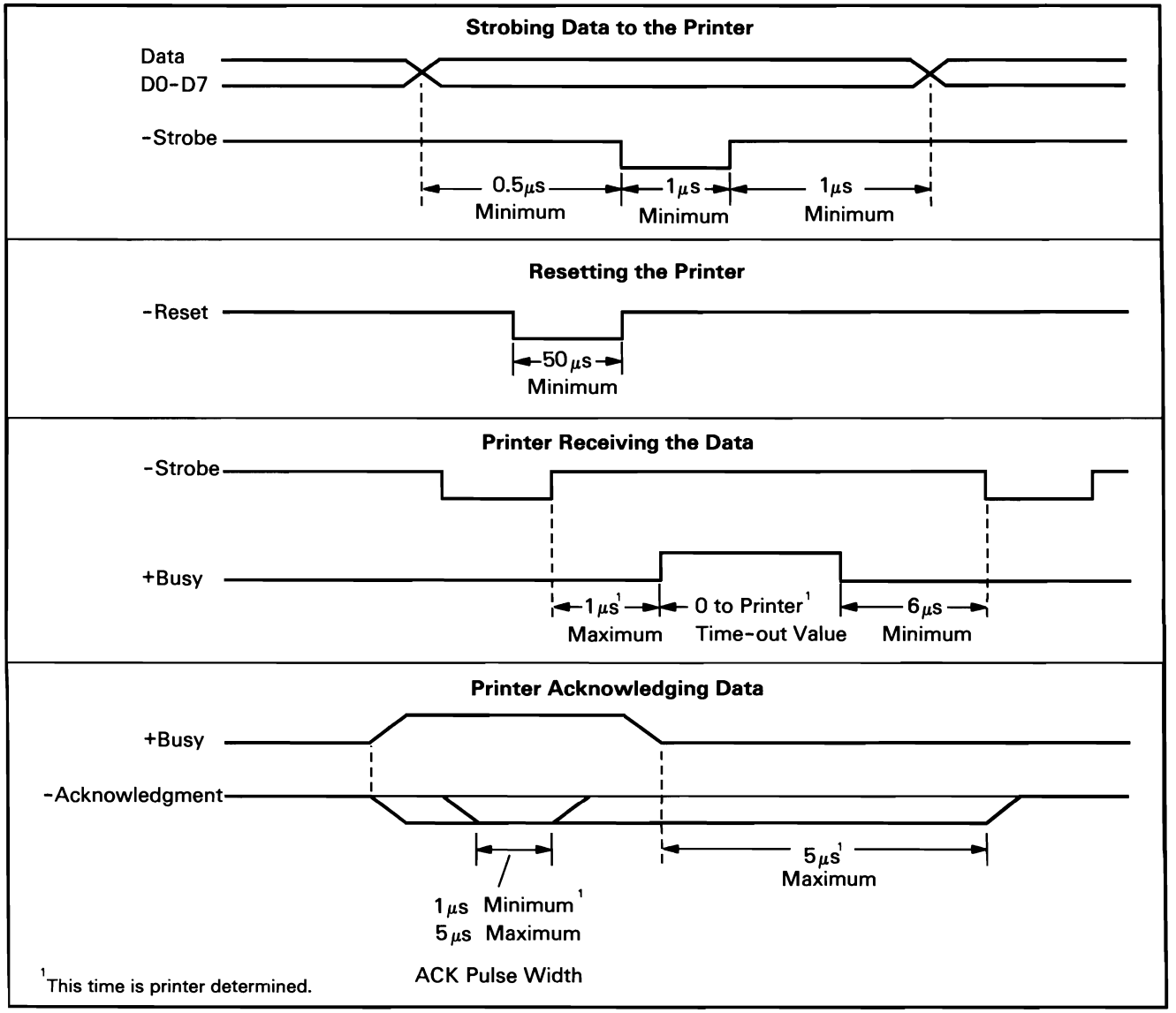
- Ground: These connections are used for signal return paths and electromagnetic noise reduction (shielding).

- -Autofeed: The 5292 does not use this signal.

- -Select input: The 5292 does not use this signal.

Signal Timings

The following signal timings must be met or exceeded by the 5292 and the printer.



The +paperout, -error (+online), and +select (enabled) lines are all asynchronous and assert their signal level for as long as the condition exists.

5292 Processing Order for Handshake

The following sequence describes how the 5292 handshakes the printer during data follows or screen copy. Before any printer data is sent to the printer, the following sequence must occur.

1. Check for + paperout (P1 error)
2. Check for + online (P2 error)
3. Check for + enabled (P3 error)
4. Check for + busy (time-out causes P4)
5. Check for -acknowledge (P3 error)
6. Put printer data on the bus
7. Send -strobe.

Printer Commands and Data

Printer commands and printer data are sent to the printer by two possible methods:

1. Printer Data Follows order from the host system
2. Screen Copy order and screen copy select option from the keyboard.

The following commands are sent to the printer when a screen copy is performed by the 5292 Model 2 microcode. The 5152 Printer uses only the items marked with an asterisk.

Command	Hexadecimal Code	
*Form Feed	0C	
*Carriage Return	0D	
Select Printer	11	
*Command Prefix (escape)	1B	
*Print from Table 2	1B 36	
Select 12 CPI	1B 3A	
*Execute Vertical Spacing	1B 4A n	n = spacing factor 5152 = 1/216 inch other = 1/144 inch
*Standard Graphics	1B 4B 1 h	1h = graphics string length
IDS Unique Deselect	1B 51 n	n = ID
Undirectional On/Off	1B 55 n	n = 01 ON n = 00 OFF
Black Ribbon Band	1B 62	
Cyan Ribbon Band	1B 63	
Relative Forward Positioning	1B 64 1 h	1h = 1/120 inches
Magenta Ribbon Band	1B 6D	
Print Aspect Ratio	1B 6E n	n = 00 5:6 n = 01 1:1
Yellow Ribbon Band	1B 79	

Keys

The basic types of keys on either of the keyboard types are:

- Alphameric keys (typewriter-like in nature; including letters, numbers, and special characters)
- Numeric keys; these are used for entering numeric data only
- Special function keys:
  - Aid-generating
  - Cursor movement
  - Field exit
  - Signal
  - Special control
  - Special host.

The following text describes the special function keys.

Aid-Generating Keys

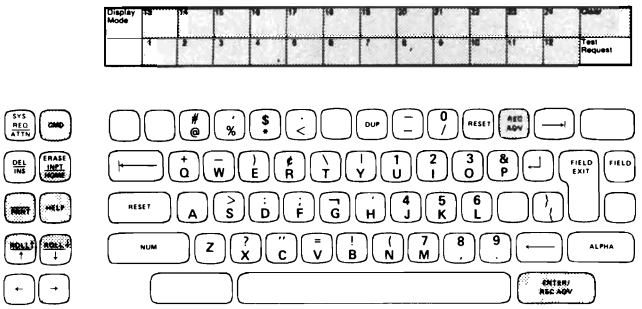
The aid-generating keys or key sequences are (see Figure 2-4):

- Clear (may be a sequence of key actions)
- Enter/Rec Adv
- Help (from nonerror state)
- Command Function 1 through 24
- Print
- Record Backspace Function.

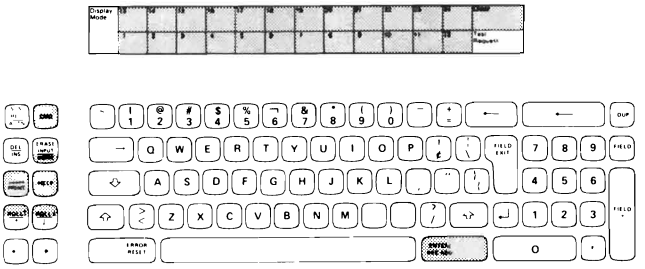
  Note: Record Backspace is not a key; it is a function performed by the operator using the Home key when the cursor is at the home position.

- Roll ↑ (Roll Up or Page Down) and Roll ↓ (Roll Down or Page Up).

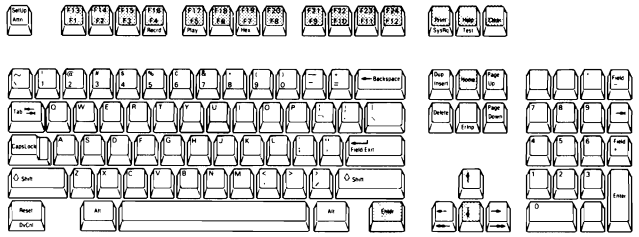
Data Entry Keyboard (5251 and 5291)



Typewriter-like Keyboard (5251, 5291, and 5292)



IBM Enhanced Keyboard



122-Key Keyboard

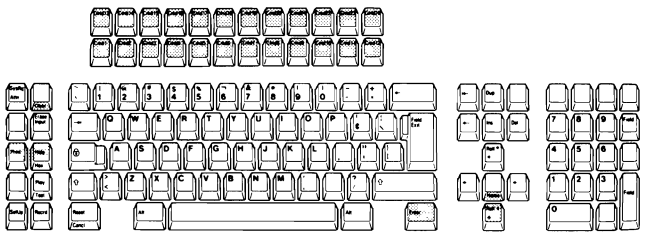


Figure 2-4. Aid-Generating Keys

The aid-generating keys (when pressed) generate aid codes that go in the display data stream to the host system in response to the LU-LU read commands. They alert the host system that the controller requires some action. These keys are not operational when the keyboard is locked, or when the cursor is in an active, right-adjust field. When the keys are operational, they lock the keyboard, and depending on the key that was pressed, the aid code either goes immediately to the host system if a read command is pending, or is kept pending until the controller receives a Read command; when this happens, the aid code is sent to the host system in the normal FM LU-LU flow.

The following text describes the functions of the aid-generating keys.

Clear (For all Displays except the 3180 and 3196)

Clear is not a key but rather a sequence of key actions that consists of the following:

1. Press and release the Cmd key.
2. Press and hold the ⇧ (Shift) key on the typewriter-like keyboards; press the Numeric Shift key on the data entry keyboards.
3. Press and release the ← (Character Backspace) key on the typewriter-like keyboard or the rightmost blank key on the top row of the data entry keyboards.

Clear (For the 3180 and some 3196 Displays)

1. Press and hold the Alt key.
2. Press the Clear key.

Clear (For 3196 Displays with an IBM Enhanced Keyboard)

Press the Clear key.

The session environment determines the results of the Clear function:

- If the LU is not involved in a session, it clears the entire display regeneration buffer (fills it with nulls and selects format level 0). See the index entry *format level 0* for details.
- If the LU is involved in a session, Clear issues the aid code hex BD, which requests that the host system issue a Clear Unit command to the LU to clear the display. See the index entry *Clear Unit command*.

Enter Rec/Adv

In the normal unlocked state, when the operator presses the Enter/Rec Adv (Enter/Record Advance) key, the following occurs:

1. The controller checks for the completion of mandatory fill, self check, and right-adjust fields when in an active field. (An active field is one in which the operator has begun entering data.) If the requirements of the field have not been satisfied, an error occurs.
2. The controller locks the keyboard.
3. If the master MDT bit is on, the controller checks for unentered mandatory enter fields, positions the cursor where there is such a field that is unentered, and posts an operator error.
4. Assuming there is a read command and CD, the controller sends the cursor address, aid code, and data in the input fields to the host system. This is the data formatting it does:
   a. Sets the zones on signed numeric fields.
   b. Sends the entire input field and changes nulls to blanks on the Read Input command.
   c. Strips trailing nulls from the fields and changes leading and embedded nulls to blanks for the Read MDT command.
   d. Resequences the field as specified by the field control word. See the index entry *field control word* for details.

Note: When the host system unlocks the keyboard, the cursor goes to the address specified by the IC, to the first nonbypass field if no IC is specified, or to row 1, column 1 if neither of these is given.

Help

(See also *Signal Keys* within this topic.)

If the display is not in an operator-error state, and the operator presses the Help key, the display issues a hex F3 aid byte to the host system. If, however, the operator presses the Help key after having used the Cmd key or the Sys Req key, an error results.

Command Function 1-24

The command function keys are those that the operator accesses by first pressing Cmd and then one of the 24 numeric keys across the top of the keyboard. The functions of these keys are user-defined.

Note: To access command function keys 13-24, press the Cmd key, then the Shift key on the typewriter-like keyboard or the Numeric Shift key on the data entry keyboards, and the appropriate numeric key.

(Some keyboards have no Cmd key. They either have 24 separate command function keys, or they have 12 separate command function keys. In the latter case, to access command function keys 13-24, first press and hold a Shift key, then press the appropriate command function key.)

In the normal unlocked state, when the operator presses a command function key, the controller:

1. Checks for the completion of mandatory fill, self check, and right-adjust fields when the operator is keying in an active field. An active field is one in which the operator has begun entering data.

2. Locks the keyboard.

3. If the master MDT bit is on, checks for unentered mandatory enter fields, positions the cursor where there is such a field, and posts an operator error.

4. Assuming there is a Read command and CD, sends the cursor address, aid code, and data in the input fields to the host system. This is the data formatting it does:

    a. Sets the zones on signed numeric fields.
    b. Sends the entire input field and changes nulls to blanks on the Read Input command.
    c. Strips trailing nulls from the fields and changes leading and embedded nulls to blanks for the Read MDT command.
    d. Resequences the field as specified by the field control word. See the index entry *field control word* for details.

Note: When the host system unlocks the keyboard, the cursor goes to the address specified by the IC, to the first nonbypass field if no IC is specified, or to row 1, column 1 if neither of these is given.

The associated Cmd aid byte is generated and sent to the host system preceding the first input field; sending the input fields can be inhibited by coding bytes 5-7 of the SOH order. See index entry *SOH order*.

Print

This key informs the host system that the operator wants to print the contents of the present display. See the index entry *copy to printer feature*.

Record Backspace (Home)

When the Home key is pressed with the cursor already at the home position, a record backspace is requested; the keyboard is locked and the aid code (hex F8) and cursor address are sent to the host system. The host system should respond by repeating the writing of the previous record to the display.

Roll↑ (Roll Up) and Roll↓ (Roll Down)

(Page Down = Roll Up and Page Up = Roll Down)

These keys ask the host system to roll the information on the display. Roll Up issues aid code hex F5, and Roll Down issues aid code hex F4. The operator must first press a shift key, then the appropriate Roll key.

The following conditions cause errors:

1. Using a roll key after the Sys Req key
2. Using a roll key after the Cmd key
3. Using a roll key when the display station is in the insert mode.

Signal Keys

The signal keys are:

- Attn
- Help (from error state).

See Figure 2-5.

The Signal keys cause a Signal command to go from the controller to the host system. The index entries *signal command, command and response code* list the pages that contain specific information about the contents of the Signal command.

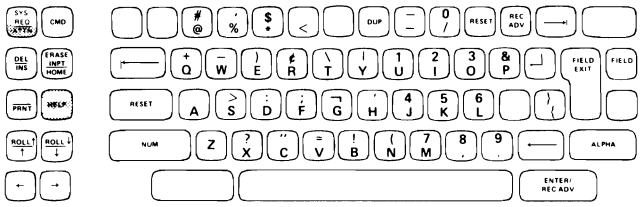
Attn

This key is valid both when the keyboard is locked and when the keyboard is unlocked. Pressing the key does not affect the state of the keyboard or of the cursor position. The operator uses the key to alert the host system that a requested function (such as Enter) is not being honored.

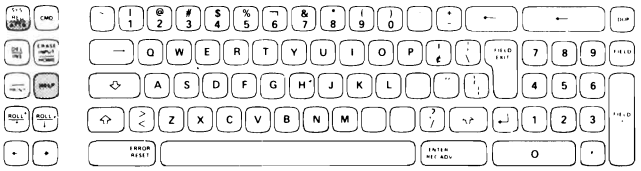
Help (from Error State)

During an error condition, the operator uses this key to request that the host system send data about the error to the display. The controller sends a Signal command to the host system containing columns 2-5 (which is the error code) of the error line in the user bytes of the Signal command on the LU-LU flow. If the host programmer wants the operator to obtain explanatory information about the error when the operator uses the Help key, you must furnish this information. One way of doing this is with the Write Error Code command. (See the index entries *signal command, command and response code; error states*, and *write error code command* for details.) If the operator uses the Help key a second time, bytes 2-5 of the error line return to the host system.

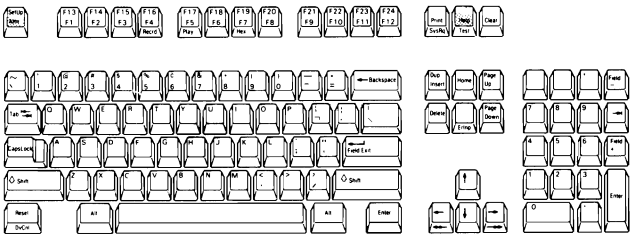
Data Entry Keyboard (5251 and 5291)



Typewriter-like Keyboard (5251, 5291, and 5292)



IBM Enhanced Keyboard



122-Key Keyboard

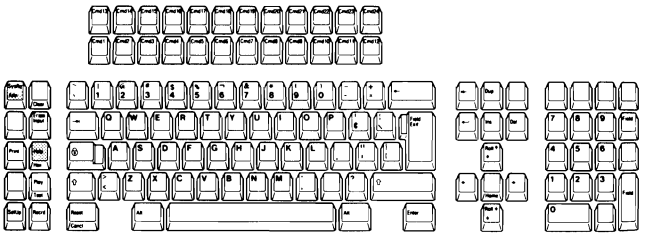


Figure 2-5. Signal Keys

Special Control Keys

The special control keys and key sequence allow the operator to alter operator-generated information on the display. They do not work when the keyboard is locked. See the index entry *states*. The following special control keys are for the 5251 and the 5252 display stations.

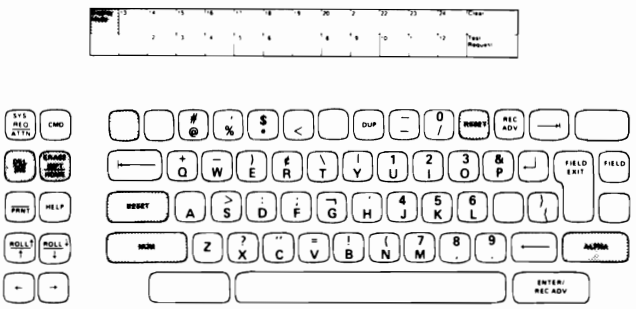
- Del (Delete)
- Display Mode (key sequence)
- Erase Input
- Error Reset
- Hex Key Function [^] on the typewriter-like keyboard and [ ] key on the data entry keyboard (the first key on the top row located to the right of the Cmd key)
- Home
- Ins (Insert)
- ⇧ (Shift) and ⇩ (Shift Lock) on typewriter-like keyboard
- [ALPHA] (Alpha) and [NUM] (Numeric) shifts on data entry keyboards.

See Figure 2-6.

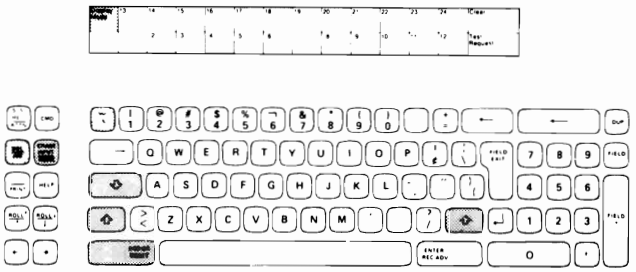
In addition, these special control keys or key sequences are found on the 5291 Display Station:

- Alternate cursor
- Display cursor location.

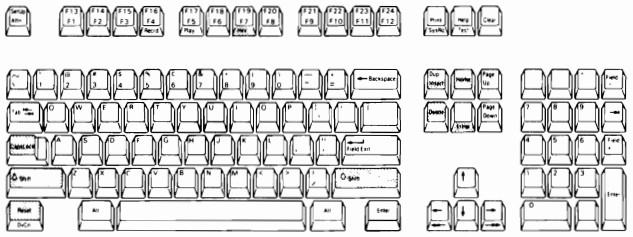
Data Entry Keyboard (5251 and 5291)



Typewriter-like Keyboard (5251, 5291, and 5292)



IBM Enhanced Keyboard



122-Key Keyboard

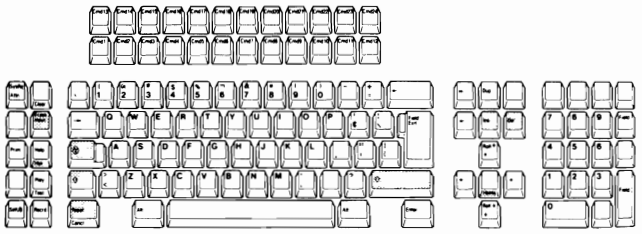


Figure 2-6. Special Control Keys

Del (Delete)

To use this key, first press and hold one of the shift keys, then press the Del key. (On some keyboards, the Delete key is by itself. If this is the case, do not press the Shift key first.) The result is a deleted character in the position where the cursor was located. All remaining characters in the field then shift to the left to fill the column vacated by the deleted character.

Display Mode (Not Available on 5292, 3179, 3180 or 3196)

This is not a single key but rather a key sequence. Use the following sequence to enter display mode:

1. Press the Cmd key.
2. Press and hold the ⇧ (Shift) key.
3. Press the ~ Grave Accent key on the typewriter-like keyboards or the leftmost blank key on the top row of the data entry keyboards. (The Grave Accent key is blank or has another character represented on some World Trade typewriter-like keyboards.)

The display mode allows adjustment of the display to the operator's preference. Normally, the display is light characters with a dark background; using display mode, the operator can change this to dark characters on a light background.

Erase Input

This key works only on the unprotected fields that the operator has modified. When the operator presses either 1) the shift key along with the Erase Input key, or 2) the Alt key along with the Erase Input key (depending on the keyboard type), all the modified fields are cleared to nulls and the cursor is moved to the insert cursor (IC) address specified in the last Write to Display command (see the index entries *write to display command* and *IC order*). The MDT bit remains on. If no IC has been specified, the cursor defaults to the first nonbypass field, or if there is no nonbypass field, to row 1, column 1 (the first input field).

Error Reset

Depending on the state of the system, pressing this key resets one of the following: operator error state, command mode, system request state, or insert mode. See the index entry *states*. During these states, using the Error Reset key restores the original data on the error line of the display and resets the state. Note, however, that during the operator error state, this key is not operational from the time the operator uses the Help key to the time he receives the Write Error Code command and contents from the host system. (The Write Error Code command and contents are issued by the host in response to the operator using the Help key.)

Hex Key Function

When display stations are connected directly to a controller in the host system, the Hex Key Function may not be supported.

On keyboards having a Hex key, press and hold the Alt key, then press the Hex key to enter hexadecimal codes from the keyboard to generate any EBCDIC characters needed for input or display. On keyboards having a Cmd key, enter hexadecimal codes from the keyboard to generate any EBCDIC character needed for input or display as follows:

Use the command function of the Grave Accent key on the typewriter-like keyboard or the first key on the top row (to the right of the Command key) on the data entry keyboards.

Press the key for the first character of the hexadecimal code you want to enter (only 4 through 9 or A through F are valid).

Press the key for the second character of the hexadecimal code you want to enter (0 through 9 or A through F are valid).

Note: **FF** is not a valid hexadecimal combination that can be entered on the display station. Diacritics entered in this manner cannot be combined with another character.

Home

This key moves the cursor to the position specified by the insert cursor (IC) address. The IC is in the last Write to Display command. See the index entries *write to display command* and *IC order*. If there is no IC order, the default is to the first nonbypass input field or, if there is none, to row 1, column 1 (the first input field). If the cursor is already in the home position when the operator uses the key, the key functions as the Record Backspace key.

Ins (Insert)

This key sets the insert state for the field the operator is in. The state must be reset before the operator is allowed to leave the field. (Using the Help, Reset, or Enter/Rec Adv key resets the state.)

⇧ (Shift) and ⇩ (Shift Lock or Caps Lock)

There are two Shift keys and one Shift Lock or Caps Lock key on the typewriter-like keyboard. The shift keys not only put the keyboard into an uppershift condition, but also act in conjunction with the Sys Req, Del, and Roll keys to perform special functions. See the index entry *inhibit downshift function*.

When pressed, the ⇩ (Shift Lock) key sets the keyboard in the uppershift condition, and this condition remains when the key is released. To unlock the keyboard, the operator must press one of the two Shift keys. If the operator presses a Shift key along with a special function key, the inhibit downshift function may be enabled. If your keyboard has a Caps Lock key, press this key to get the upper case of alphabetic characters that are on separate keys. To temporarily leave Caps Lock mode, press and hold a Shift key while pressing a data key. To permanently leave Caps Lock mode, press the Caps Lock key again.

ALPHA (Alpha) and NUM (Numeric) Shifts

There are two shift keys on the data entry keyboards. The Alpha Shift key puts the keyboard into lower shift when the operator wishes to select lower symbols on the keytop in a programmed numeric field. The Numeric Shift key is used to select upper symbols on a keytop when in a programmed alpha field and also to select upper shift command functions.

There is no Shift Lock on the data entry keyboards.

Alternate Cursor (5291 only)

This is a key sequence. To enable this function:

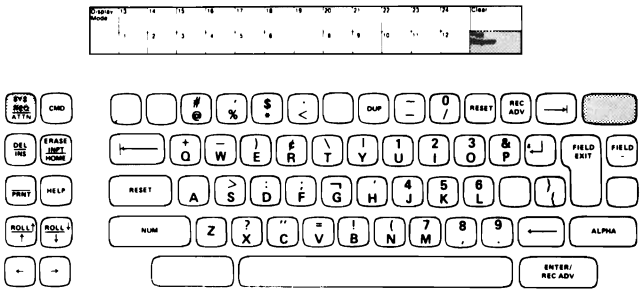
1. Press and hold the Cmd key.
2. Press the Error Reset key.

This function allows implementation of the bar type cursor (as opposed to the normal block cursor). To cancel this function, press the 1 key again.

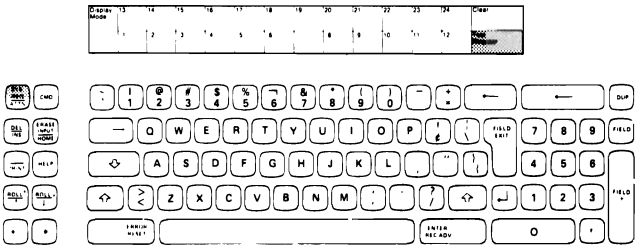
Special Host Keys

The special host keys are Sys Req and Test Request (command function key sequence). See Figure 2-7.

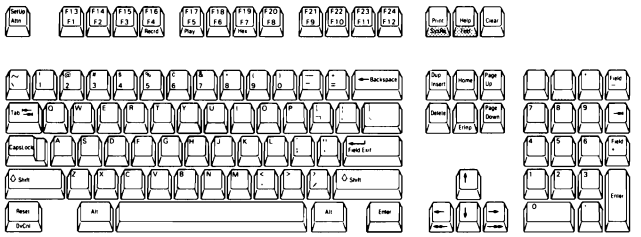
Data Entry Keyboard (5251 and 5291)



Typewriter-like Keyboard (5251, 5291, and 5292)



IBM Enhanced Keyboard



122-Key Keyboard

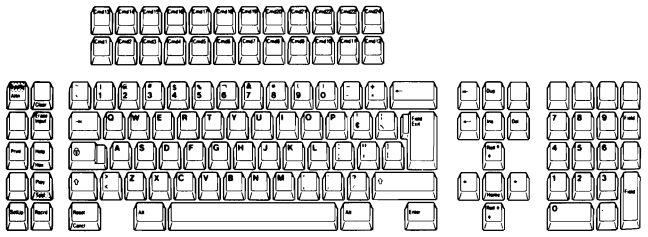


Figure 2-7. Special Host Keys

Sys Req

This key allows the display to enter the system request state. See the index entry *system request state*. The key will not work when the display is in an error or SS state or when the controller is processing a Read, Write, Roll, Save, Restore, Write Error, or Copy command. See the index entry *display, commands*. Otherwise, the key is operational when the keyboard is in the locked or unlocked state. When Sys Req is used to exit a field, all field requirements must be met or an error occurs and Sys Req is ignored. See the index entry *fields* for a description of the field restrictions.

Using the Sys Req key results in the following actions:

- Data on the error line is saved.
- The error line is cleared.
- A column separator and an underscore field attribute are supplied for column 1 of the error line.
- The cursor is located under column 2 and polling for keystrokes begins.

When the LU is in the system request state, a message can be entered. When the operator presses the Enter/Rec Adv key, the controller sends the message to the host system on the SS-LU flow. No cursor address or aid codes are returned, embedded and leading nulls are converted to blanks, and trailing nulls are stripped. The resulting recovery depends on the state of the LU:

- If the LU was in an LU-LU session, the previous contents of the error line are restored and the LU is returned to its pre-system request state.

- If the LU was in an SS-LU session, the message stays on the display but has normal attributes assigned. The LU returns to the pre-system request state.

- If the LU had not been activated, it is restored to its pre-system request state and an operator error of 004X, 005X, or 0099 is posted. For details, see the index entry *operator error codes*.

Any replies sent on the SS-LU (FMD) session are posted on the error line. When the operator presses the Error Reset key, the previous contents of the error line are restored and the LU returns to its pre-system request state.

MDT Bit

There is a modified data tag (MDT) bit for each input field and there is a master MDT bit. These bits are used to determine which fields the controller should send to the host system in response to the Read MDT command. The host system programmer can set the MDT bit for a field and the master MDT bit by coding bit 4 of the field format word in the SF order of the Write to Display command; the operator sets the master MDT bit and the MDT bit for a field any time he keys data into or alters the field. Once the bits are set, only a control character for resetting it, a Clear Unit or Clear Format Table command, or an SOH order can reset them. For details, see these index entries *field format word; display, commands; orders;* and *control characters, display*.

Modems

There are basically two types of modems: synchronous and nonsynchronous. In a synchronous modem, the clocking signals are generated within the modem and sent to the controller for clocking purposes. In a nonsynchronous modem, a clock in the 5251 Model 2 or 12 must supply the synchronization for signals to be sent to and from the host system. See the index entry *clock*. The 5294 does not support nonsynchronous modems.

Modes — SDLC

This topic describes the SDLC/SNA modes that the controllers support; if you want information about the display station and printer modes, see *States and Modes* in this section. These are the available SDLC modes.

- Normal response mode (NRM): For 5250 controllers, this means that the work station/controller has entered an operational mode that will allow an informational interchange in response to receiving an SNRM.

- Normal disconnect mode (NDM): For 5250 controllers, this means that the controller is in a disconnected state that will not allow informational interchange (except XID or test information). SNRM, XID, DISC, TEST, and CFGR (CFGR not supported on the 5294) commands are accepted and acted upon. All other commands are responded to with DM. In this mode, no I or supervisory frames are allowed to be sent. See the index entries *SDLC, commands and responses* and *frames*.

Multinational Character Set

The Multinational Character Set displays a 188-character set (184 of which are printable) and supports the hexadecimal usage and diacritic keys on all displays in the 5250 family except the 5291 Models 1 and 2.

The 5294 Control Unit supports the diacritic function for the multinational character set. The 5294 also supports the diacritic function for the different languages if either the Display Write/36 Program Product feature or the Enhanced Keyboard Support feature is installed.

The 5294 does not have the Multinational Character set in the U.S.A. base product. A feature is available for the U.S.A. that allows multinational devices to be used.

Hexadecimal Usage of the Keyboard

By entering hexadecimal codes on the keyboard, you can generate any EBCDIC character that is not available on the keyboard but is needed for input and displaying within an input field. The hexadecimal usage of the keyboard is not allowed when the display station is in the insert mode.

To enter a hexadecimal code for an EBCDIC character, refer to Hex Key Function.

Diacritic Keys

Using a diacritic key allows you to place a diacritic (modifying) mark above a character to indicate a different phonetic value for that character.

Various diacritic keys are available. However, the only diacrictic you can enter above a character is one that appears on one of the diacritic keys on your keyboard. The available diacritics are shown below:

` (Grave Accent)
' (Acute Accent)
~ (Tilde)
^ (Circumflex)
¨ (Diaeresis)
¸ (Cedilla)

To enter a diacritic above a character, press the diacritic key and then the character. The 5251 Model 2 or 12, 5294, or the host system then checks to see that the diacritic key and the character key pressed are a valid combination. Valid combinations for each diacritic are shown below:

Diacritics:	Allowable Characters:
` (Grave Accent)	A E I O U
' (Acute Accent)	A E I O U
~ (Tilde)	A N O
^ (Circumflex)	A E I O U
¨ (Diaeresis)	A E I O U y (y is allowable only as a lower case character)
¸ (Cedilla)	C

After the diacritic and character combination has been checked and found to be correct, the cursor moves to the next position. If the combination is not valid, a 0029 error code is shown on the display screen.

Note: When the diacritic is keyed, the cursor will stay under the diacritic in anticipation of the combining character. If only a diacritic is desired, press the Spacebar on the typewriter-like keyboard or on the data entry keyboard, the Space key on the data entry keyboard with Proof Arrangement, or the → (Right Cursor Movement) key to advance the cursor to the next position.

Using the Hexadecimal Code to Enter Diacritics or Accented Characters

For the U.S.A. and multinational countries, the diacritics, their allowable characters, and corresponding hexadecimal codes are given in the following chart. For non-multinational countries, refer to the charts in Figure 2-2 and Figure 2-3. Characters that have a heavy line surrounding them will not print as shown but will print as specified by the Set Graphic Error Action control character or, if unspecified, as a hyphen.

Select the desired diacritic or the accented character from the chart. Its corresponding hexadecimal code can be found by:

1. Following the column containing the diacritic or the accented character to the top of the chart. The character at the top of the chart is the first character of the hexadecimal code.

2. Following the row containing the diacritic or the accented character to the left of the chart, the character at the left of the chart is the second character of the hexadecimal code.

Multinational Only

Second Hexadecimal Character ↓	First Hexadecimal Character →											
	4	5	6	7	8	9	A	B	C	D	E	F
0	Space	&	-	ø	Ø	º	µ	¢	{	}	\	0
1	Required Space	é	/	É	a	j	~	£	A	J	Numeric Space	1
2	â	ê	Â	Ê	b	k	s	¥	B	K	S	2
3	ä	ë	Ä	Ë	c	l	t	₧	C	L	T	3
4	à	è	À	È	d	m	u	ƒ	D	M	U	4
5	á	í	Á	Í	e	n	v	§	E	N	V	5
6	ã	î	Ã	Î	f	o	w	¶	F	O	W	6
7	å	ï	Å	Ï	g	p	x	¼	G	P	X	7
8	ç	ì	Ç	ì	h	q	y	½	H	Q	Y	8
9	ñ	ß	Ñ	‘	i	r	z	¾	I	R	Z	9
A	[	]	¦	:	≪	ª	¡	¬	-	1	2	3
B	.	$	,	#	≫	º	¿	|	ô	û	Ô	Û
C	<	*	%	@	đ	æ	Ð	¯	ö	ü	Ö	Ü
D	(	)	_	'	≤	ъ	Ý	¨	ò	ù	Ò	Ù
E	+	;	>	=	Þ	ƒ	þ	´	ó	ú	Ó	Ú
F	!	^	?	"	±	¤	®	=	õ	ÿ	Õ	

Negative Responses

The state of the LU determines the sequence of actions that results from: (1) hardware failures or (2) data stream errors or contention.

Hardware Errors

If the LU is receiving RU chains from the host system and a hardware error occurs, the controller sends the host system a negative response followed by the Rshutd command and the Lustat command.

If the LU is sending RUs, or is not sending or not receiving RUs when a hardware error occurs, the controller sends an Rshutd and a Lustat command to the host system. See the index entry *rshutd command.*

Data Stream or Contention Errors

If the LU is receiving RU chains from the host system when a data stream error or contention error occurs, the controller issues a negative response to the host system.

If the LU is sending RU chains when a data stream error or contention occurs, the controller sends a Cancel command followed by a Lustat (indicating the error has been sent to the host system). A Lustat is sent when a contention error is cleared. See the index entries *cancel command* and *lustat command* for details.

Contents of the Negative Response

The negative response is an 8-bit code that has the following format:

Major/Minor Code	**User Byte 1**	**User Byte 2**
xxxx	yy	zz

The major/minor code is a standard SNA code that identifies the error class. User byte 1 identifies the failing component:

for **yy**:

00 =	SNA data, SS-PU error, or cluster feature controller error
01 =	display
02 =	printer

User byte 2 identifies the specific error. The following chart gives detailed information about these contents.

The negative responses that follow are generated by the controller and may differ from negative responses generated by the host system.

Major/ Minor Code (xxxx)	User Byte 1 (yy)	User Byte 2 (zz)	Description
(All code is shown in hexadecimal.)			
0801	00	00	Resource is not available.
0809	00	00	Mode inconsistency.
0811	02	zz	Break.
		00	Cancel from printer while not in error state.
		01	Cancel from printer while in error state.
0813	00	00	Begin bracket indicator on in RQ.
0815	00	00	Bind received but LU already active. See the index entry *bind command*.
081C	yy	zz	Hardware error.
	00	zz	Controller error.
		70	Invalid sense information.
		72	Cable overrun condition.
		73	Send hardware failure.
		98	Undefined hardware error.
	01	zz	Display failure.
		00	No response.
		01	Transmit activity check.
		03	Receive parity check.
		04	Send parity check.
		06	Receive length check.
		07	Wrong station response.
		08	Power on transition.
		09	Missing activate read/write response.
		20	Invalid command.
		21	Invalid register value.
		22	Storage or input queue overrun.
		23	Null/attribute exception check.
		24	Invalid activate.
		25	Undefined exception response.
		49	Invalid bit in poll response.
		89	Invalid outstanding status.
		90	Even/odd status time out.
		91	Busy time out or invalid busy.

Major/ Minor Code (xxxx)	User Byte 1 (yy)	User Byte 2 (zz)	Description
081C (cont.)	02	zz	Printer hardware failure.
		00	No response.
		01	Transmit activity check.
		03	Receive parity check.
		04	Line parity check.
		06	Receive length check (wrong number of bytes, poll or read status).
		07	Wrong work station responded.
		08	Power-on transition (in session).
		20	Invalid command.
		21	Undefined exception station (110).
		22	Input queue or storage overrun.
		23	Line parity error during active sequence should have been reported (0204).
		24	Invalid activate.
		25	Undefined exception status (011).
		90	Even/odd status time out.
		91	Hardware busy time out.
0821	00	00	Invalid session parameters in Bind or Actlu command.
0829	01	00	CD bit not sent with request that requires it; for example, CD not sent with a Save, Read Screen, or Read Immediate command.
082D	01	00	The command is valid but has been rejected because the display is in a mode that does not support the command. (For example, display error line is in use.) Chain processing ceases. **Note:** The host system should send a null RU with CD on if this -rsp is received on the LU-LU flow. The controller will send Lustat X00010000 when the contention condition has cleared.

Major/ Minor Code (xxxx)	User Byte 1 (yy)	User Byte 2 (zz)	Description
1003	yy	zz	Actlu or Bind type not supported. See the index entries *actlu command* and *bind command*.
	00	00	
	01	01	Invalid data stream command.
	01	03	Copy to Printer feature not installed.
1005	yy	zz	Parameter error. All chain processing stops.
	01	zz	Display data stream error.
		10	Invalid length value (LL or L) for structured field.
		11	Invalid class or type for structured field.
		12	Invalid parameter value in structured field.
		1B	Invalid data stream command in WP mode.
		1C	Invalid data stream command in DP mode.
		1D	Command cannot be displayed with unlocked keyboard.
		21	Premature data stream termination.
		22	Invalid row and column parameters in SBA, IC, or RA order. See the index entry *orders*.
		23	The address in the RA order is less than the display address. See the index entry *RA order*.
		25	Invalid SF order field length. See the index entry *SF order*.
		26	Invalid SF order starting address. See the index entry *SF order*.
		27	Invalid data following Restore command. See the index entry *restore screen command*.
		28	Attempt to define a field past the end of the display.
		29	Format table overflow.
		2A	Attempt to write data past the end of the display.
		2B	Invalid SOH length. See the index entry *SOH order*.

Major/ Minor Code (xxxx)	User Byte 1 (yy)	User Byte 2 (zz)	Description
1005 (cont.)	01 (cont.)	2C	Parameter error in the Roll command. See the index entry *roll command*.
		2D	Reserved.
		2E	Reserved.
		2F	Reserved.
		30	Invalid SF order screen attribute. See the index entry *SF order*.
		80	Printer in session. See the index entry *copy to printer features*.
		81	The LSID is not valid for the printer. See index entry *copy to printer feature*.
		86	Expanded Function feature not installed.
		87	Invalid self check length. See the index entry *FCW Self check*.
		88	Invalid self check FCW. See the index entry *FCW, self check*.
	02	zz	Printer data stream error. See index entry *printer, data stream*.
		28	Invalid SNA SCS command. See the index entry *Control characters, printer*.
		29	Invalid SNA SCS parameter. See the index entry *control characters, printer*.
		2A	Invalid IPDS printer command.
		60	IPDS reset or read multiple status requested.
2002	00	00	Chaining error detected.
2004	00	00	Request received while in send state.
8004	00	00	The specified LSID is not assigned to an LU. See the index entry *addresses*.
8005	00	00	A request is issued to an LU that is not in session. See the index entries *bind command* and *actlu command*.

Operator Error Codes

The controller performs the following actions to post an operator error to the display:

1. Locks the keyboard.

2. Determines the error display line by using byte 5 of the SOH order or defaults to the last line. See the index entry *SOH order*.

3. Saves the contents of the error display line.

4. Writes a screen attribute and a 4-digit error code to the error display line. The beginning screen attribute is a high-intensity blink and the trailing screen attribute is nondisplay. See the index entry *screen attributes*.

5. Positions the cursor at the error and then blinks the cursor.

6. Polls the locked keyboard looking for the operator to press one of the following keys:

   - Attn: When this key is pressed, the controller sends the host system a Signal command. See the index entries *signal command, command and response code.*

   - Help: When this key is pressed, the controller:

     - Changes the leading screen attribute of the error message to a high-intensity no-blink.
     - Sends the Signal command, which includes the 2-byte error code. If the host system does not respond with a Write Error Code command and text, the keyboard remains locked. See the index entries *signal command, command and response code* for details.
     - Waits for the operator to press the Error Reset key. If, instead, the operator presses Help again, the controller sends a Signal command containing bytes 2, 3, 4, and 5 of the error message back to the host.

   - Error Reset: When this key is pressed, the controller:

     - Restores the contents of the area that had been saved, when the error code was written, back to the display.
     - Leaves the cursor at its current position.
     - Unlocks the keyboard and allows the operator to enter data.

     Note: All other keys except the shift keys, which are always valid, are ignored.

The operator's guide for each device contains a list of operator error codes and a description of the error.

Orders

Five orders appear in the Write commands (FM LU-LU flow of the output data stream) for the display station LUs. (The output data stream is what the host system sends the LU via the controller in the SNA RU.) The orders specify the characteristics of the display. These orders are:

- Insert Cursor (x'03')
- Repeat to Address (x'02')
- Set Buffer Address (x'11')
- Start of Field (x'1D')
- Start of Header (x'01')

The topic *Display Data Stream Commands* under the heading *Commands* in this section describes how the orders are coded within the output LU-LU commands. Figure 2-8 illustrates the sequence of the orders.

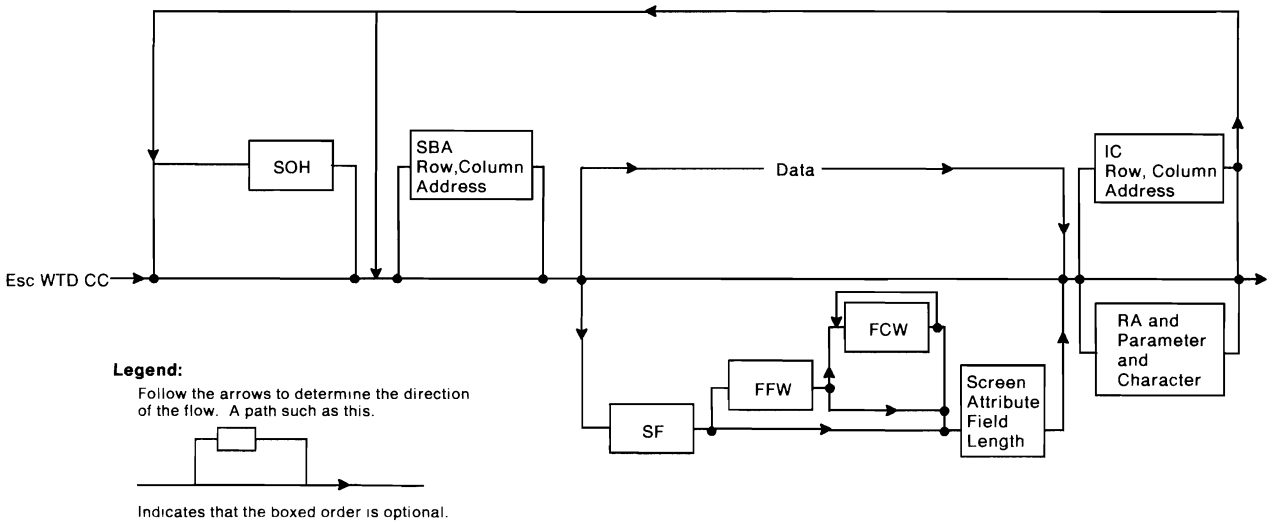


Figure 2-8. Orders

The following description gives specified information about each order.

Insert Cursor (IC) Order

Function: This order (1) sets the system insert cursor (IC) address to the location specified by the two bytes that follow the order when it is included in the Write to Display command or (2) moves the cursor to the specified address without affecting the system IC address when it is included in Write Error Code command. Byte 1 gives the row address and byte 2 gives the column address. See the index entries *home key* and *display, commands.*

Note: If there are more than one of these orders in the display station output data stream (LU-LU commands from host system to controller for LU), only the last one is saved. It is used as the home address (system IC address) for the Home function.

Restrictions: A parameter error is posted when:

- There are fewer than two bytes following the order.
- The row address equals 0 or is greater than:
  - 24 for Model 12 (1920 characters) or
  - 12 for Model 2 (960 characters).
- The column address equals 0 or is greater than 80.

Format:

Insert Cursor Order	Byte 1 (Row	Byte 2 (Column
Hex 03	Address)	Address)
Hex 13		

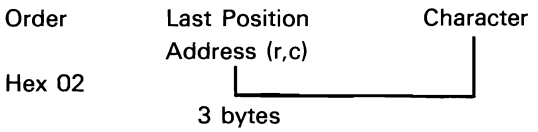
Results:

- When the order is used in the Write to Display command, the cursor is not immediately moved; the address is saved for later use. The cursor is moved when the entire WTD is completed.
- When the order is used in the Write Error Code command, the cursor is moved to the address given in the IC order and does not affect the system IC address. The cursor exits the field regardless of the type and does not perform any field checks. For example, it does not check for a filled field for a field specified as mandatory fill.

Repeat to Address (RA) Order

Function: This order displays a character in every position starting from the current display address and going to the last position specified by this order. If these two addresses match, 1 character is displayed.

Format:



Restrictions: A parameter error is posted when there are fewer than 3 bytes after the order; when there is a row address value either equal to 0 or greater than 12 for Model 2 (960 characters) or 24 for Model 12 (1920 characters); or when there is a column address value greater than 80 or equal to 0. The order is also rejected if the specified ending address is less than the current display address.

Note: Although any character can be repeated, avoid using hex 11 (SBA), because this value is used as the delimiter between the fields sent in response to the Read MDT command.

Results: The character is repeated from the current display address through the ending display address specified. The current display address is then updated to the value of the last position + 1.

Set Buffer Address (SBA) Order

Function:

- Read: Used as a delimiter between fields that are sent back to the host system in response to the Read MDT command. See the index entry *read MDT fields command.*
- Write: Used to set the current display address and thereby determine where the data display or field definition begins. Two bytes that follow this order tell the 5251 Models 2 or 12 this information.

Restrictions: A parameter error is posted when:

- There are fewer than 2 bytes following the order.
- The row address is equal to 0 or greater than 12 for Model 2 (960 characters) or 24 for Model 12 (1920 characters).
- The column size is equal to 0 or greater than 80.

Default: When the SBA is not specified in the Write to Display, the data starts at row 1, column 1 because this is where the Write to Display command initializes it. See the index entry *write to display command*.

Format:

Set Buffer Address Order Hex 11	Byte 1 (Row Address)	Byte 2 (Column Address)

Start of Field (SF) Order

Function: This order defines input and output fields. If an input field is being defined, it also resets any pending aid byte and locks the keyboard.

Note: Although this order can be used for output fields, it is not recommended because it degrades performance. Use the SBA order instead.

Restrictions: A parameter error is posted when:

- The output data stream ends before the given number of bytes have been sent.
- The field length is equal to 0, if the field is not signed numeric. If the field is signed numeric, either a 0 or a 1 causes an error.

  Note: The length byte is ignored when an entry is modified in the format table.
- The address for the end of the field exceeds the end of the display.
- The input field addresses are not in ascending order. For input fields defined by previous Write to Display commands, the input field address must be equal to the starting address of an already specified field or greater than the last field already defined.
- Too many input fields are defined for the display.
- Invalid screen attribute is specified.
- The defined input field overlays a previously defined field.

Format:

SF Order Hex 1D	2-Byte Field Format Word (optional)	2-Byte Field Control Word (optional) 1 or more	1-Byte Screen Attribute (See Note.)	2-Byte Field Length

Note: See the index entry *screen attributes*. Bits 0-2 must be in the format B'001xxxxx' or an invalid screen attribute error is posted. All other bits are described in the screen attributes text.

Results:

1. The display address is set to the end-of-field address (as specified by the last SF order) +1. This does not happen if this is the first SF order or if an SBA order precedes it. The SBA will point to the field starting attribute.
2. The screen attribute in the SF order is written in the location defined by the display address.
3. The start-of-field address is set to the display address +1.
4. The end-of-field address is set to the display address + the field length specified in the SF order. See Notes 1, 2, and 3.

5. The ending screen attribute (hex 20) is supplied by the controller and written at the end-of-field address + 1. See Notes 1, 2, and 3.

6. The display address is incremented by 1.

7. If this is an input field (one in which a field format word has been specified), a format table entry consisting of the field format and field control words is generated. In addition, if the SF order is rejected, the keyboard is locked and any outstanding aid byte is cleared. See Notes 1, 2, and 3.

Notes:

1. Format Table Modification: If the display address + 1 is equal to the starting address of an input field that was previously defined, then:

   a. The field format word of the previously defined field is overlaid with the new field format word. The previous screen starting attribute is overlaid with the new screen starting attribute.
   b. All field control words and length parameters that were specified are ignored. Two bytes, however, are still required for the length parameter even though no value check is made against them.
   c. The field ending address is set equal to the field's original ending address.
   d. Writing the screen ending attribute at the end of the field is suppressed.

2. The defined field is not filled with nulls; if you require nulls in the field, use the Clear Unit command prior to issuing the Write to Display command.

3. If the SF order is rejected due to an error condition, the keyboard will be locked and the aid codes cleared; however, all other operations associated with the SF order will be suppressed and the format table will be intact.

4. If data characters follow the length field, they will be written into the newly defined field.

Start of Header (SOH) Order

Function: This order specifies the header information that goes into the format table. See the index entry *format table*. It also selects the resequencing function when data is read from the display. See the index entry *field control word*.

Restrictions: A parameter error is posted when the output data stream ends before the number of bytes needed have been sent or when the first byte of the order is not between 1 and 254.

Format:

Order	Length	Variable Bytes
Hex 01	(Note 1.)	(Note 2.)

Notes:

1. The length byte determines the number of header bytes following the length byte, but this number does not include the length byte. It must be greater than 0 and less than 255.

2. This chart shows what the bytes following the length byte can contain:

Byte	Description
1	Reserved
2	Format ID - from hex 00 to hex FF
3	Hex 00 = no resequencing (all resequencing field control words are ignored). Hex xx = resequence per field control words in format table. See the index entry *field control word*. (For example, xx = 01 = field 1). Byte 3 also points to the first field to be returned when the Read Input Fields/Read MDT command is serviced.
4	Row address of the operator error line. If this is unspecified or out of range, the error line defaults to the last line of the display, or to the message line, if supported. **Note:** If a display were in 132 x 27 mode, selection of line 26 would result in line 26 being used. If the same display were in 80 x 24 mode, the message line would be selected.
5-7	The following chart shows the data-included switches for the command function keys.

Byte	Bit	Command Function Key
5	0	24
	1	23
	2	22
	3	21
	4	20
	5	19
	6	18
	7	17
6	0	16
	1	15
	2	14
	3	13
	4	12
	5	11
	6	10
	7	9
7	0	8
	1	7
	2	6
	3	5
	4	4
	5	3
	6	2
	7	1

Note: If the mask bit = 0, then the field data is returned via the Read MDT or Read Input Fields command when the command function key is pressed. If the mask bit = 1, only the cursor address and aid code are returned. Remember, if all three data-included bytes are not coded, the Cmd and command function keys will act as aid-generating keys and return the cursor address, aid code, and data in the input fields to the host system when they are used.

P/F Bit

The P/F (poll/final) bit is a single bit that is in the control field of every SDLC frame type (Supervisory, Nonsequenced, and Information). When the host system sends an SDLC frame to the controller, the bit becomes the poll bit. When the poll bit is on, it indicates that the host system's transmission of data is complete; it also demands an immediate response from the controller. When the controller sends an SDLC frame to the host system, the bit becomes the final bit. When the final bit is on, it indicates that the controller transmission of data is complete.

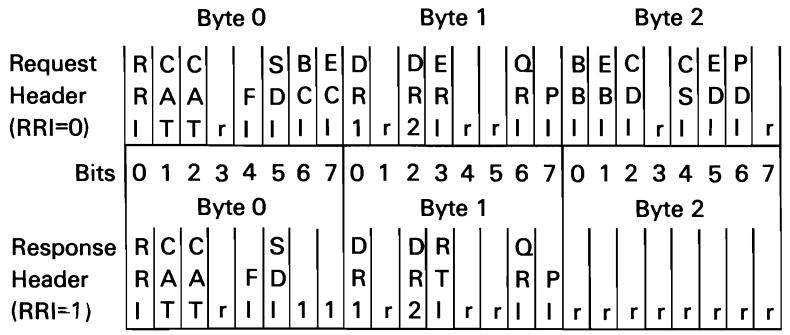
Pacing

Byte 9 of the Bind command (see the index entry *bind command*) contains a parameter that allows the user to determine the rate at which the receiver can accept data via the SNA data flow. This ability to control the rate of transmission of data is called pacing. The host system should use a pacing count of 0 (no pacing) when it transmits to the display station and a pacing count of 3 when it transmits to the printer.

Note: If the host system wants to pace the display, its pacing value should be placed in byte 8 of the Bind request.

Request/Response Header (RH)

The RH consists of 3 bytes. These 3 bytes follow the TH and immediately precede the RU part of the SDLC frame. The following illustration shows the RH and a description of the fields.



Field	Explanation
RRI Request Response Indicator	0 = Request (RQ) 1 = Response (RSP)
CAT Request/Response Unit Category	00 = FM data (FMD) 01 = Network control (NC); invalid 10 = Data flow control (DFC) 11 = Session control (SC)
FI Format Indicator	0 = No SNA command follows 1 = SNA command follows
BCI Begin Chain Indicator	0 = Not first in chain 1 = First in chain
ECI End Chain Indicator	0 = Not last in chain 1 = Last in chain
	00 = MIC 01 = LIC 10 = FIC 11 = OIC
DR1 Definite Response 1	0 = Not DR1 1 = DR1
DR2 Definite Response 2	0 = Not DR2 1 = DR2
ERI Exception Response Indicator	Used in conjunction with DR1, DR2 to indicate the form of RSP requested as follows:

DR1,DR2,ERI = 000	No response
= 001	Reserved
= 100/010/110	Definite response (RQD1/2)
= 101/011/111	Exception response (RQEL1/2)

Field	Explanation	
RTI	Response Type Indicator	0 = Positive response 1 = Negative response
QRI	Queued Response Indicator	0 = Bypass queue 1 = Use queues (QR)
PI	Pacing Indicator	0 = No pacing 1 = Pacing (PAC)
BBI	Begin Bracket Indicator	0 = No BBI 1 = Begin bracket (BB)
EBI	End Bracket Indicator	0 = No EBI 1 = End bracket (EB)
CDI	Change Direction Indicator	0 = Do not change direction 1 = Change direction (CD)
CSI	Code Selection Indicator	0 = Code 0 1 = Code 1 (invalid)
EDI	Enciphered Data Indicator	0 = RU not enciphered 1 = RU is enciphered (invalid)
PDI	Padded Data Indicator	0 = RU is not padded 1 = RU is padded (invalid)
r	Reserved	Set to 0

The Format Indicator (FI) designates the contents of the RU as Data, command, or Formatted Header (FMH). The 5294 does not support FM headers.

Any time the Response Type Indicator (RRI) is equal to 1 (negative response), the Sense Data Included Indicator (SDI) will be equal to 1. Also a 4-byte sense data field will immediately follow the RH and be included as part of the RU. Any user data contained in the RU follows the sense data field.

The Begin Chain indicator (BCI) and End Chain indicator (ECI) are encoded to represent the relative position of the associated RU within a chain as follows:

BCI	ECI	
1	0	First RU in chain (FIC)
0	0	Middle RU in chain (MIC)
0	1	Last RU in chain (LIC)
1	1	Only RU in chain (OIC)

RU (Request/Response Unit)

The request/response unit (RU) contains all the commands and data sent between the host system and the controller. It is immediately preceded by the TH and RH. The RU, together with the TH and RH, form the path information unit (PIU). Each RU can be a maximum of 256 bytes long; however, FMD RUs may be chained together, if more than 256 bytes need to be sent, by marking the RUs relative to their position in a chain by bits in the RH.

ESC Hex 04	Command Code and Associated data (See the index entry *display, commands.)*	ESC More Cmds

See also *Protocols and Synchronization for 5250 Implementation of SNA* in Section 1.

Screen Attributes

Each screen attribute is eight bits long; the screen attributes reside in the regeneration buffers and control the characteristics of the display. They are coded in the SF order or may be embedded with other display data following the Write to Display command. See the index entries *SF order* and *Display commands* and the appropriate operator's guide for your machine. Each bit of the screen has a specific reference to the display. These bits determine how the information is going to be displayed.

The bits representing screen attributes show as blanks on the normal display. The following chart describes the resulting display characteristics for each screen attribute bit pattern for the various displays.

Hexadecimal Code	Bit/Code						Resulting Character Display	
	0-2	3	4	5	6	7	5251, 5252, 5291, 3180, and 3196 3179 and 5292 (Limited Color)	5292 (Full Color), 3179 Models 2 or 220
20	001	0	0	0	0	0	Normal	Green
21	001	0	0	0	0	1	Reverse image	Green/reverse image
22	001	0	0	0	1	0	High intensity[1]	White
23	001	0	0	0	1	1	High intensity[1]/reverse image	White/reverse image
24	001	0	0	1	0	0	Underscore	Green/underscore
25	001	0	0	1	0	1	Underscore/reverse image	Green, underscore, reverse imag
26	001	0	0	1	1	0	Underscore, high intensity[1]	White, underscore
27	001	0	0	1	1	1	Nondisplay	Nondisplay
28	001	0	1	0	0	0	Blink	Red
29	001	0	1	0	0	1	Blink, reverse image	Red, reverse image
2A	001	0	1	0	1	0	Blink, high intensity[1]	Red, blink
2B	001	0	1	0	1	1	Blink, high intensity[1], reverse image	Red, reverse image, blink
2C	001	0	1	1	0	0	Blink, underscore	Red, underscore
2D	001	0	1	1	0	1	Blink, underscore, reverse image	Red, underscore, reverse image
2E	001	0	1	1	1	0	Blink, underscore, high intensity[1]	Red, underscore, blink
2F	001	0	1	1	1	1	Nondisplay	Nondisplay
30	001	1	0	0	0	0	Column separator	Turquoise, column separator
31	001	1	0	0	0	1	Column separator, reverse image	Turquoise, column separator, reverse image
32	001	1	0	0	1	0	Column separator, high intensity[1]	Yellow, column separator
33	001	1	0	0	1	1	Column separator, high intensity[1], reverse image	Yellow, column separator, reverse image
34	001	1	0	1	0	0	Column separator, underscore	Turquoise, underscore, column separators
35	001	1	0	1	0	1	Column separator, underscore, reverse image	Turquoise, underscore, reverse image, column separators
36	001	1	0	1	1	0	Column separator, underscore, high intensity[1]	Yellow, underscore, column separators
37	001	1	0	1	1	1	Nondisplay	Nondisplay
38	001	1	1	0	0	0	Column separator, blink	Pink
39	001	1	1	0	0	1	Column separator, blink, reverse image	Pink, reverse image
3A	001	1	1	0	1	0	Column separator, blink, high intensity[1]	Blue
3B	001	1	1	0	1	1	Column separator, blink, high intensity[1], reverse image	Blue, reverse image
3C	001	1	1	1	0	0	Column separator, blink, underscore	Pink, underscore
3D	001	1	1	1	0	1	Column separator, blink, underscore, reverse image	Pink, underscore, reverse image
3E	001	1	1	1	1	0	Column separator, blink, underscore, high intensity[1]	Blue, underscore
3F	001	1	1	1	1	1	Nondisplay	Nondisplay

[1]In limited color, high intensity will always be displayed as white on 5292 displays.

SDLC/Counter Error Codes (006X)

The 006X error codes are for SDLC. They are placed in the error log when the controller counters that track SDLC transmission errors overflow or when the host system solicits the error log. The operator may display the counters that are formatted into these errors. See *Problem Determination Procedures* in the *IBM 5251 Models 2 and 12 Operator's Guide*, GA21-9323, or the *5294 Operator's Guide*, GA21-9370. See the index entries *errors, error log; errors, handling;* and *reqms command*.

The following chart describes each SDLC error code.

0060 Bad test counter.
Used with the SDLC Test command for diagnostic purposes.

0061 Good test counter.
Used with the SDLC Test command for diagnostic purposes.

0062 Communications adapter underrun counter.

0063 Communications adapter overrun counter.

0064 Carrier detect glitch counter.
Occurs when the carrier detect line is unexpectedly inactive.

0065 Clear to send glitch counter.
Occurs if the clear to send line is unexpectedly inactive.

0066 Data set ready glitch counter.
Occurs if the data set ready line is unexpectedly inactive.

0067 Frame sequence error counter.
Occurs when frame sequence errors occur.

0068 Transmit retry counter.
Occurs each time an I frame must be retransmitted.

0069 CRC errors in FCS field.
Occurs each time the FCS character does not match the expected FCS character.

006A Frame aborts received.

006B XLCA card detected errors.

006E Number of I frames transmitted by the 5294 (4 bytes).

006F Number of I frames received by the 5294 (4 bytes).

SNA Chain End

The last RU in a chain is indicated by turning on the Last in Chain indicator (bit 7) in byte 0 of the RH.

States and Modes

The display station can be in one of several states (conditions) with their accompanying modes (methods of operation). A list of these states and modes follows:

- Hardware error
- Normal locked
- Normal unlocked
  - Command mode
  - Insert mode
  - Data mode.
- Power-on
- Prehelp and posthelp error
- SS message
- System request.

An explanation of each of the display station states and any accompanying modes follows.

Hardware Error State

The keyboard enters the hardware error state when a malfunction in the physical machine is detected. The characteristic of this state is that no keystrokes are processed. When the error is cleared, the exit is to the normal unlocked state (format level 0 selected). See the index entry *format level 0*.

Normal Locked State

This state is entered either by the operator pressing a key that requires host system attention or by the host issuing a command that locks the keyboard. These are the valid commands the host system can use to bring the display station into this state:

- Clear Unit
- Clear Format Table
- Write to Display (if the format table is altered)
- Restore (if Save was issued to a locked keyboard).

The characteristics of the locked state are:

- The keyboard is locked, the clicker is off, and the Input Inhibited indicator is on.
- All keys except Sys Req, Attn, Print (Cancel), and the Shift keys are ignored.

The operator can exit this state by pressing the Sys/Req key. This places the display station in the system/request state. The user can exit this state by (1) issuing an unlock control character in a host command that will unlock the keyboard, (2) entering the SS message state, or (3) issuing an Actlu, Dactlu, Bind, or Unbind command. See the index entries *control characters, display; SNA, commands; display, commands*; and *system request state*.

See Figure 2-11.

Normal Unlocked State

The characteristics of this state are:

- The keyboard is unlocked, the clicker is on, and the Input Inhibited indicator is off.
- Invalid keys cause errors.

The possible ways to enter the normal unlocked state are via:

- Host commands that contain CC to unlock the keyboard.
- The operator pressing the Error Reset after a keying error.
- The operator performing one of the following reset operations when the original operation was initiated during a normal unlocked state:
  - Error reset following a Write Error command
  - Error reset following a Sys Req key activation
  - Error reset following an SS message
  - Error reset following a Cmd key activation.

There are three modes that can be selected within the normal unlocked keyboard state. They are characterized in the following way:

Command Mode

(Command mode only exists on keyboards that have a Cmd key. It is not needed on other keyboards.)

The operator selects this mode by pressing the Cmd key, which allows selection of preprogrammed command function keys. This mode cannot be entered when the keyboard is in the system request, normal locked, or error state, or in the insert mode. The operator can exit from this by pressing the Error Reset key or any of the top row function keys.

Insert Mode

The operator selects this mode by pressing the Ins key, which allows insertion of data or text into existing data or text. When the insert mode is in effect, the Insert indicator is on. This mode cannot be entered if the keyboard is in the normal locked, or error state, or in command mode. The exit is to the data mode when the operator presses the Error Reset key.

Data Mode

The operator selects this mode by keying, or the programmer selects it with a CC. During this mode, the operator can preform any of the normal keying functions; the keyboard clicker is on, the Input Inhibited indicator is off, and the keyboard is unlocked. Exit to any of the other states is possible.

See Figure 2-9.

Posthelp Error State

The operator enters the keyboard into this state by pressing the Help key after an error has occurred. The characteristics of this error state are:

- The keyboard is locked, the clicker is off, and the Input Inhibited indicator is on.
- Only the Attn and Shift keys are operational.
- The leading attribute on the error line becomes high intensity.
- A signal is sent to the host system; see the index entry *signal keys*.

See Figure 2-12.

Power-On State

This is the state that occurs between the time the controller receives electrical power and the time it enters another state such as the system request state. During this time, it is in a free keying mode. (Note that free keying cannot occur if the controller is powered down.) During this free keying mode, all functions that do not require the host system but that can be done under the control of the controller are allowed. The characteristics of this state are:

- From row 1 and column 2 of the display to the end of the display is considered one alphanumeric field.
- The cursor movement and shift keys are functional.
- Alphanumeric characters are accepted, translated, and returned to the display. The cursor is updated to the next entry position.
- Functions that the controller can handle are operational. These are such functions as Del, Ins, Clear, and Display.
- Function keys that require the host system cause errors when activated.

See Figure 2-10.

Prehelp Error State

The prehelp error state is the first that the keyboard enters when the operator makes a keying error. The programmer can also enter this error state by coding the Write Error Code command. The characteristics of this error state are:

- The keyboard is locked, the clicker is off, and the Input Inhibited indicator is on.
- All keys except Attn, Help, Reset, and the Shift keys are ignored.
- The error line is saved.
- The error code is posted.
- The cursor blinks.

The operator can exit this state by pressing the Error Reset key; this returns the keyboard to its previous state. The operator can also choose to press the Help key and enter the posthelp error state.

See Figure 2-11.

SS Message State

The host system enters the keyboard into this state by using information contained in the host to controller SS-LU data flow. The characteristics of this state are that:

- The keyboard is locked, the clicker is off, the Input Inhibited indicator is on.
- Invalid keys are ignored.
- The error line is saved.

The operator exits this state by pressing the Error Reset key; the exit is to the previous state.

See Figure 2-12.

System Request State

The operator initiates this state by pressing the Sys/Req key. The characteristic of the system request state is that the keyboard is unlocked. The error line is saved and filled with null characters. Use of invalid keys causes an exit to the error state. If the system request state was entered from the normal unlocked state by using the Sys Req key, the operator can reenter the normal unlocked state by pressing the Error Reset key; otherwise, input inhibited remains in effect.

See Figure 2-10.

Key(s)/ Function(s)	Command Mode	Insert Mode	Data Mode
Alpha (shift)	Always valid.	Always valid.	Always valid.
Alt (shift)	Always valid.	Always valid.	Always valid.
Attn	Invalid. Causes an error.	Always valid.	Always valid.
Cancel	Invalid. Causes an error.	Printer: Ignores the key unless it is receiving SNA chains. Then it issues a -rsp to direct the user to stop sending chains.	Printer: Ignores the key unless it is receiving SNA chains.Then it issues a -rsp to direct the user to stop sending chains.
		Keyboard: Ignores the key unless the Copy to Printer feature is installed and operating. Then it terminates the operation without causing an error	Keyboard: Ignores the key unless the Copy to Printer feature is installed and operating. Then it terminates the operation without causing an error.
Caps Lock	Always valid.	Always valid.	Always valid.
← (Character Backspace)	Not applicable. On the U.S.A. typewriter keyboard, this is the Clear and Test Request command function key.	Valid if the cursor does not leave the field.	Invalid if there is an attempt to leave a mandatory fill or self-check field without first satisfying the field requirements.
Clear	Always valid. Goes to the normal locked state and services any pending read commands by returning the clear aid code. If you are not in session, the controller clears the screen and format table.	For the 5251, 5252, 5291, and 5292, this key sequence is invalid because the Cmd key is invalid in this mode. This key is always valid for all other displays. Goes to the normal locked state and services any pending Read commands by returning the clear aid code. If you are not in session, the controller clears the screen and format table.	Not applicable. The Cmd key exits from this mode. For the 5251, 5252, 5291, and 5292, this key sequence is invalid because the Cmd key is invalid in this mode. This key is always valid for all other displays. Goes to the normal locked state and services any pending Read commands by returning the clear aid code. If you are not in session, the the controller clears the screen and format table.
Cmd Key or Command/ Function Keys	Always valid.	Invalid. Causes an error.	Invalid if a mandatory fill or self-check field was being keyed without the operator satisfying the requirements of the field.

Figure 2-9 (Part 1 of 5). Effects of the Normal Unlocked State on the Display Station Keys/Functions

Key(s)/ Function(s)	Command Mode	Insert Mode	Data Mode
Command Function Keys 1-24, (5251, 5252, 5291, and 5292 only. For other displays, see Cmd Key or Command Function Keys on this chart.)	Invalid if there is an attempt to leave a field without first satisfying the mandatory fill, self-check, or right-adjust requirements of the field. It causes a mandatory enter check if the master MDT bit is on. If it is valid, it goes to the locked state and services any pending Read commands.	Not applicable. The Cmd key is invalid in this mode.	Not applicable. The Cmd key exits from this mode.
↓(Cursor Down)	Invalid. Causes an error.	Valid if the cursor does not leave the field.	Invalid if an attempt is made to leave a mandatory fill or self-check field without the operator satisfying the field requirements.
←(Cursor Left)	Invalid. Causes an error.	Valid if the cursor does not leave the field.	Invalid if an attempt is made to leave a mandatory fill or self-check field without the operator satisfying the field requirements.
→(Cursor Right)	Invalid. Causes an error.	Valid if the cursor does not leave the field.	Invalid if an attempt is made to leave a mandatory fill or self-check field without the operator satisfying the field requirements.
↑(Cursor Up)	Invalid.Causes an error.	Valid if the cursor does not leave the field.	Invalid if an attempt is made to leave a mandatory fill or self-check field without the operator satisfying the field requirements.
Data Keys	Invalid. Causes an error.	Validity depends on the format table, cursor location, and data on the display.	Same as for insert mode.
Del	Invalid. Causes an error.	Always valid.	Validity depends on the format table and cursor location.
Display Mode (5251, 5252, 5291, 5292 only)	Always valid.	Not applicable. The Cmd key is invalid in this mode.	Not applicable. The Cmd key exits from this mode.
Dup	Invalid. Causes an error.	Invalid. Causes an error.	Validity depends on the format table and cursor location.

Figure 2-9 (Part 2 of 5). Effects of the Normal Unlocked State on the Display Station Keys/Functions

Key(s)/ Function(s)	Command Mode	Insert Mode	Data Mode
Enter/Rec Adv	Invalid. Causes an error.	Invalid if there is an attempt to leave a field without the operator satisfying the mandatory fill, self-check, or right adjust requirements of the field. Clears the insert mode. Causes a mandatory enter check if the master MDT bit is on. If valid, goes to the locked state, and services any pending read commands.	Invalid if there is an attempt to leave a field without the operator satisfying the mandatory fill, self-check, or right-adjust requirements of the field. Clears the insert mode. Causes a mandatory enter check if the master MDT bit is on. If valid, goes to the locked state, and services any pending Read commands.
Erase Input	Invalid. Causes an error.	Invalid. Causes an error.	Always valid.
Error Reset	Always valid.	Always valid.	Always valid.
Field+ (typewriter-like keyboard only)	Invalid. Causes an error.	Invalid. Causes an error.	Validity depends on the format table, cursor location, and data on the display.
Field-	Invalid. Causes an error.	Invalid. Causes an error.	Validity depends on the format table, cursor location, and data on the display.
→| (Field Advance)	Invalid. Causes an error.	Valid if the cursor does not leave the field.	Invalid if there is an attempt to leave a mandatory fill or self-check field without the operator satisfying the field requirements.
|← (Field Backspace)	Invalid. Causes an error.	Valid if the cursor does not leave the field.	Invalid if there is an attempt to leave a mandatory fill or self-check field without the operator satisfying the field requirements.
Field Exit	Invalid. Causes an error.	Invalid. Causes an error.	Validity depends on the format table, cursor location, and data on the display.
Help	Invalid. Causes an error.	Always valid. Goes to the normal locked state, and services any pending read commands. Clears the insert mode.	Valid except in active right-adjust fields. Goes to the normal locked state, and services any pending read commands.

Figure 2-9 (Part 3 of 5). Effects of the Normal Unlocked State on the Display Station Keys/Functions

Key(s)/ Function(s)	Command Mode	Insert Mode	Data Mode
Home	Invalid. Causes an error.	Invalid. Causes an error.	Invalid if an attempt is made to leave a mandatory fill or self-check field without the operator satisfying the field requirements.
Ins	Invalid. Causes an error.	Always valid.	Validity depends on the format table and cursor location.
↵ (New Line)	Invalid. Causes an error.	Valid if the cursor does not leave the field.	Invalid if an attempt is made to leave a mandatory fill or self-check field without the operator satisfying the field requirements.
Num (Shift)	Always valid.	Always valid.	Always valid.
Print	Invalid. Causes an error.	Invalid. Causes an error.	Invalid if an attempt is made to leave a mandatory fill, self-check, or active right-adjust field without the operator satisfying the field requirements. If valid, it goes to the locked state and services any pending read commands.
Record Backspace Function	Invalid. Causes an error.	Invalid. Causes an error.	Valid any time except from an active right-adjust field. Goes to normal locked state and services any pending read commands.
Roll↓ or Roll↑ (Roll Down) or (Roll Up)	Invalid. Causes an error.	Invalid. Causes an error.	Invalid if an attempt is made to leave a mandatory fill, self-check, or active right-adjust field without the operator satisfying the field requirements. If valid, it goes to the locked state and services any pending read commands. If the master MDT bit is on, it causes a mandatory enter check.

Figure 2-9 (Part 4 of 5). Effects of the Normal Unlocked State on the Display Station Keys/Functions

Key(s)/ Function(s)	Command Mode	Insert Mode	Data Mode
↑Page Up or Page Down	Invalid. Causes an error.	Invalid. Causes an error.	Invalid if an attempt is made to leave a mandatory fill, self-check, or active right-adjust field without the operator satisfying the field requirements. If valid, it goes to the locked state and services any pending read commands. If the master MDT bit is on, it causes a mandatory enter check.
⇩ (Shift Lock) (typewriter-like keyboard only)	Always valid.	Always valid.	Always valid.
⇧ (Shift Up) (typewriter-like keyboard only)	Always valid.	Always valid.	Always valid.
Sys Req	Invalid. Causes an error.	Invalid. Causes an error.	Invalid if an attempt is made to leave a mandatory fill or self-check field without the operator satisfying the field requirements. Flushed when the controller is processing data received from the host system.
Test Req (Test)	Always valid. Goes to the normal locked state.	Invalid. Causes an error.	For the 5251, 5252, and 5292, not applicable because the Cmd key exits this mode. For all other displays, the key is valid and the display goes to the normal locked state.

Figure 2-9 (Part 5 of 5). Effects of the Normal Unlocked State on the Display Station Keys/Functions

Key	Power-On State	System Request State
Alpha (Shift)	Always valid.	Always valid.
Attn	Invalid. Causes an error.	Invalid. Causes an error.
Cancel	Flushed.	Ignored. Same as for normal unlocked state.
Caps Lock	Always valid.	Always valid.
← (Character Backspace)	Always valid.	Always valid.
Clear	Always valid.	For 5251, 5252, 5291, and 5292, this key sequence is invalid because the Cmd key is invalid in this mode. For all other displays, the Clear key is always valid.
Cmd	Always valid.	Invalid. Causes an error.
Command Function Keys 1-24	Invalid. Causes an error.	Invalid. Causes an error.
↓ (Cursor Down)	Always valid.	Always valid.
← (Cursor Left)	Always valid.	Always valid.
→ (Cursor Right)	Always valid.	Always valid.
↑ (Cursor Up)	Always valid.	Always valid.
Data Keys	Always valid.	Always valid.
Del	Always valid.	Always valid.
Display mode	Always valid.	Not applicable. The Cmd key is invalid.
Dup	Invalid. Causes an error.	Invalid. Causes an error.
Enter/Rec Adv	Invalid. Causes an error.	Always valid.
Erase Input	Invalid. Causes an error.	Always valid.
Error Reset	Always valid.	Always valid.
Field+ (Typewriter-like keyboard only)	Always valid.	Always valid.
Field-	Invalid. Causes an error.	Invalid. Causes an error.
→ | (Field Advance)	Always valid.	Always valid.
| ← (Field Backspace)	Always valid.	Always valid.
Field Exit	Always valid.	Always valid.
Help	Invalid. Causes an error.	Invalid. Causes an error.
Home	Always valid.	Always valid.
Ins	Always valid.	Always valid.
↵ (New Line)	Always valid.	Always valid.
Num (Shift)	Always valid.	Always valid.
Page Down	Invalid. Causes an error.	Invalid. Causes an error.
Page Up	Invalid. Causes an error.	Invalid. Causes an error.
Print	Invalid. Causes an error.	Invalid. Causes an error.
Record Backspace Function	Invalid. Causes an error.	Invalid. Causes an error.
Roll ↓ (Roll Down)	Invalid. Causes an error.	Invalid. Causes an error.
Roll ↑ (Roll Up)	Invalid. Causes an error.	Invalid. Causes an error.
⇩ (Shift Lock)(Typewriter-like keyboard only)	Always valid.	Always valid.
⇧ (Shift Up)(Typewriter-like keyboard only)	Always valid.	Always valid.
Sys Req	Always valid. Goes to system request state.	Ignored.
Test Req (Test)	Invalid. Causes an error.	Invalid. Causes an error.

Figure 2-10. Effects of the Power-On and System Request States on the Display Station Keys/Functions

Key(s)/Function(s)	Normal Locked State	Prehelp Error State
Alpha (Shift)	Always valid	Always valid.
Attn	Always valid.	Always valid.
Caps Lock	Always valid.	Always valid.
Cancel	Always valid.	Ignored.
← (Character Backspace)	Ignored.	Ignored.
Clear	Ignored.	Ignored.
Cmd		
Command Function Keys 1-24	Ignored.	Ignored.
↓(Cursor Down)	Ignored.	Ignored.
←(Cursor Left)	Ignored.	Ignored.
→(Cursor Right)	Ignored.	Ignored.
↑(Cursor Up)	Ignored.	Ignored.
Data Keys	Ignored.	Ignored.
Del	Ignored.	Ignored.
Display Mode	Not applicable. The Cmd key is invalid.	Not applicable. The Cmd key is invalid.
Dup	Ignored.	Ignored.
Enter/Rec Adv	Ignored.	Ignored.
Erase Input	Ignored.	Ignored.
Error Reset	Ignored.	Always valid.
Field+ (Typewriter-like keyboard only)	Ignored.	Ignored.
Field-	Ignored.	Ignored.
→| (Field Advance)	Ignored.	Ignored.
|← (Field Backspace)	Ignored.	Ignored.
Field Exit	Ignored.	Ignored.
Help	Ignored.	Always valid.
Home	Ignored.	Ignored.
Ins	Ignored.	Ignored.
↵ (New Line)	Ignored.	Ignored.
Num (Shift)	Always valid.	Always valid.
Print	Ignored.	Ignored.
Record Backspace Function	Ignored.	Ignored.
Roll↑ or Page Down (Roll Up)	Ignored.	Ignored.
⇩ (Shift Lock) (typewriter-like keyboard only)	Always valid.	Always valid.
⇧ (Shift Up) (typewriter-like keyboard only)	Always valid.	Always valid.
Sys Req	Valid when the display station is not processing data from the host system. Flushed otherwise.	Ignored.
Test Req (Test)	Ignored.	Ignored.

Figure 2-11. Effects of the Normal Locked and Prehelp Error States on the Display Station Keys/Functions

Key(s)/Function(s)	Posthelp Error State	SS Message State
Alpha (Shift)	Always valid.	Always valid.
Attn	Always valid.	Always valid.
Cancel	Ignored.	Ignored.
←(Character Backspace)	Ignored.	Ignored.
Clear	Ignored.	Ignored.
Cmd	Ignored.	Ignored.
Command Function Keys 1-24	Ignored.	Ignored.
↓ (Cursor Down)	Ignored.	Ignored.
← (Cursor Left)	Ignored.	Ignored.
→ (Cursor Right)	Ignored.	Ignored.
↑ (Cursor Up)	Ignored.	Ignored.
Data Keys	Ignored.	Ignored.
Del	Ignored.	Ignored.
Display Mode	Not applicable. The Cmd key is invalid.	Not applicable. The Cmd key is invalid.
Dup	Ignored.	Ignored.
Enter/Rec Adv	Ignored.	Ignored.
Erase Input	Ignored.	Ignored.
Error Reset	Ignored.	Always valid.
Field+ (Typewriter-like keyboard only)	Ignored.	Ignored.
Field-	Ignored.	Ignored.

Figure 2-12 (Part 1 of 2). Effects of the Posthelp Error and SS Message States on the Display Station Keys/Functions

Key(s)/Function(s)	Posthelp Error State	SS Message State
→| (Field Advance)	Ignored.	Ignored.
|← (Field Backspace)	Ignored.	Ignored.
Field Exit	Ignored.	Ignored.
Help	Ignored.	Ignored.
Home	Ignored.	Ignored.
Ins	Ignored.	Ignored.
↵ (New Line)	Ignored.	Ignored.
Num (Shift)	Always valid.	Always valid.
Print	Ignored.	Ignored.
Record Backspace Function	Ignored.	Ignored.
Roll↓ (Page Up) (Roll Down)	Ignored.	Ignored.
Roll↑ (Page Down) Roll Up)	Ignored.	Ignored.
⇩ (Shift Lock) (typewriter-like keyboard only)	Always valid.	Always valid.
⇧ Shift Up) (typewriter-like keyboard only)	Always valid.	Always valid.
Sys Req	Ignored.	Ignored.
Test Req (Test)	Ignored.	Ignored.

Figure 2-12 (Part 2 of 2). Effects of the Posthelp Error and SS Message States on the Display Station Keys/Functions

Figure 2-13 illustrates the errors that result from using invalid keys.

Key	Data Mode Errors				Insert Mode Errors
	Mandatory Enter Field	Right-Adjust Field	Mandatory Fill Field	Check Digit Field	
Command Function 1-24	0007	0020	0014	0015	0013 (Note 1)
Clear	--	0020	--	--	0013 (Note 3)
Test Req (Test)	--	0020	--	--	0013 (Note 1)
Display Mode	--	--	--	--	0013 (Note 1)
Sys Req	--	0020	0014	0015	0013
Attn	--	--	--	--	--
Erase Input	--	--	--	--	0013
Home	--	--	0014 (Note 2)	0015 (Note 2)	0013
Print	--	0020	0014	0015	0013
Help (non-error)	--	0020	--	--	-- (Note 1)
Roll	0007	0020	0014	0015	0013
Enter/Rec Adv	0007	0020	0014	0015	-- (Note 1)
Sys Req/Attn	--	NA	NA	NA	NA
Record Backspace	--	0020	--	--	NA

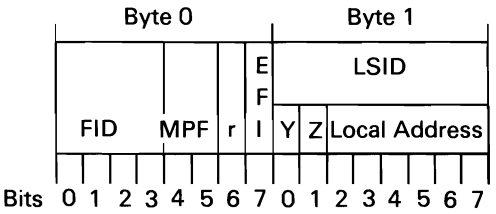
Notes:
1. See Figure 2-9.
2. The error occurs only if the home position is not in the field. The insert mode is automatically reset.
3. A 0013 occurs when the operator presses the Cmd key on a 5251, 5252, 5291, or 5292. All other displays execute the Clear function.

Legend:
00-- The operator error code is displayed if the display is in insert mode, or if the field specified is mandatory enter, right-adjust, mandatory fill, or check digit and the function specified is not satisfactorily fulfilled.
-- The function is valid and is performed.
NA Not applicable.

Figure 2-13. Errors that Occur When Invalid Keys are Used in Data and Insert Modes

TH (Transmission Header)

The TH is a control field used by path control in SNA. The TH is 2 bytes long and follows the FAC in the SDLC frame. The following illustration shows the fields in the TH and also contains a brief description of each field.



Field	Explanation
FID Format Identification	0000 = FID0 (invalid) 0001 = FID1 (invalid) 0010 = FID2 (invalid) 0011 = FID3
MPF Mapping Field (Segmenting)	00 = Middle segment (invalid) 01 = Last segment (invalid) 10 = First segment (invalid) 11 = Only segment
EFI Expedited Flow	0 = Normal flow 1 = Expedited flow
Y SS/LU Indicator	0 = SS 1 = LU
Z PU/LU Indicator	0 = PU 1 = LU
LSID local Session Identification	00000000 = SS/PU session 01xxxxxx = SS/LU session 10xxxxxx = Reserved 11xxxxxx = LU/LU session xxxxxx = 0 to 63 local address
r Reserved	Set to 0

The expedited flow indicator is set to 1 when expedited commands are sent.

The LSID is used to identify each logical session that exists between the 5294 and the host system.

Expanded Cluster Feature

This feature is an optional feature for users who require more work station capacity. The Expanded Cluster feature adds two twinaxial connectors (ports 1 and 2) to the 5294 to support up to eight work stations (six with X.25 support).

1200 bps Integrated Modem

The 1200 bps Integrated Modem is an internal modem that provides a means of communication between a 5251 Model 2 or Model 12 and a host system over switched or nonswitched communications lines. It requires the Internal Clock feature to generate a clocking pulse to synchronize its signals for transmitting and receiving.

The 5294 does not support the 1200 bps Integrated Modem.

2400 or 4800 bps Integrated Modem

The 2400 or 4800 bps Integrated Modem is an internal modem that provides communications between the 5251 Model 2 or Model 12 and a host system over switched or nonswitched communications lines.

When either of these modems is used, the Internal Clock feature must not be installed on the 5251 Model 2 or Model 12. The 2400 or 4800 bps Integrated Modems generate the clocking pulse needed to synchronize the signals for transmitting and receiving signals.

The 5294 does not support the 2400 or 4800 bps Integrated Modem.

X.25 Feature

The X.25 feature is required to connect the 5294 Control Unit to the X.25 Packet Switching Network. This feature provides the HDLC protocol for X.25 communications. When the X.25 feature is selected, either the EIA/CCITT Interface adapter for X.21 bis support or the XLCA Adapter for an X.21 nonswitched line must be specified. Packet sizes of 64, 128, or 256 bytes are supported.

The host system converts SNA/SDLC information into a packet form that the network can handle. The X.25 feature provides a similar function in the 5294 Control Unit. Line speeds between the X.25 feature and the network may be as high as 48,000 bps in duplex mode. A switched virtual circuit (SVC) or a permanent virtual circuit (PVC) can be used.

Packet switching data network facilities that can be optionally specified are:

- Reversed charging
- Closed user group
- Flow control negotiation of both packet window size and packet size
- Throughput class negotiation
- Recognized private operating agency (RPOA) selection.

The X.25 feature also allows the use of facilities not specified by CCITT Recommendation X.25 (1980); for example, priority class of service.

X.25 operations differ from other communications networks as follows:

- The SDLC communications protocol is not available.
- A DDS adapter may not be used.
- The test request option link test can only be initiated from the host.
- Some operator error codes are changed or added.
- Communications codes are added; a complete list is given in this manual.
- The error log includes X.25 information.

Other operations, such as the following, remain the same:

- Controller and work station addressing procedures are identical.
- SNA session control and data flow remain the same.
- SNA commands are unchanged.

X.25 Feature Functions

The functions of the CCITT Recommendation X.25 (1980) supported by the 5294 are:

- Packet Layer
  - Packet size (specifically the user data field) can be 64, 128, 256 bytes.
  - Window size can be 2-7 packets.
  - Packet sequence numbering is modulo 8.

- Link layer
  - Link access protocol, balanced mode (LAPB) is the data link protocol. Link access protocol (LAP) is not supported.
  - SABM and DISC commands are always sent with the P bit on.
  - RR and RNR commands are always sent with the P bit on.
  - The maximum number of bits in a frame (excluding flags, the frame check sequence, and 0 bits inserted for transparency) is 2,088 (259 bytes).
  - The maximum number of transmissions and retransmissions of a frame after a T1 time out is ten.

- Physical layer
  - CCITT Recommendation X.21 is followed.
  - X.21 bis is allowed.
  - X.21 nonswitched is allowed.

Some functions are not supported by the 5294:

- Packet layer
  - Interrupt packets and datagrams are not used, and if received, are treated as errors.
  - Reject packets are not supported.
  - The fast select facility is not supported.
  - The bilateral closed user group facility is not supported.
  - Receive not ready (RNR) packets are not transmitted. An RNR packet arriving at the 5294 suspends packet transmission until a receive ready (RR) packet arrives.

Five time outs are used by the 5294:

- If the clear-to-send signal on the network DCE drops, a 30-second delay is allowed for error recovery.
- T1 time out is fixed at 3.0 seconds.
- Call request (T21) time out is about 200 seconds.
- Reset request (T22) time out is about 200 seconds.
- Clear request (T23) time out is about 200 seconds.

Additional requirements for the 5294 are:

- In an incoming call packet, byte 0 of the call user data field must contain hex C2 (PSH), C3 (QLLCT) or C6 (ELLC). The 5294 defaults to the protocol indicated in the incoming call packet.
- In an incoming call packet, the maximum size of the facilities field is 63 bytes.

Frame Level Performance Characteristics

- When one frame has completed transmission successfully, the 5294 preempts other processing to initiate transmission of a new frame as soon as possible.

- *Piggybacking* avoids the transmission of unnecessary overhead packets and frames by having the information carried with data flowing in the opposite direction. The 5294 performs packet-level piggybacking.

SNA/X.25 Relationship

Figure 2-14 shows how the SNA layers already provided in the 5294 relate to the X.25 layers provided by the X.25 feature. Function management data (FMD) services, the highest SNA layer, are followed by data flow control, transmission control, and path control. The lowest SNA layer, data link control, is replaced by a logical link control layer and three layers defined by X.25: the packet layer, the link layer, and the physical layer.

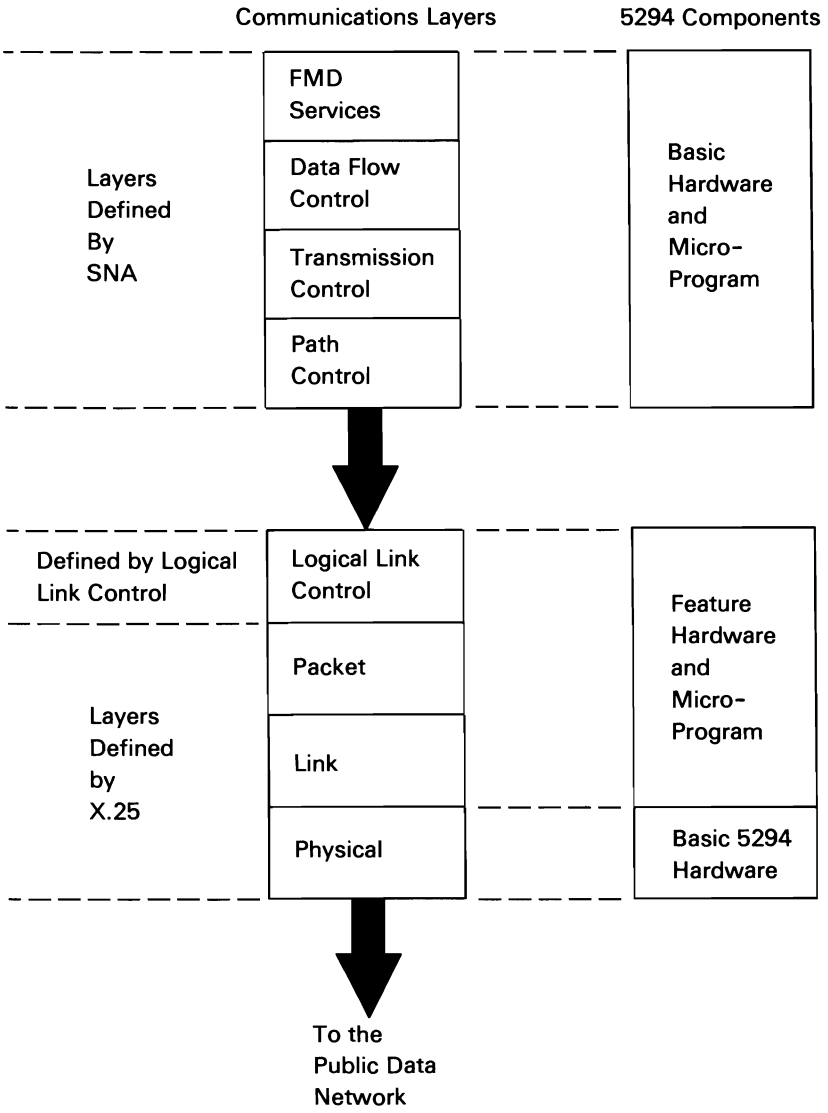


Figure 2-14. Relationship between SNA and X.25 Levels with the X.25 Feature

The X.25 packet and link layers provide another form of data link control. The third X.25 layer, the physical layer, provides functions that are used by SNA layers but are not specifically defined as a separate layer. The physical layer conforms to CCITT Recommendations X.21 bis and X.21 (nonswitched).

When the 5294 establishes connection to the packet-switching data network, the lower layers are activated first. That is, the physical layer is activated first, then the link layer, then the packet layer, and so on.

Establishing and Closing an SVC/PVC Connection

The sequence for establishing an SVC/PVC connection between the 5294 and the host is defined below. Figure 2-15 shows these steps and indicates the parts of the network involved with each step.

1. The controller obtains the parameters for the connection from either operator input or customer setup.

2. The controller activates the physical layer and the link layer, and the link layer issues the link access procedure, balanced mode (LAPB) command, SABM, to establish the data link to the network node. A 15-second delay is provided between operator input and link activation.

3. The controller activates the packet layer by issuing a restart request packet. After packet level activation, a call request packet is sent for an outgoing request or the controller waits for an incoming call packet for an incoming request. This step is not required for PVC connections, because the virtual circuit is permanently established.

4. After the host has established an SNA connection with the 5294, the controller builds SNA commands and data into packets, and sends them to the host via the X.25 network.

5. When the data reaches the controller, the data is in the form of SNA path information units (PIUs). The controller builds the PIUs into packets and sends the packets to the host inside LAPB frames via the X.25 network.

The connection is closed down in reverse order using four steps:

1. Following the issuing of the Vary Off command at the host, SNA commands and the SNA session.

2. For a PVC, the virtual circuit remains active and another SNA session can be started by a Vary On command at the host. For an SVC, the NIA or host sends a clear request packet to the network. The network in turn sends a clear indication packet to the 5294 to clear the SVC.

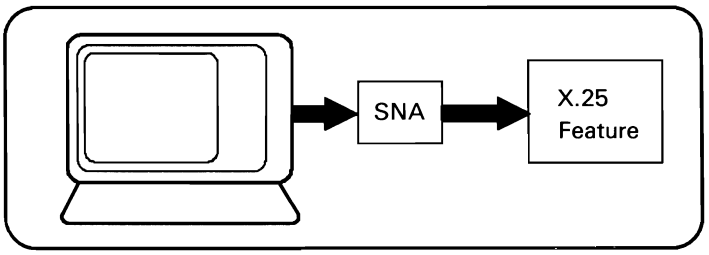
3. The controller displays a communications code on the operator's screen (SVC only).

4. On an SVC, the operator may begin a new connection procedure to an alternate (or the same) host.

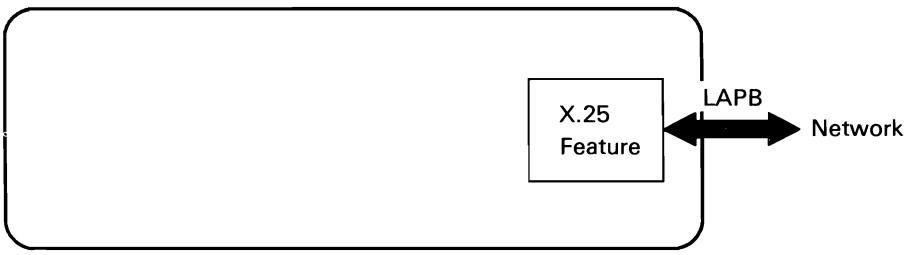
Formats of Communications Components

The relationship between the three major components involved in the communications process between the 5294 and the host is shown in Figure 2-16. The SNA path information unit (PIU), developed by the SNA handling portion of the 5294 is built into one or more packets by the controller, depending on the size of the PIU and packet size. Each packet is, in turn, built into an LAPB frame and then sent to the network.

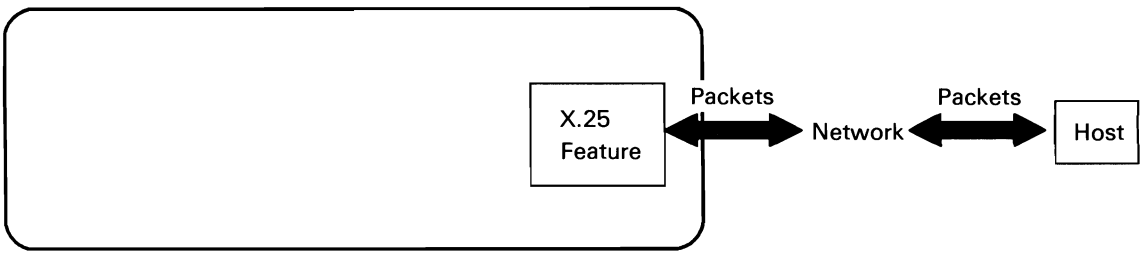
Step 1: Obtaining connection parameters



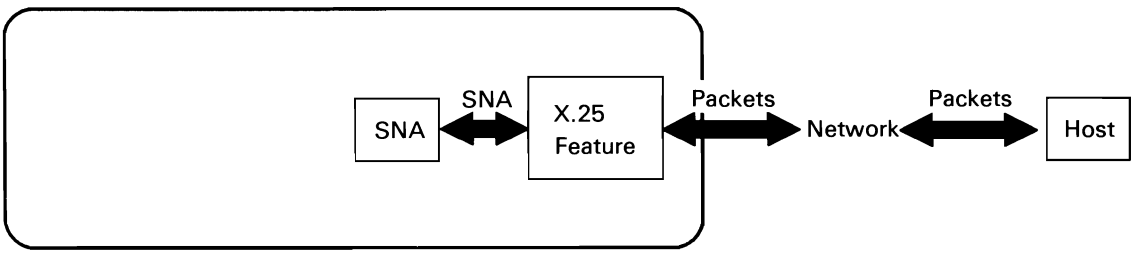
Step 2: Establishing the link to the network



Step 3: Establishing the virtual circuit



Step 4: Establishing the SNA connection



Step 5: Data transfer

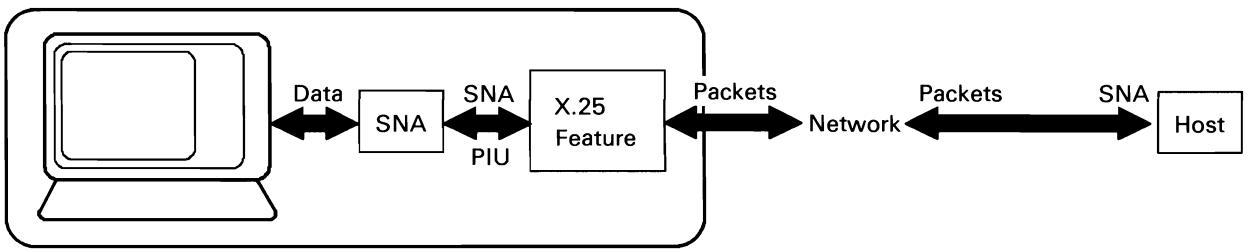
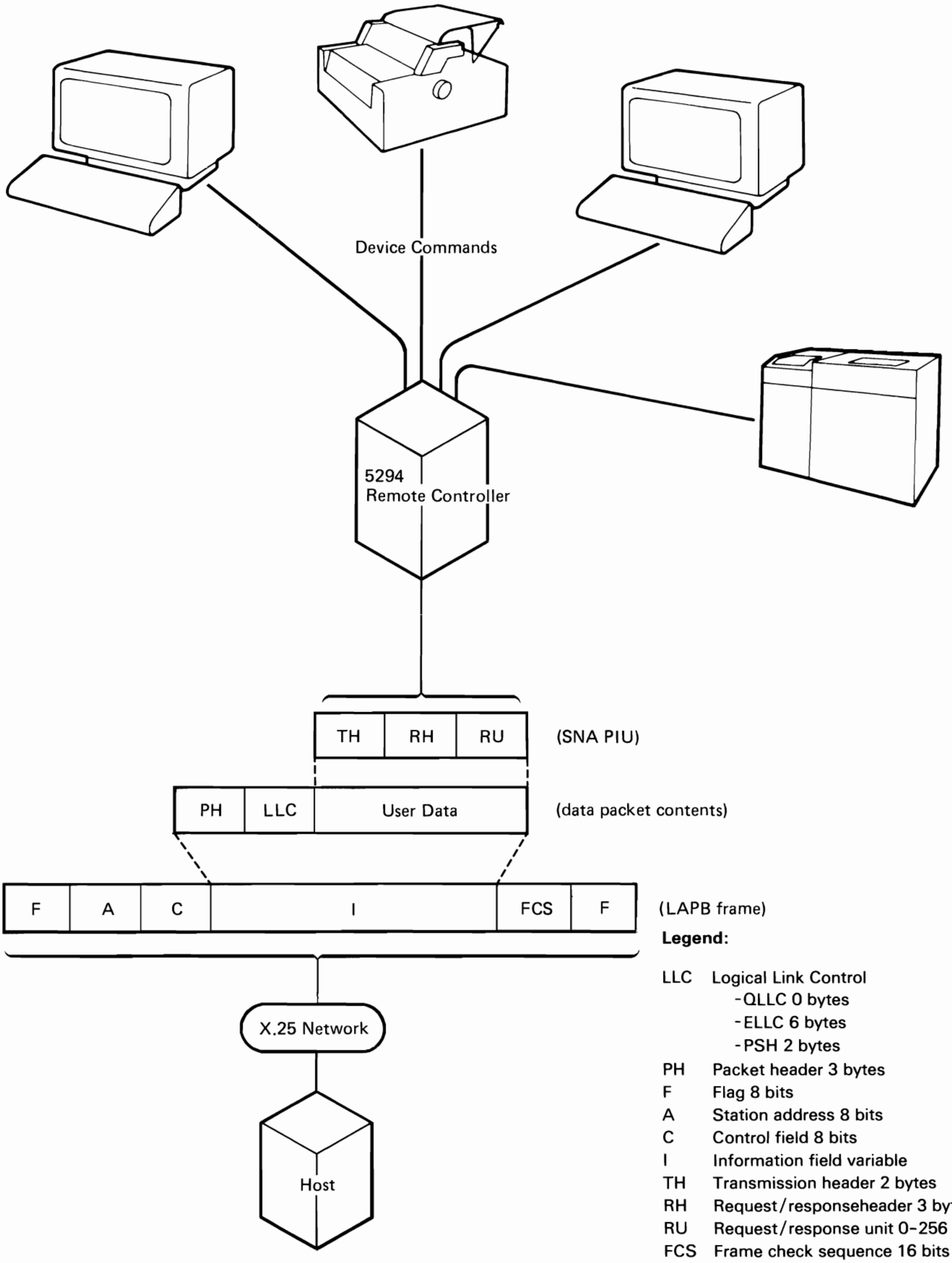


Figure 2-15. Establishing the Connection between the 5294 Control Unit and the Host



Legend:

LLC	Logical Link Control -QLLC 0 bytes -ELLC 6 bytes -PSH 2 bytes
PH	Packet header 3 bytes
F	Flag 8 bits
A	Station address 8 bits
C	Control field 8 bits
I	Information field variable
TH	Transmission header 2 bytes
RH	Request/responseheader 3 bytes
RU	Request/response unit 0-256 bytes
FCS	Frame check sequence 16 bits
F	Flag 8 bits

Figure 2-16. The PIU/Packet/Frame Relationship

LAPB Frames and Commands

LAPB frames consist of:

- A leading flag
- An address field
- A control field containing a command or response
- An information field (I-frames only)
- A frame check sequence
- A trailing flag.

LAPB commands and responses supported by the X.25 feature are:

Commands	Responses
I-Frames	
RR	RR
RNR	RNR
REJ	REJ
SABM	DM
DISC	UA
-	FRMR

Packets

The information field of the LAPB information frame contains a packet. The packet consists of as many as three fields:

- A packet header containing, for example, the general format indicator, the logical channel number, and the packet type identifier
- A logical link control header, if the packet is a data packet
- A user data field containing the PIU developed by the SNA logic.

Packet types that are used or supported by the feature are:

Call Request
Incoming Call
Call Accepted
Call Connected
Restart Request
Restart Indication
Restart Confirmation
Clear Request
Clear Indication
Clear Confirmation
Reset Request
Reset Indication
Reset Confirmation
Data
Receive Ready (RR)
Receive Not Ready (RNR)
Diagnostic.

Logical Link Control (LLC)

There are three types of LLC that can be used on the 5294. They are:

- QLLC: Q bit logical link control
- ELLC: Enhanced logical link control
- PSH: Physical services header.

These protocols serve to make an X.25 virtual circuit appear as an SDLC link to the highest levels of SNA. The type of LLC is determined at customer setup time.

The formats for each type of LLC are described in the following topics.

Q Logical Link Control (QLLC)

QLLC is a type of logical link control available on the 5294. The selection of the type of LLC is determined by:

- Customer setup
- Operator input of call parameters
- Incoming call packet (SVC)
- First data packet (PVC).

QLLC commands and responses are transmitted in a normal data packet with the qualifier bit (Q bit) set to 1.

QLLC Data Packet Format

Byte 0-2	3,4	4,5	5,6
Packet Header	Address Field	Control Field	Information Field

Byte 0, 1, 2 - See Packet header format
Byte 3, 4 - QLLC address field
Byte 4, 5 - QLLC control field
Byte 5, 6 - QLLC information field (if allowed)

- QLLC Address Field
  - Obtained from customer setup data for QLLC data packets transmitted
  - Ignored on QLLC data packets received.
- QLLC Control Field

Command			Response		
QSM	(SNRM)	X'93'	QUA	(UA)	X'73'
QDISC	(DISC)	X'53'	QXID	(XID)	X'BF'
QXID	(XID)	X'BF'	QTEST	(TEST)	X'F3'
QTEST	(TEST)	X'F3'	QDM	(DM)	X'1F'

- The 5294 will respond to any nonsupported commands by issuing a clear request packet (for SVC) or a reset request packet (for SVC) or a reset request packet (for PVC) with the diagnostic code = X'50' (QLLC error).

The QLLC commands and responses are described in the following paragraphs.

QSM

This is a mode-setting command equivalent to a normal secondary station receiving a SNRM command, which may have been initiated by a Vary On command at the remote host.

The 5294 initiates a NRM-entered TCB to SNA when a QSM is received.

QDISC

This is a mode-setting command equivalent to a normal secondary station receiving a DISC command, which may have been initiated by a Vary Off command at the remote host.

The 5294 initiates a DISC command TCB to SNA when a QDISC is received.

QXID

This is a XID command equivalent to a normal primary station sending a XID command, which may have been initiated by a Vary On command at the remote host.

The QXID response returned has the same data content as the 5294.

QTEST

The QLLC command/response pair performs the same function as the 5294 test command/response.

QUA

This is a mode-setting response equivalent to a normal secondary station transmitting a UA response to a SNRM command.

QDM

This is a QLLC response indicating that normal data packets have been received prior to receiving a QSM command.

- QLLC information field
  - Test Data: Same as transmitted by host
  - XID Data: Same as transmitted by the 5294.

Enhanced Logical Link Control (ELLC)

Recovery from temporary network outages is possible using ELLC. When a network generated reset, restart, or clear (with nonzero cause code) is received by the 5294, the packet level responds with the appropriate confirmation packet and initiates ELLC recovery.

Upon timer expiration, if the circuit is SVC, a reconnection process is attempted. If the 5294 initiated the original call, a new call request is generated and the connection ID in the call request indicates that this is a reconnect.

If the 5294 answered the original call, the circuit state is ready and the incoming call must indicate in the connection ID that this is a reconnected call.

In either case, if the connection ID does not indicate a reconnect, the recovery attempt is terminated with a clear request and a diagnostic code of X'5B'.

ELLC commands and responses are transmitted in a normal data packet with six ELLC header bytes as the first six data bytes, as shown below.

Logical Protocol Data Unit (LPDU) Format

Byte 0-3	4,5	6,7	8,9	10 through n
Packet Header	Address Field	Control Field	Check Sum Field	Information Field

Byte 0-3: See *Packet Header Format* in this chapter (not part of the LPDU).

LPDU Commands and Responses

Protocol Data Unit	Command Response		Bit Positions															
			0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
IPDU	LI[1]		LNs							0	LNr							P
SPDU	LRR[1]	LRR[1]	0	0	0	0	0	0	0	1	LNr							P/F
	LRNR	LRNR	0	0	0	0	0	1	0	1	LNr							P/F
	LREJ	LREJ[1]	0	0	0	0	1	0	0	1	LNr							P/F
UPDU		LDM[1]	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	F
	LSABME		0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	1
	LDISC		0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1
		LUA[1]	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	F
		LPDUR	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	F
	LXID	LXID[1]	1	0	1	0	1	1	1	1	0	0	0	0	0	0	0	P/F
	LTEST	LTEST[1]	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	P/F

[1]Transmitted by the 5294 Control Unit.

The 5294 responds to any invalid PDUs by issuing a clear request packet (for SVC) or a reset request packet (for PVC).

Unsolicited F bits (received when the 5204 is not in checkpoint recovery state) are ignored. Those PDUs are processed as if the final bit was not on.

Nonsupported responses (LUA, LXID, LTEST) are ignored.

LSABME

This is a Mode-Setting command equivalent to a normal secondary station receiving a SNRM command, which may have been initiated by a Vary-On command at the remote host.

Receipt of this command is a requirement for the ELLC level of the 5294 to enter the data transfer state and exchange I- and S-PDUs with the adjacent logical link node.

The 5294 sends an LUA response. The LNr and LNs counts are reset to zero and all unacknowledged IPDUs are purged.

LSABME is never sent by the 5294.

LDISC

This is a Mode-Setting command that causes the 5294 to leave the data transfer state and enter the logically disconnected state.

The 5294 sends an LUA response. All acknowledged IPDUs are purged.

If LDISC is received while the 5294 is in the logically disconnected state, a LDM response is sent.

A reset/clear is not issued to the virtual circuit.

LDISC is never sent by the 5294.

LXID

This is a XID command equivalent to a normal primary station sending a XID command that may have been initiated by a Vary On command at the remote host.

The LXID response returned by the 5294 has the same data content as the base 5294. This response is sent whether the 5294 is in data transfer state or not.

LXID commands are never sent by the 5294.

LTEST

This ELLC command/response pair performs the same function as the base 5294 test command/response.

Any test data received in the information field is returned in the LTEST response. This response is sent whether the 5294 is in the data transfer state or not.

LTEST commands are never sent by the 5294.

LDM

The LDM is sent in response to any I- or S- commands, with the poll bit on, when the 5294 has not first been placed in the data transfer state by the receipt of a LSABME command.

LDM is the response to LDISC, received when the 5294 is in the logically disconnected state.

LDM responses received causes the 5294 to reset and clear the virtual circuit.

LUA

This is a mode-setting response equivalent to a normal secondary station transmitting a UA response to a SNRM or DISC command.

The 5294 responds with LUA to a LSABME command if the P bit is on. If the P bit is off, a reset/clear is initiated.

If an LUA response is received, it is ignored.

LPDUR

Upon receipt of LPDUR the 5294 resets and clears the virtual circuit.

LPDUR is never sent by the 5294.

LI

This is the informational command PDU used to transfer SNA PIUs. It is never sent with P = 1 or as a response by the 5294.

When LI is received error free, it is processed and passed to SNA.

If LI is received with P = 1, the 5294 responds with LRR (F = 1).

Each LI PDU transmitted from the 5294 contains an LNR count, which acknowledges all IDPUs received and processed at that time. Since the receive and transmit functions are interleaved, each IPDU transmitted could carry an LNR count, which acknowledges IPDUs received since the previous LNR count was transmitted.

LRR

The LRR is equivalent to the receive ready frame at the link level. As a response, it is used to acknowledge IPDUs received. As a command, it is used to request acknowledgment of the number of IPDUs received. LRR also clears any previously established busy condition.

When LRR is received as a command with P = 1, the 5294 responds with LRR (F = 1).

When LRR is received as an expected checkpoint response (F = 1), the 5294 frees all acknowledged IPDUs from the retransmit queue, and retransmits any unacknowledged IPDUs.

The 5294 puts an LRR response in the transmit queue, as outlined under *LT2 Timer* in this section. When this response works its way to the top of the transmit queue, a decision is made whether to send it or not. If the LNr count to be sent is the same as the last LNr sent (no new IPDUs to be acknowledged), it is not sent.

The 5294 sends an LRR command with P = 1 when its LT1 timer expires, and enters checkpoint recovery state. No other IPDUs are sent until the LRR response with F = 1 is received.

LRNR

The LRNR is equivalent to the receive not ready frame at the link level. As a response, it is used to acknowledge IPDUs received. As a command it is used to request acknowledgment of the IPDUs received. The LRNR also indicates the inability to receive IPDUs. This busy condition is cleared when the 5294 receives a LRR, LREJ, or LSABME.

When LRNR is received as a command with P = 1, the 5294 responds with LRR (F = 1).

When LRNR is received as an expected checkpoint response (F = 1), the 5294 frees all acknowledged IPDUs from the retransmit queue, but does not transmit/retransmit any IPDUs until the remote DTE indicates the busy condition has cleared.

LRNR is never sent by the 5294.

LREJ

LREJ is equivalent to the reject frame at the link level.

Receipt of LREJ clears any previously established busy condition.

When LREJ is received as a command with P = 1, the 5294 responds with LRR (F = 1), frees all acknowledged IPDUs from the retransmit queue, and retransmits any unacknowledged IPDUs.

When LREJ is received as an expected checkpoint response (F = 1), the 5294 frees all acknowledged IPDUs from the retransmit queue, and retransmits any unacknowledged IPDUs.

IPDUs received out of sequence (wrong LNs count) cause the 5294 to respond with LREJ. This establishes a reject exception condition within the 5294, which is cleared upon receipt of the IPDU being requested by the LNr count in the LREJ. Only one reject exception condition is established at a time.

LREJ with F = 1 is the response to a rejected IPDU received with P = 1.

LREJ commands are never sent by the 5294.

LT1 Timer

The LT1 timer value is derived from operator input at call time and can range from 10 to 99 seconds. A default value of 10 is used if no operator input is processed. The LT1 timer provides a time-out function to protect against a lost reply deadlock condition.

The LT1 timer is started when an IPDU is transmitted or retransmitted and the LT1 timer is not already running. The LT1 timer is stopped when a response is received, acknowledging all outstanding IPDUs that have been transmitted or retransmitted. The LT1 timer is restarted upon receipt of a partial acknowledgment.

Upon expiration of the LT1 timer, an LRR command (P = 1) is transmitted to request status from the other end, and LT1 is restarted. At this time, checkpoint recovery state is entered and no IPDUs are sent until the requested response is received. If the LT1 timer stops during checkpoint recovery state, the LRR command is resent and the LT1 timer is restarted. Upon the tenth expiration of the LT1 timer (LN2 reached) a reset/clear is issued to the virtual circuit.

LN2 Counter

The LN2 counter is used to control the number of successive LT1 time outs that can occur before the reset/clear is issued to the virtual circuit. The LN2 counter is set to zero initially and incremented each time LT1 expires. When the LN2 counter reaches 10, the reset/clear is issued. This value cannot be changed by the user.

LT2 Timer

This timer is implemented to delay the LRR response to an IPDU and thus reduce traffic on the virtual circuit. The value is one-fourth the value of LT1.

If the number of received but not acknowledged IPDUs exceeds a threshold of three before LT2 has reached a time out, an acknowledgment (LRR response) is put in the queue for transmission.

PSH Logical Link Control

PSH commands are carried only in data packets. Figure 2-17 shows the general format of the PSH and the format for physical services commands and responses.

General Format

Bit-	0	1	2	3	4	5	6	7
First byte	1	1	1	1	0	SI	PSI	CPI
Second byte	Sequence Num., Control or Data							

SI - Segment Indicator
PSI - Packet Sequence Indicator
CPI - Control Present Indicator

Format for PSDISC Command and Response

Bit-	0	1	2	3	4	5	6	7
First byte	1	1	1	1	0	0	0	1
Second byte	0	0	0	0	0	0	1	0

No Data Follows

Format for PSXID Command and Response

Bit-	0	1	2	3	4	5	6	7
First byte	1	1	1	1	0	0	0	1
Second byte	0	0	0	0	0	1	0	0

XID Data Follows

Format for PSTEST Command

Bit-	0	1	2	3	4	5	6	7
First byte	1	1	1	1	0	0	0	1
Second byte	0	0	0	0	0	1	1	0

Test Data Follows

Format for PSTEST Response

Bit-	0	1	2	3	4	5	6	7
First byte	1	1	1	1	0	0	0	1
Second byte	0	0	0	0	0	1	1	0
Third byte	Local Station Address							

Test Data Follows

Figure 2-17 (Part 1 of 2). Format of the Physical Services Header

Format for PSCONT Command

Bit-	0	1	2	3	4	5	6	7	
First byte	1	1	1	1	0	0	0	1	No Data Follows
Second byte	0	0	0	0	1	0	0	0	

Format for PSCONT Response

Bit-	0	1	2	3	4	5	6	7	
First byte	1	1	1	1	0	0	0	1	
Second byte	0	0	0	0	1	0	0	0	No Data Follows
Third byte	5294 Station Address								

Format for First or Middle Segment of Segmented Data

Bit-	0	1	2	3	4	5	6	7	
First byte	1	1	1	1	0	1	1	0	Data Follows
Second byte	Sequence Number								

Format for Last Segment of Segmented Data

Bit-	0	1	2	3	4	5	6	7	
First byte	1	1	1	1	0	0	1	0	Data Follows
Second byte	Sequence Number								

Figure 2-17 (Part 2 of 2). Format of the Physical Services Header

As shown in Figure 2-17, the PSH is two bytes long. The first byte contains three indicator bits:

- Segment indicator
  - When SI = 0, the data packet contains the last or only segment.
  - When SI = 1, the data packet contains the first or a middle segment of segmented data.

- Packet sequence indicator (PSI)
  - When PSI = 0, the second byte of the PSH contains either control information or data (as defined by the control present indicator).
  - When PSI = 1, the second byte of the PSH contains a data packet sequence number.

- Control present indicator (CPI)
  - When CPI = 0, the second byte of the PSH contains data or a sequence number as defined by the PSI bit.
  - When CPI = 1, the second byte of the PSH contains control information.

Data Development with the X.25 Feature

The development of data as it is transported through the SNA and X.25 layers is shown in Figure 2-18.

Data emerges from the SNA data flow control layer as a request/response unit (RU). In the transmission control layer, a request/response header (RH) is added and in the path control layer a transmission header (TH) is added. The combination of TH, RH, and RU becomes a path information unit (PIU).

The PIU is sent to the X.25 feature where LLC headers are added, then sent to the X.25 packet layer where a packet header (PH) and a logical link header (LLC) are added to the PIU to form a data packet. In the link layer, the packet becomes the information field in an LAPB frame.

The format of the data packet is shown in Figure 2-18 The packet header is three bytes long and contains the following fields:

- A general format identifier

  General format identifier in byte 0, bits 0-3:

  Bit 0 1 2 3
  Q D C1C2

  The PSH or ELLC protocol requires that the qualifier (Q) bit be set to zero. The delivery confirmation (D) bit is not used by the controller and must be set to zero. C1 and C2 bits indicate the modulus of the packet sequence count:

  C1C2 = 01 modulo 8

- A logical channel identifier byte 0 bits 4-7 and byte 1. This indicates the logical channel (as seen by the controller) is being used.

- Packet-received P(R) and packet-send P(S) sequence numbers are used for acknowledging received data packets and for sequence checking of data packets.

- A more-data (M) bit. The PSH protocol does not use the M bit in the packet header. QLLC and ELLC protocols use the M bit for segmenting. The M bit is used to indicate middle segments in segmented data as described by CCITT Recommendation X.25.

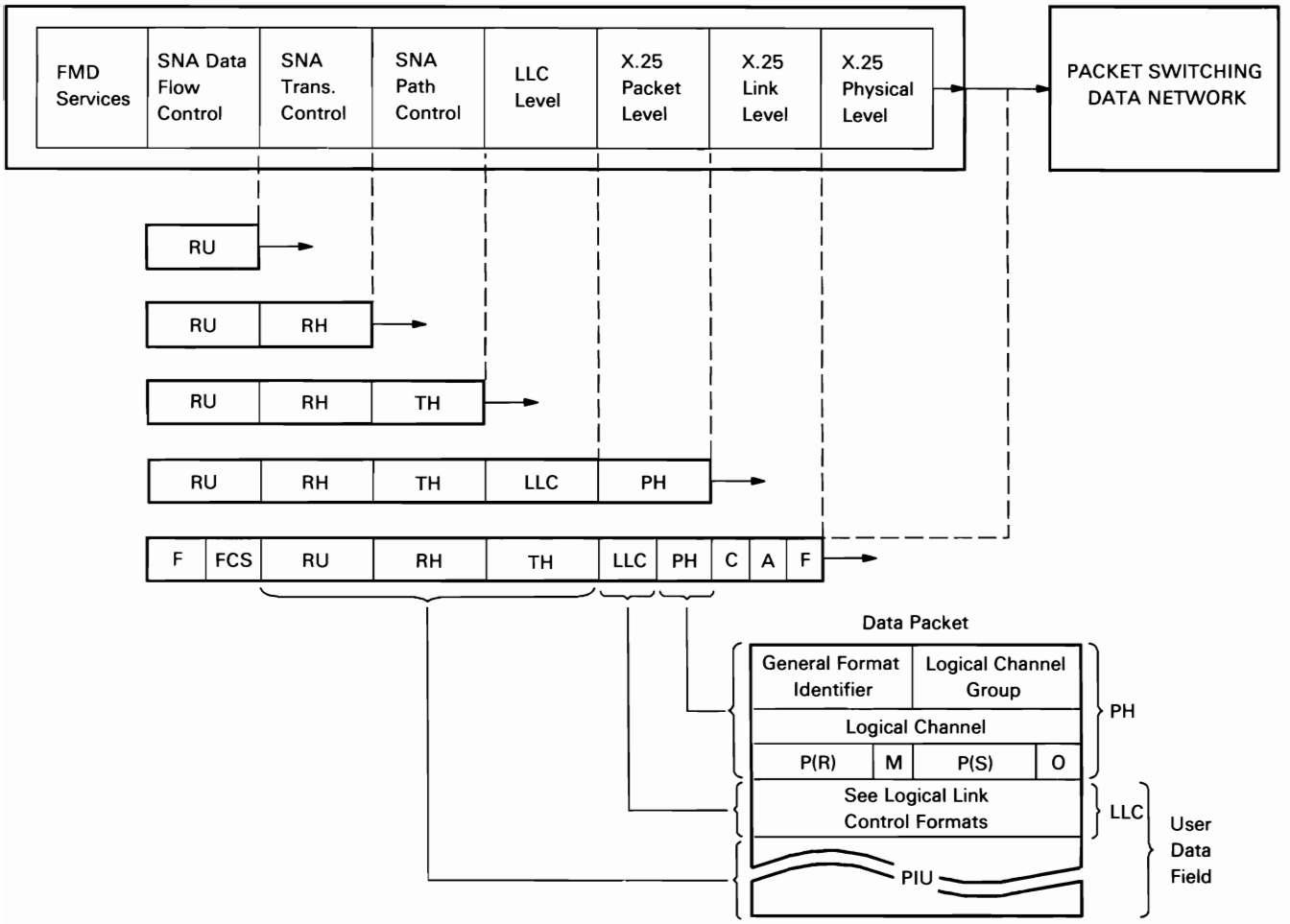
- A bit that identifies the packet as a data packet. Byte 2, bit 7 = 0 for a data packet.

Following the packet header (PH) is:

- The user data field that contains the LLC header (QLLC and ELLC only)

- All or part of a PIU depending on the size of the PIU and the packet size used.

SNA commands such as ACTLU and BIND are transported in the request/response unit (RU) of the PIU, which is treated as data by the controller.



LLC	Logical Link Control	FCS	Frame Check Sequence
RU	Request Unit	PIU	Path Information Unit
RH	Request/Response Header	SI	Segment Indicator
TH	Transmission Header	PSI	Packet Sequence Indicator
PH	Packet Header	CPI	Control Present Indicator
F	Flag	P(R)	Packet-Received Sequence Number
A	Address	P(S)	Packet-Sent Sequence Number
C	Command	M	More-Data Mask

Note that the LLC is part of the User Data Packet.

Figure 2-18. Data Development with the X.25 Feature

Examples of Signal Exchange During Connection

Figure 2-19 and Figure 2-20 show the exchanges of signals involved in establishing a connection between a host and the 5294 with the X.25 feature. Figure 2-19 applies when the 5294 starts the call and Figure 2-20 applies when the host starts the call. These illustrations show how SNA commands, LAPB commands, and packets work together.

In Figure 2-19, the host starts link operations by issuing an LAPB Set Asynchronous Balanced Mode (SABM) command. The network replies with a positive acknowledgment in the form of an unnumbered acknowledgment (UA) response.

With a similar procedure, the 5294 initializes its link to the network by sending an SABM command and obtaining a UA response.

In this example, the initiative to call belongs to the 5294. The host operator enters a Vary-On command and waits for the 5294 to call. The 5294 signals the network to restore the connection to the 5294 to an initial state by sending a restart request packet. All packets are sent in LAPB information frames. A restart confirmation packet acknowledges that the network has initialized the connection.

If the connection is a switched virtual circuit (SVC), the call is started when the 5294 sends a call request packet. This packet contains information about the facilities required for the call, possibly the address of the caller (5294), the address of the called (the host), and the logical channel to be used. This information is obtained from the display station operator through keyboard input.

If the request is acceptable, the network sends an incoming call packet to notify the host about a call from the 5294. If the request is not acceptable, the network clears the 5294 call with a clear indication packet.

Again, if the call is acceptable, the host sends a call accepted packet to the network. On receiving the call accepted packet, the network confirms that the virtual circuit is established by sending a call connected packet to the 5294. If the call is not acceptable to the host, it is rejected when the host sends a clear request packet to the network, which then sends a clear indication packet to the 5294.

If the connection is a permanent virtual circuit (PVC), the connection is pre-established and the call request sequence just described is not needed.

With the connection complete, and the 5294 varied on, the host issues an SDLC XID command. When this occurs, the host builds a data packet with the Q bit on, containing a QXID command. The data packet is sent through the network to the controller, which builds a reply and sends it within a data packet containing a QXID response.

In Figure 2-19, the host tries to contact the other end of the connection by sending a QSM command to the 5294. Again the host builds a data packet; in this case the Q bit is on and the command is QSM. When the 5294 receives this data packet, it replies with a data packet that contains a QUA response.

At this point, the host knows that a connection to the 5294 exists and that the 5294 has been contacted. The host may now activate the logical unit in the 5294 by sending an SNA ACTLU command. This command is a PIU sent to the host X.25 feature, which builds a data packet around the PIU and sends it across the network to the 5294. The 5294 strips off the data packet and sends the PIU to the SNA handling portion of the 5294.

Normal SNA operations continue, with each SNA command and response being a whole or partial PIU that is transported across the network inside a data packet.

Figure 2-20 shows a similar sequence except that, in this case, the host starts the call.

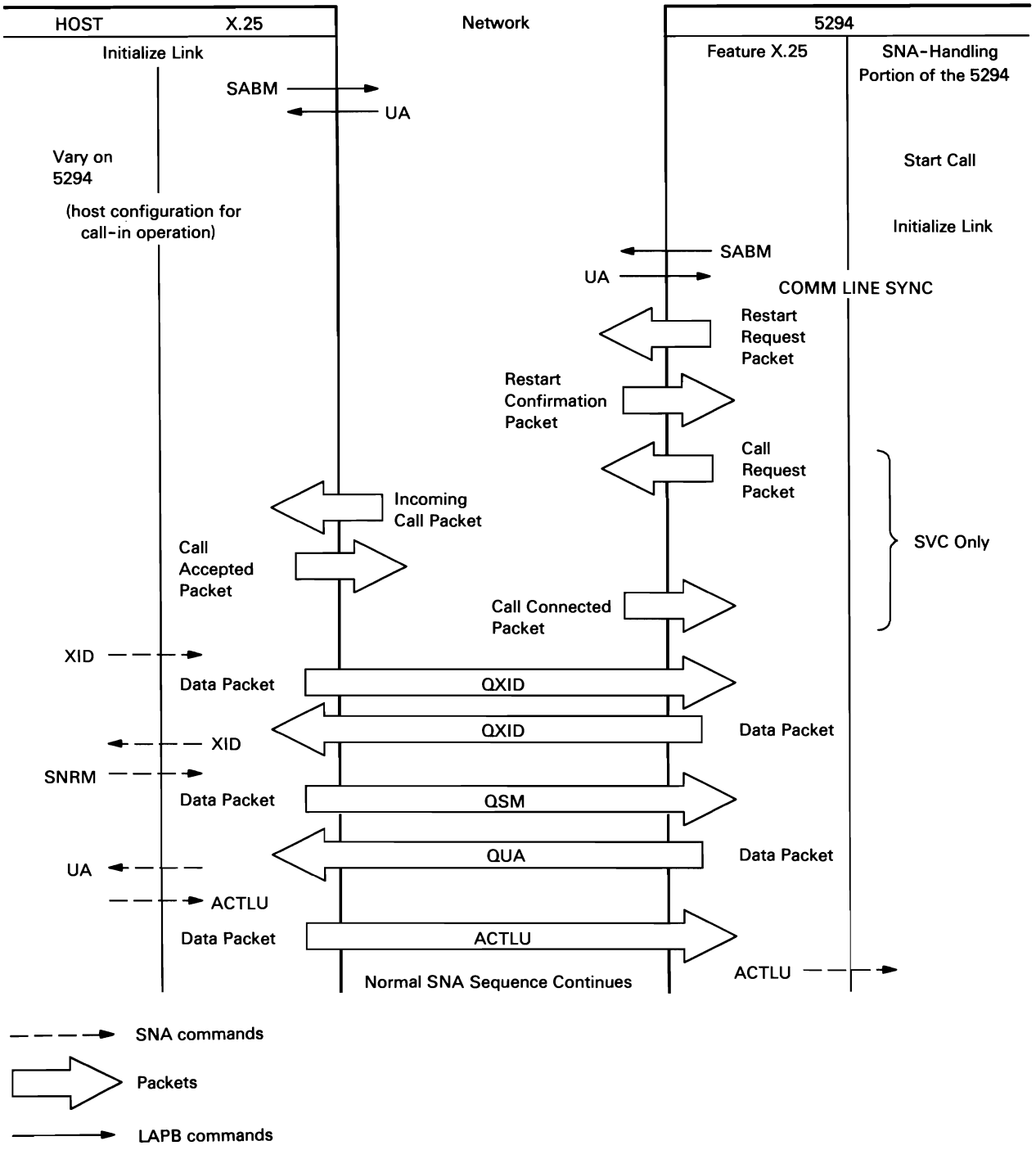
Figure 2-21 shows an example of a connection close-down sequence. This starts when the host operator issues a Vary-Off command. An SNA Unbind command is received by the X.25 feature at the host and is built into a data packet, and is sent across the network to the 5294.

The controller removes the Unbind command from the data packet and sends it to the SNA handling portion of the 5294. The controller then builds a data packet for the response from the SNA handling portion of the 5294 and sends it to the host.

An identical exchange sequence occurs for the SNA DACTLU command, issued by the host to deactivate the LU in the 5294.

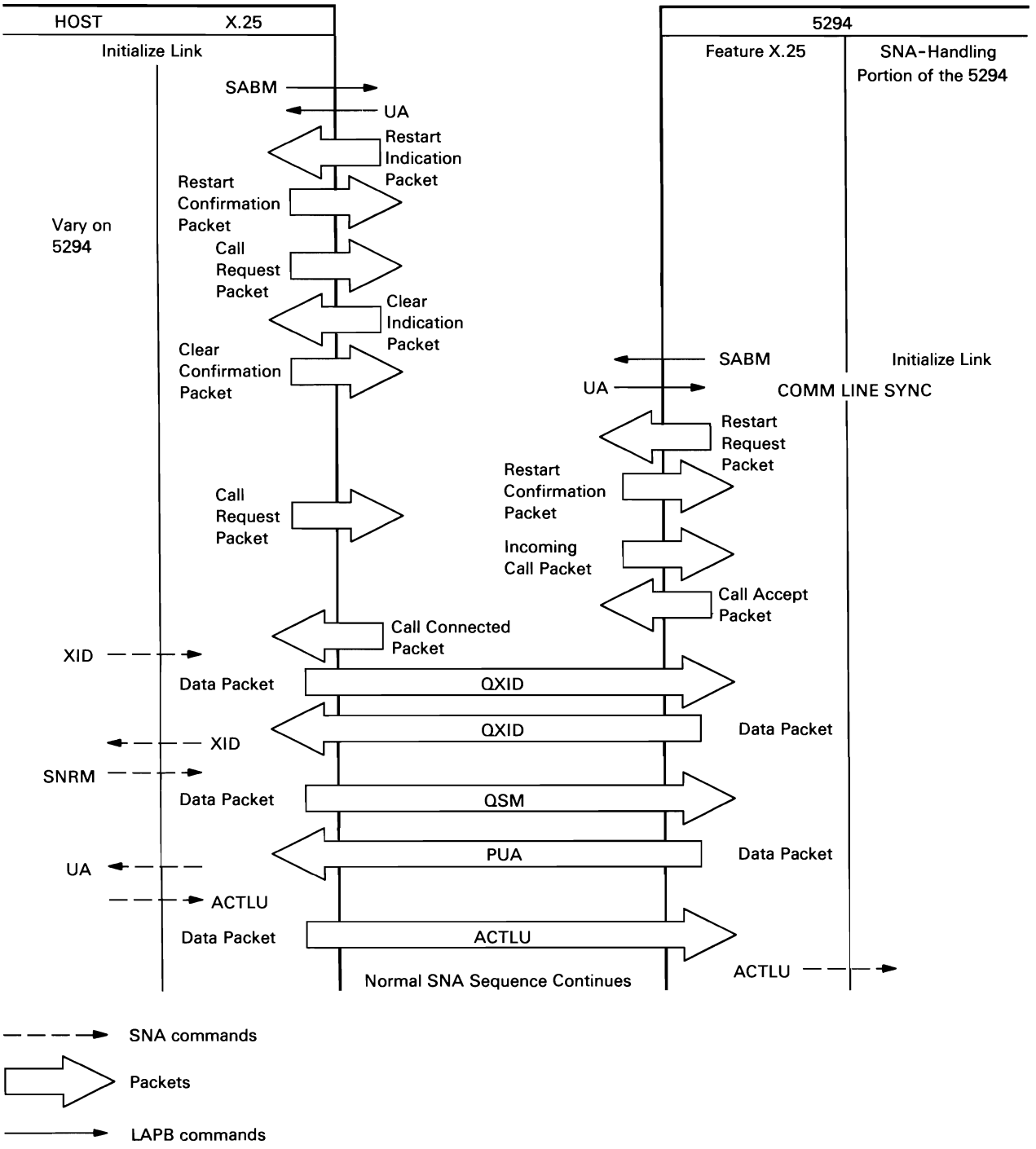
The host can retrieve the contents of the statistical counters maintained by the 5294 by sending an SNA REQMS command to the X.25 feature at the host, which sends the contents inside a data packet to the 5294. The 5294 sends the error log, as well as the contents of the statistical counters if the log is not full, to the host with an SNA RECFMS response. This information is built into a data packet and sent to the host.

When the host issues the QDISC command, a data packet with the Q bit on containing the QDISC command. For a PVC, the virtual circuit remains active and another SNA session can be started by a Vary-On command at the host. For an SVC, the host sends a clear request packet to the network. The network in turn sends a clear indication packet to the 5294 to clear the SVC.



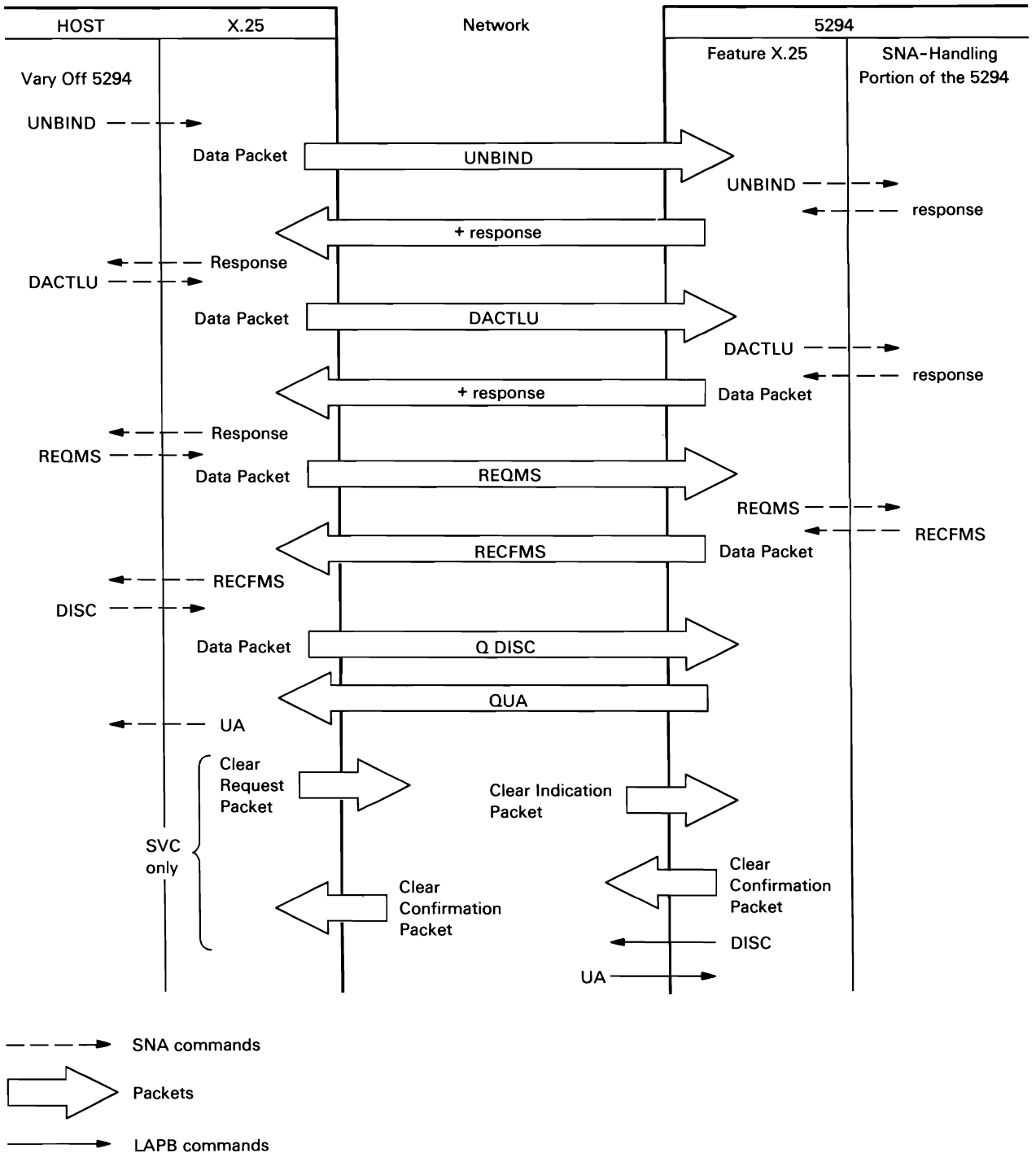
Note: For simplicity, RR packets and frames are not shown.

Figure 2-19. Establishing a connection - 5294 starts the call



Note: For simplicity, RR packets and frames are not shown.

Figure 2-20. Establishing a connection - Host starts the call



Note: For simplicity, RR packets and frames are not shown.

Figure 2-21. Closing Down a Connection

Errors and Problem Determination

The error handling process used with the X.25 feature is built upon the normal 5250 error handling described in this manual under *Error Handling*. Most 5250 error codes are unchanged, but some codes have been revised. In addition, the controller uses the error log and maintains soft error and status statistics that can be retrieved by the host.

Complete problem determination procedures are contained in the *5294 Operator's Guide*.

Error Code Types

As in the 5250, there are three types of errors:

- Operator errors
- Programming errors
- Hardware errors.

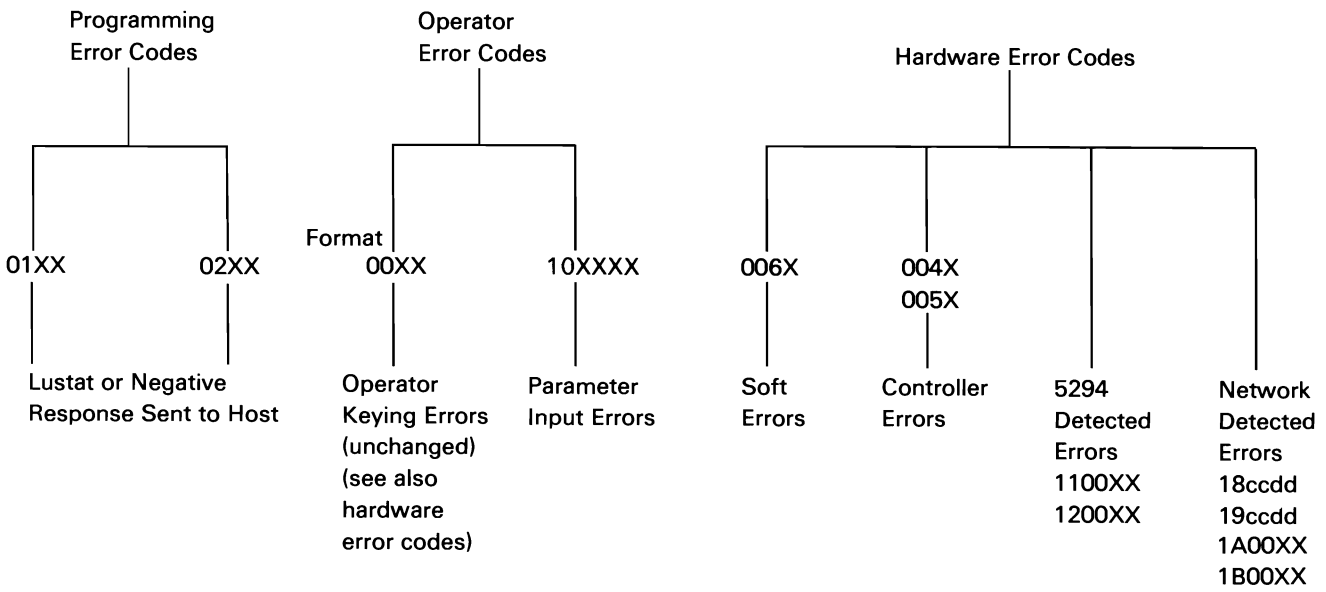
The X.25 feature does not change the programming error codes but because of additional operator procedures and additional hardware there are some changes to operator error codes and hardware error codes.

As shown in Figure 2-22, most of the operator error codes are unchanged. An added group of operator error codes indicates errors that can occur when network parameters are entered by the display station operator. These errors have the format **10xxxx**.

The hardware error codes shown in Figure 2-22 are those that are new or have been changed because of the X.25 feature. In particular, **004x, 005x,** and **006x** codes have new assignments. A new class of hardware error codes called communications codes is divided into two groups:

- **11xxxx, 12xxxx, 1Axxxx,** and **1Bxxxx** codes for controller detected errors and messages
- **18ccdd** and **19ccdd** codes for network detected errors.

Figure 2-23 shows how the controller handles these new groups of hardware errors.



Note: **cc** is a cause code; cause codes are supplied by the network. **dd** is a diagnostic code; diagnostic codes are supplied by the network, host, and controller.

Figure 2-22. Error Code Types

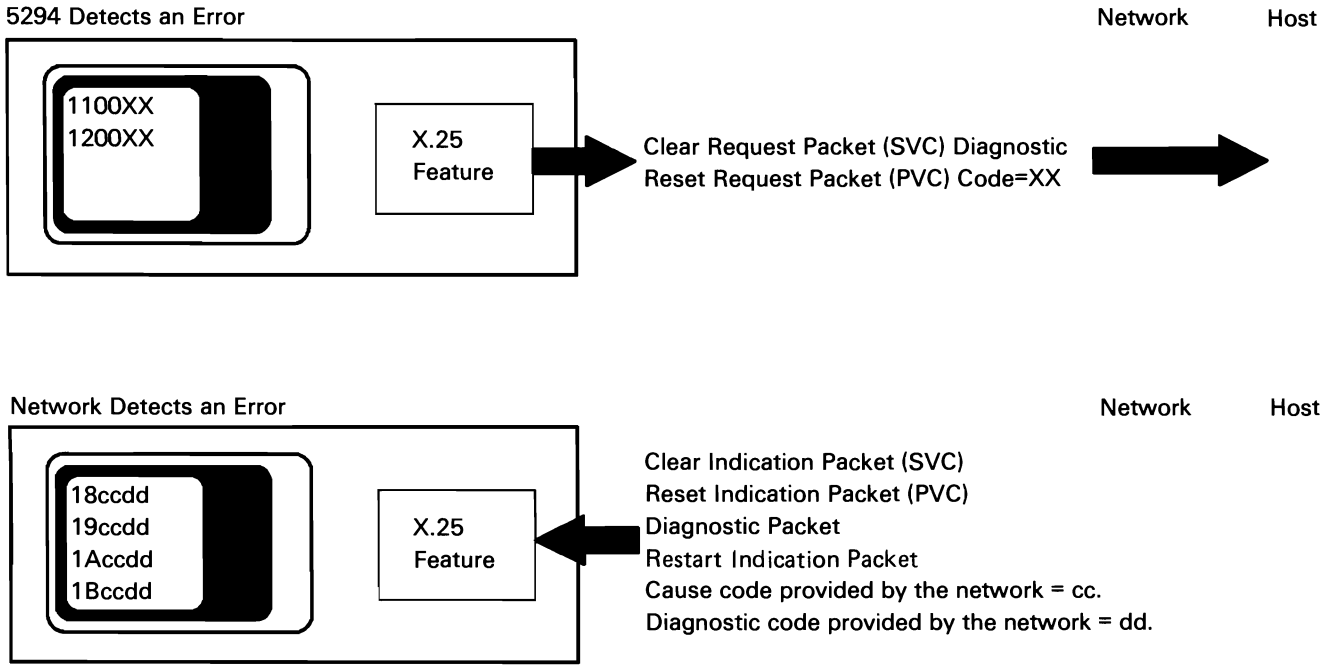


Figure 2-23. Hardware Error Actions

When the controller detects an error, it sends a clear request packet (for a switched virtual circuit) or a reset request packet (for a permanent virtual circuit) through the network to the host. The packet contains a diagnostic code indicating that the X.25 feature has detected an error. The diagnostic code is identical to the last 2 digits of the code that is displayed on the operator's screen: **1100xx, 1200xx**.

When the host detects an error in the communications with the 5294, it sends a clear indication packet (SVC) or a reset indication packet (PVC) to the controller, with a diagnostic code to identify the problem. The display station operator's screen displays an error code of **1800xx** or **1900xx,** where **xx** is the diagnostic code that the controller received from the host.

When the network detects an error, the controller receives one of the following packets, depending on the particular network, the type of error, and the type of virtual circuit:

- Clear indication packet (SVC)
- Reset indication packet (PVC)
- Diagnostic packet
- Restart indication packet.

The packet contains a cause code and a diagnostic code issued by the network. The display station operator's screen shows an error code with the following format:

```
xxccdd   xx00dd
xxccdd
xxccdd
```

cc = Cause code
dd = Diagnostic code
xx = Type of packet

xx = 18 reset indication packet
xx = 19 clear indication packet
xx = 1A restart indication packet
xx = 1B diagnostic packet

Note: On networks that do not propagate the host diagnostic code, the 5294 displays **dd = 00**.

Note: For a diagnostic packet received, **cc = A5** and **dd** indicate the diagnostic code passed in the diagnostic packet.

SDLC Counter Error Codes (X.25 Only)

The 006X error codes are for SDLC. They are placed in the error log when the controller counters that track SDLC transmission errors overflow or when the host system solicits the error log. The operator may display the counters that are formatted into these errors. See *Problem Determination Procedures* in the *IBM 5251 Display Station Models 2 and 12 Operator's Guide*, GA21-9323, or the *5294 Operator's Guide*, GA21-9370. See index entries *errors, error log; errors, handling; and reqms command.*

The following chart describes each SDLC error code.

0060 Bad test counter.
Used with the SDLC Test command for diagnostic purposes.

0061 Good test counter.
Used with the SDLC Test command for diagnostic purposes.

0062 Communications adapter underrun counter.

0063 Communications adapter overrun counter.

0064 Carrier detect glitch counter.
Occurs when the carrier detect line is unexpectedly inactive.

0065 Clear to send glitch counter.
Occurs if the clear-to-send line is unexpectedly inactive.

0066 Data set ready glitch counter.
Occurs if the data set ready line is unexpectedly inactive.

0067 Frame sequence error counter.
Occurs when frame sequence errors occur.

0068 Transmit retry counter.
Occurs each time an I frame must be retransmitted.

0069 CRC errors in FCS field.
Occurs each time the FCS character does not match the expected FCS character.

006A Frame aborts received.

006B XLCA card-detected errors.

006C Number of T1 time outs for X.25.

006D Number of ELLC recovery attempts.

006E Number of I frames transmitted by the 5294 (4 bytes).

006F Number of I frames received by the 5294 (4 bytes).

Keyboard-Entered Options Error Codes (X.25 Only)

If the 5294 Control Unit has the X.25 feature attachment and an error occurs during the keyboard entry of commands, options, or parameters, a 6-digit error code of the form **10xxxx** (where **xxxx** represents 4 hexadecimal digits) is displayed. The codes are summarized in the following chart.

Error Code	Meaning
100000	A call command is still in progress.
100100	The host has not varied on the 5294 and a second command was attempted.
100200	An answer command was entered for a permanent virtual circuit.
100300	A call command was entered for a permanent virtual circuit (PVC).
100400	The logical channel ID requested is invalid because it is not 3 characters long.
100500	The logical channel ID requested is invalid because it is not an alphanumeric value.
100600	The password entered is invalid because it is longer than 8 characters.
100700	The TO address (first network address) is invalid because it is greater than 15 decimal digits.
100800	The FROM address (second network address) is invalid because it is greater than 15 decimal digits.
100900	The network address is invalid because it does not contain all numeric digits (0 through 9).
100A00	Keyboard entry of optional parameters has been attempted, but the manual options (field 5, position 4 of the configuration setup) is 0 (off). A flow-control negotiation facility code (42 or 43) was entered, but the flow-control negotiation (field 5, position 3 of the configuration setup) is 0 (off).
100B00	A facility was entered but the characters were not hexadecimal (0 through 9, and A through F).
100C00	The window size requested is invalid because it is less than two.
100D00	The window size requested is invalid because it is greater than seven (modulo 8 is specified).
100E00	The window size entered is greater than 15 and modulo 128 is specified.
100F00	The packet size entry is not equal to 64, 128, or 256.
101000	The closed-user group requested does not contain two decimal digits.
101100	An invalid control character was entered.
101200	The host network address is missing for a call command.
101300	An A, O, C, or D was not entered as the first control character.
101400	A network address was entered for a permanent virtual circuit.
101500	A password was entered for a PVC.
101600	The password entered is not valid because it is not alphanumeric.
101700	A logical channel identifier was entered for an answer.
101800	Closed user group was entered either for an answer command or an open command.
101900	The E option was selected with the answer option.
101A00	An F (facilities) control character or an R was entered for an answer command or a PVC.
101B00	The logical link control value requested is invalid because it is not a decimal value.

Network Communications Error Codes (X.25 Only)

If the 5294 Control Unit accepts the keyboard entries but the network operation with the host system fails, one of the following codes, indicating the type of communications problem, is shown on the attached work stations.

Error Code	Meaning
1100ff	The data termination equipment (DTE) issued a clear request packet after detecting an error. The cause of the error is contained in the diagnostic field (ff).
14	Invalid packet type for state p1.
15	Invalid packet type for state p2.
17	Invalid packet type for state p4.
50	General LLC error.
51	Undefined C-field.
52	Unexpected C-field.
53	Missing I-field.
54 55	Undefined I-field. I-field too long.
56	Frame reject received.
57	Header invalid.

Error Code	Meaning
1100ff (cont)	
58	Data received in wrong state.
59	Time-out (LT1xLN2) condition.
5A	LNr invalid.
5B	Recovery rejected/terminated.
60	General PSH error.
61	PSH sequence error.
A1	Invalid M bit packet sequence.
A6	Packet too short.
A7	Packet too long.
AB	Invalid Ps.
AC	Invalid Pr.
AD	Invalid D bit received.
D2	PIU too long.
E6	Facility parameters not supported.
E8	Unexpected calling DTE.
E9	Invalid D bit requested.
EA	Reset indication on virtual call.
EB	Invalid protocol identifier.
EC	Password mismatch.
ED	Invalid facility length.

Error Code	Meaning
1200ff	The data termination equipment (DTE) issued a reset request packet after detecting an error.
1B	Invalid packet type for state d1.
50	General LLC error.
51	Undefined C-field.
52	Unexpected C-field.
53	Missing I-field.
54	Undefined I-field.
55	I-field too long.
56	Frame reject received.
57	Header invalid.
58	Data received in wrong state.
59	Time-out (LT1xLN2) condition.
5A	LNr invalid.
5B	Recovery rejected/terminated.
60	General PSH error.
61	PSH sequence error.
A1	Invalid M bit packet sequence.
A6	Packet too short.
A7	Packet too long.
AB	Invalid Ps.
AC	Invalid Pr.
AD	Invalid D bit received.
D0	General resources.
D2	PIU too long.

Error Code	Meaning
18ccdd	The data circuit-terminating equipment (DCE) issued a clear indication packet after detecting an error. The cause codes (cc bytes) listed below are issued by the network and may vary from network to network. The cause codes listed here are defined by the CCITT Recommendation X.25.
01	Host busy.
03	Invalid facility request.
05	Network congestion.
09	Out of order. Host not ready.
0B	Access to the host not allowed.
0D	Unrecognized host network address.
11	Error at the host.
13	Error at the 5294.
15	Recognized private operating agency (RPOA) out of order.
19	Reverse charging not subscribed.
21	Incompatible destination.
29	Fast selection not subscribed.

Error Code	Meaning
18ccdd	The diagnostic codes (dd bytes) shown below are issued by the network and may vary from network to network. The codes listed here are defined by the CCITT Recommendation X.25.
00	No additional information.
01	Invalid send sequence-P(S).
02	Invalid receive sequence-P(R).
10	Invalid packet type.
11	State r1.
12	State r2.
13	State r3.
14	State p1.
15	State p2.
16	State p3.
17	State p4.
18	State p5.
19	State p6.
1A	State p7.
1B	State d1.
1C	State d2.
1D	State d3.
20	Packet not allowed.
21	Unidentifiable packet.
22	Call on one-way logical channel.
23	Invalid packet type on a permanent virtual circuit.
24	Packet on unassigned logical circuit.
25	Reject not subscribed to.
26	Packet too short.
27	Packet too long.
28	Invalid general format identifier.
29	Restart with nonzero in bits 1 through 4 and 9 through 16.

Error Code	Meaning
18ccdd (cont)	
2A	Packet type not compatible with facility.
2B	Unauthorized interrupt confirmation.
2C	Unauthorized interrupt.
30	Time expired.
31	Timer expired for incoming call.
32	Timer expired for clear indication.
33	Timer expired for reset indication.
34	Timer expired for restart indication.
40	Call setup problem.
41	Facility code not allowed.
42	Facility parameter not allowed.
43	Invalid called address.
44	Invalid calling address.
50	Call clearing problem.
51	Nonzero address length field.
52	Nonzero facility length field.
60-7F	Not assigned.
80-FF	Network specific diagnostic information.

Error Code	Meaning
19ccdd	The data circuit-terminating equipment (DCE) issued a reset indication packet after detecting an error. The following cause codes (**cc** bytes) are issued by the network and may vary from network to network. These codes are defined by CCITT Recommendation X.25.
01	Out of order-disconnected host.
03	Error at the host.
05	Error at the 5294.
07	Network congestion.
09	Remote DTE operational.
0F	Network operational.
11	Incompatible destination.

Error Code	Meaning
19ccdd	The diagnostic codes (**dd** bytes) listed below are issued by the network and may vary from network to network. These codes are defined by the CCITT Recommendation X.25.
00	No additional information.
01	Invalid send sequence-P(S).
02	Invalid receive sequence-P(R).
10	Invalid packet type.
11	State r1.
12	State r2.
13	State r3.
14	State p1.
15	State p2.
16	State p3.
17	State p4.
18	State p5.
19	State p6.
1A	State p7.
1B	State d1.

Error Code	Meaning
19ccdd (cont)	
1C	State d2.
1D	State d3.
20	Packet not allowed.
21	Unidentifiable packet.
22	Call on one-way logical channel.
23	Invalid packet type on a permanent virtual circuit.
24	Packet on unassigned logical circuit.
25	Reject not subscribed to.
26	Packet too short.
27	Packet too long.
28	Invalid general format identifier.
29	Restart with nonzero in bits 1 through 4 and 9 through 16.
2A	Packet type not compatible with facility.
2B	Unauthorized interrupt confirmation.
2C	Unauthorized interrupt.
30	Time expired.
31	Timer expired for incoming call.
32	Timer expired for clear indication.
33	Timer expired for reset indication.
34	Timer expired for restart indication.
40	Call setup problem.
41	Facility code not allowed.
42	Facility parameter not allowed.
43	Invalid called address.
44	Invalid calling address.
50	Call clearing problem.
51	Nonzero address length field.
52	Nonzero facility length field.
60-7F	Not assigned.
80-FF	Network specific diagnostic information.

Error Code	Meaning
1Bxx00	The data termination equipment (DTE) issued a reset request packet after detecting an error. The cause codes (**xx** bytes) are listed below.
A5	Diagnostic packet received. See note.
A6	Packet length less than two.
A8	Invalid GF (restart indication/confirmation only).
11	Unsolicited restart confirmation received.
E2	LCID not equal to 0 on restart indication/confirmation.
31	Call connected not received within 200 seconds.
32	Clear confirmation not received within 200 seconds.
33	Reset confirmation not received within 200 seconds.
34	Restart confirmation not received within 200 seconds.
Note: The diagnostic packet received has 2 additional descriptive bytes. The 5294 appends the first of these in the **yy** position indicated.	

Error Code	Meaning
1BA5yy	The definition of the yy bytes is described in the *X.25 Interface for Attaching IBM SNA Nodes to Packet-Switched Data Networks, General Information Manual, GA27-3345.*

X.21 Switched Circuit Feature

The X.21 Switched Circuit feature for the 5294 Control Unit enables the 5294 to be connected to X.21 Public Data Networks that provide circuit switched services.

Supported Functions

The X.21 call establishment protocol, the call progress protocol, the call clearing protocol, and the necessary International Alphabet No. 5 support are added to the 5294 to implement the X.21 automatic answer and calling functions. With the X.21 Switched Circuit feature and the X.21 adapter, the 5294 can operate at speeds of 2400 to 48,000 bps.

Other X.21 functions supported are:

- Abbreviated Address Calling
- Charge Transfer
- Closed-User Group
- Closed-User Group with Outgoing Access
- Direct Call
- Incoming Calls Barred
- Outgoing Calls Barred
- Registration/Cancellation of User Facilities
- Redirection of Call
- Registered Private Operating Agency (RPOA).

The 5294 supports X.21 digital network communications and the SNA/SDLC protocol when exchanging information with host systems.

5294 Interchange Connector

The X.21 interface between the 5294 as a Data Terminal Equipment (DTE) and the network Data Circuit-terminating Equipment (DCE), complies with the International Organization for Standardization (ISO) Data Communications 15-pin DTE/DCE Interface Connector and Pin Assignments, International Standard (IS) 4903. Balanced Voltage digital interface communications circuits are used.

Connector Assignments

Connector Pin	Circuit Name	Direction of Transmission
1	Not Used: Shield Ground	
2	T(A) Transmit Line A	to DCE
3	C(A) Control A	to DCE
4	R(A) Receive Line A	from DCE
5	I(A) Indicator A	from DCE
6	S(A) Signal Element Timing A	from DCE
7	Not Used: Byte Timing A	
8	G Ground	
9	T(B) Transmit Line B	to DCE
10	C(B) Control B	to DCE
11	R(B) Receive Line B	from DCE
12	I(B) Indicator B	from DCE
13	S(B) Signal Element Timing B	to DCE
14	Not Used: Byte Timing B	
15	Not Used: Reserved	

The 5294 supports the following X.21 signaling circuits. Byte Timing is not implemented. The electrical characteristics comply with EIA Standard RS422 and CCITT Recommendations X.24/27(V.11).

- Circuit T: Transmit Pair T(A) and T(B)

  During call establishment phase and call clearing phase, binary call control signals, originated by the 5294, are transmitted to the local DCE over circuit T. During data transfer phase, binary data, originated by the 5294 and intended for transmission to the host system, is transmitted to the local DCE over circuit T.

- Circuit R: Receive Pair R(A) and R(B)

  During call establishment phase and clearing phase, binary call control signals, originated by the network or the local DCE, are transmitted to the 5294 over circuit R. During data transfer phase, binary data as received from the host system is transmitted to the 5294 over circuit R.

- Circuit C: Control Pair C(A) and C(B)

  During call establishment phase, if this circuit is in the on condition, the call control signals on circuit T informs the local DCE of the 5294 state or status. During data transfer phase, circuit C is on continuously. During quiescent and call clearing phase, circuit C is off.

- Circuit I: Indicate Pair I(A) and I(B)

  When Circuit I is on, this indicates to the 5294 that the call end-to-end condition has been established and any signal on circuit R contains information from the host system. When circuit I is off, the DCE has indicated that signals on circuit R are network controls.

- Circuit S: Signal Element Timing Pair S(A) and S(B)

  Circuit S provides timing or clock signals to the 5294.

Communication Codes

The 5294 Control Unit with the X.21 Switched-Circuit feature can receive messages and exchange information with the network by using the International Alphabet No. 5 7-bit code. The received messages can contain a limited selection of the following characters:

- Decimal digits 0 through 9
- Control characters:
  - BEL
  - SYN
  - SI
  - :
  - +
  - ,
  - -
  - .
  - /
  - *

The 5294 responds to DCE-defined network messages such as number busy, access barred, and changed numbers. The 5294 also recognizes Call Progress Signals (CPS) starting with Shift-In (SI) characters. Other DCE network information received by the 5294 is discarded and no operator messages are posted.

The 5294 supports the transmission of all International Alphabet No. 5 codes to accommodate the network Registration Facility usage, but it does not perform message syntax checking. Data entered by the operator is translated from EBCDIC to IA5 characters with odd parity and sent to the network. If a keyboard character not included in the IA5 character set is entered, the 5294 translates that entry to a NULL.

The 5294 assures that the transmitted network messages are appended with a + character delimiter. The delimiter is either entered by the operator or is automatically added.

The following chart shows the coding for the International Alphabet No. 5 (IA5) characters:

b7 b6 b5 b4 b3 b2 b1		0	1	2	3	4	5	6	7
		0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
0	0000	NUL	TC7 (DLE)	SP	0	@	P	\	p
1	0001	TC1 (SOH)	DC1	!	1	A	Q	a	q
2	0010	TC2 (STX)	DC2	"	2	B	R	b	r
3	0011	TC3 (EXT)	DC3	#	3	C	S	c	s
4	0100	TC4 (EOT)	DC4	$	4	D	T	d	t
5	0101	TC5 (ENQ)	TC8 (NAK)	%	5	E	U	e	u
6	0110	TC6 (ANK)	TC9 (SYN)	&	6	F	V	f	v
7	0111	BEL	TC10 (ETB)	'	7	G	W	g	w
8	1000	FEO (BS)	CAN	(	8	H	X	h	x
9	1001	FE1 (HT)	EM	)	9	I	Y	i	y
A	1010	FE2 (LF)	SUB	*	:	J	Z	j	z
B	1011	FE3 (VT)	ESC	+	;	K	[	k	{
C	1100	FE4 (FF)	IS4 (FS)	,	<	L	\	l	|
D	1101	FE5 (CR)	IS3 (GS)	-	=	M	]	m	}
E	1110	SO	IS4 (RS)	.	>	N	^	n	~
F	1111	SI	IS5 (US)	/	?	O	-	o	DEL

Character Code Table Legend

TC = Transmission Control Characters

FE = Format Effectors

DC = Device Control Characters

IS = Information Separator

The 5294 supports the following 7-bit IA5 control codes:

Control Codes Received

Code	Definition
BEL	Indicates an incoming call when preceded by a minimum of two SYN characters and the 5294 is in State 1.
SYN	A character that precedes all transmissions and may be embedded within transmissions to maintain synchronization.
SI	Shift In. Used in Japanese network only. Follows SYN SYN and precedes Call Progress signals or DCE-provided information.
+	An ending delimiter that indicates end-of-transmission (EOT).
'	A field separator used to separate fields in Call Progress signals or DCE-provided information.
/	Indicates the start when a DCE-provided change information. Must be preceded by SYN SYN and information must be followed by a +.
*	Indicates the start when a DCE-provided calling and called line identification. Must be preceded by SYN SYN and information must be followed by a +.

Control Codes Sent

Code	Definition
SYN	A character that precedes all transmissions and may be embedded within transmissions to maintain synchronization.
NUL	A character used for fill purposes. The NUL character may be inserted into a data stream without affecting the information content. It is used by the 5294 to replace any operator-entered character that does not have an equivalent in the IA5 alphabet.
	Indicates the start of an abbreviated address selection sequence. Must be preceded by SYN SYN, and the address must be followed by a +.
	Used to separate Facility Request signals within a facility request block that contains two or more Facility Request signals, or used to separate Facility Registration/Cancellation signals within a facility registration/cancellation block that contains two or more Facility Registration/Cancellation signals.
/	Used to separate fields (request code, indicator, parameter, or address) within a Facility Registration/Cancellation signal.
-	Terminating delimiter of facility request or facility registration/cancellation blocks. Must be followed by a +.
+	Ending delimiter used to indicate the end-of-transmission (EOT). Used for all transmissions.
nnn	If preceded by SYN SYN and terminated by a +, the sequence **nnn...n** is an address selection sequence. If preceded by SYN SYN and terminated by a - and then a +, the sequence **nnn...n** is a facility block.

Since there are only four electrical signal lines (two from the DTE to the DCE and two from the DCE to the DTE), the meaning of the signals is dependent upon the previous state. A description of the X.21 interface states follows.

Note: Communication over a public switched data network is possible using SDLC only when connecting to the network through a DCE using the X.21bis interface via the EIA feature; however, only a limited set of functions is available. Also, this option may not be available for all networks. When allowed by the network, operation is possible between a DTE using X.21bis on one end and a DTE using X.21 (X.24/X.27) on the other end.

X.21 Switched Circuit Operations

The operation of work stations attached to the 5294 Control Unit is based on interactive terminal support and is dependent on the communications link. A call must be established and the data link must be connected for work station operation. With the X.21 Switched Circuit feature, the 5294 supports automatic call establishment (call is made following a work station keystroke sequence) and automatic call clearing. The host system or a 5294 work station operator can initiate the call or call clearing.

Following power-on and successful power-on diagnostics, the 5294 places the attached work stations into free key mode. The work stations are set up with the entire display being one input field and the printers are inoperative. The input field format word is set to alpha shift with no Field Exit key required. Mandatory entry, auto record advance, right adjust, and mandatory fill are not supported. Data may be entered anywhere on the display.

If any Aid generating key, excluding the Sys Req key and Enter/Record advance keys is pressed in the initial free key mode, operator error code 0099 will be posted on the work station display. If a permanent link error is posted, the last link error code may be displayed instead of the 0099.

If the communications link is not established, a Sys Req keystroke is recognized as an indicator that the operator wants to place a call. The 5294 then sets up one input field, highlighted with column separators between 78 columns, for the operator to enter call information or facility requests.

Normal Call Initiation

The work station operator initiates a call in the following sequence:

- Press the Reset key to ensure there is no device error.
- Press the Sys Req key.
- Key the network call information into the highlighted input field and press the Enter key.

The data entered should be the assigned numeric network identification code for the appropriate host system followed by a plus (+) character as a delimiter or the appropriate network registration request code for the desired facility.

Direct Call Initiation

The work station operator initiates a direct call in the following sequence:

- Press the Reset key to ensure there is no device error.
- Press the Sys Req key.
- Press the Enter key.

Under these conditions, the 5294 makes a direct call request. The request is made to the network to place a call to a preassigned number supported by the network. The 5294 does not send X.21 information in the direct call sequence.

Call Clearing Initiation

Calls are cleared under the following conditions:

- The 5294 initiates a call-clearing sequence through a DTE clear-request sequence as the result of a time-out for transmit call selection sequence or as part of an error recovery procedure.
- The work station operator initiates call clearing when the 5294 is in the data transfer phase and prior to entering normal response mode by entering the keystroke sequence of Sys Req and the character D.

Short Hold Mode

In short hold mode (SHM), the link between two stations is established and maintained only when there is data to transfer. The 5294 Control Unit supports SHM but will not initiate an SHM session. The host system determines and controls the SHM operation.

To start an SHM session, either the host system or the remote display station initiates a call to the network. The call then proceeds as any other X.21 call sequence. When Ready for Data state is reached and the SNA/SDLC operation starts, the host system sends a XID command specifying the SHM operation.

The XID format includes the following fields:

- SHI: Short Hold Mode indicator (byte 9, bit 7). This bit indicates that the XID sender is able to operate in SHM.

- SHSI: Short Hold Mode Status indicator (byte 9, bit 6). This bit indicates the state, active or reset, or the SHM session.

- SHMDIALN: Short Hold Mode Dial Number (byte 19). This byte contains the number of dial digits of the XID sender.

- SHMDIALD: Short Hold Mode Dial Digits (bytes 20 through 46 max). This bytes contain the dial digits of the XID sender. These digits are of the form **X'Fn'** where **n** = 0-9.

After SHM is selected by the XID exchange, the host system sends an SNA/SDLC SNRM command to start the SHM session. At any time in the session when the host does not have any frames to transmit or acknowledge, the host can clear the connection. Either the host system or the remote display station can call to reestablish the connection.

The XID command contains the dial digits for the host system to be used by the 5294 Control Unit to reconnect the link. These digits are received in EBCDIC code. The 5294 uses these digits on each reconnection to assure that the reconnection is to the correct host. The 5294 also translates the EBCDIC codes to the IA5 codes to be used when the 5294 initiates a reconnection. If SHMDIALN = 0, or if the configuration bit Direct Call is set on, the 5294 performs a Direct Call request to the network for reconnection.

In SHM, when a work station has data to be sent to the host system, and the X.21 connection is not made, the 5294 uses the dial digits that were received in the XID command and makes the reconnect call. When the reconnection is made and the X.21 Data Transfer phase is entered, the host system must send an XID with the SHM status on to continue the same SHM session. After the XID exchange, the host sends an SNA/SDLC RR command to enable the 5294 to send the work station data.

The host system terminates the SHM session by sending the DISC command and then clearing the connection. The 5294 interprets the Clear Requests received during NRM as SHM line disconnects and maintains the SNA session in progress. An SHM reconnection is necessary to either continue the session or to terminate the session.

XID Format

The 5294 only responds to an XID command in either Format 0 or Format 1. The 5294 does not issue the XID command. The XID command or response is identified in the SDLC unnumbered frame control field modifier bits as shown below:

10111 = XID Command or XID Response

The host system sends the code to solicit an XID response from the 5294 whenever a session is to be established or reconnected. The SDLC frame information field can be in either Format 0 or Format 1 as defined below.

The 5294 will send the code to the host system after an XID command has been received. The SDLC frame information field will be in Format 1.

Byte	Bits	Field	Value/Description
			– = Unique to host.
			* = 5294 response.
0		Format XID I Field.	
	0-3	XID Format	
			–X'0' = Format 0.
			* X'1' = Format 1.
	4-7	Sending Node Type.	* X'1' = PU Type 1 (T1).
1		XID Field Length	
	0-7		* X'14' = Not SHM
			* X'xx' = SHM.
2-5		Node Identification.	
	0-11	Block Number.	* X'045' = 5294 Block #.
	12-31	ID Number.	
	12-23		* X'000'.
	24-31		* 'xx' = SDLC Station Address.
		End for Format 0.	
		Bytes 6-p for Format 1.	
6-7	0-15	Reserved.	* X'0000'.
8		Link Protocol Flags.	
	0-3	Transmission Type.	* X'0' = Sender is secondary.
			– X'2' = Sender is primary.
	4-7	Transmission Mode.	* X'0' = Half duplex.
			* X'1' = Full duplex.
9		Sender Node Characteristics.	

Byte	Bits	Field	Value/Description
	0-3	Segmenting is not supported.	* X'3' = Whole BIUs only.
	4-5	Reserved.	
	6	Short Hold Status.	* B'0' = Not SHM.
			* B'1' = SHM.
	7	Short Hold Support.	* B'0' = SHM not supported.
			* B'1' = SHM supported.
10-11	0-15	Maximum I Field Length.	* X'105' = 261 bytes.
12	0-7	SDLC Profile.	* X'00' = Only value defined.
13		SDLC Mode Option.	
	0	SREJ.	* B'0' = Not supported.
	1	SARM.	* B'0' = Not supported.
	2	SIM/RIM.	* B'0' = Not supported.
	3-7	Reserved.	* B'00000'.
14-15		Reserved.	* X'0000'.
16	0-7	Maximum Number of I Frames Received.	* X'1' to X'7' for displays.
			* X'1' to X '3' for printers.
17	0-7	Reserved.	* X'00'.
18	0-7	Reserved.	* X'00'.
		End if Not SHM.	
		Bytes 18-p for SHM.	
18-p		Short Hold Parameters.	
18	0-7	Reserved.	* X'0'.
19	0-7	Number of Dial Digits.	* X 'xx'(xx can be '00' through '1B').
20-p		Dial Digits p = Byte 46 Maximum.	* X'Fi' (i can be 0-9).
		End Format 1.	

Call Retry Attempts

An unsuccessful call may be retried by the operator but the success may be determined by the network call progress signal response. The 5294 does not significantly control these actions.

X.21 Network States

The 5294 Control Unit supports the X.21 interface states as defined in the CCITT Recommendation X.21: Interface between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for Synchronous Operation on Public Data Networks (Geneva, 1972; as amended 1976 and 1980). The following information identifies the specifics for 5294 operation.

The following circuit reference conditions are used to describe the 5294 operations:

Symbol	Circuit	Name	Conditions
c	Circuit C	Control	On or Off
i	Circuit I	Indicate	On or Off
r	Circuit R	Receive	1 or 0
t	Circuit T	Transmit	1 or 0

Initial Conditions Following Power On

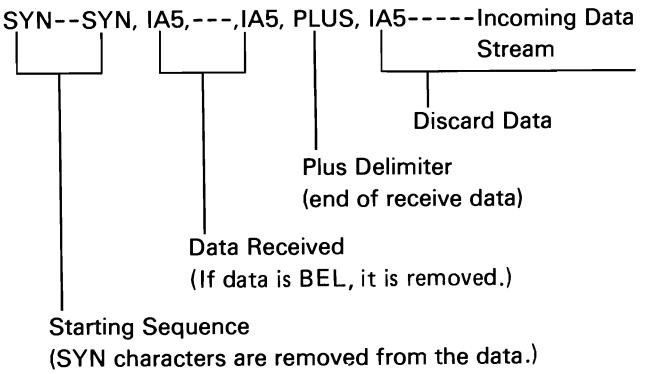
Following power-on reset, the 5294 is initialized to an uncontrolled not ready (clear request to DCE) with circuits t = 0 and c = Off. This condition will remain during successful power on diagnostics, which is approximately 5 to 10 seconds. The 5294 does not check the state of the DCE during this period. Circuits R and I can be in any condition during this period. The 5294 then presents Ready to the DCE (t = 1 and c = Off) and immediately starts looking for SYN characters on the receive line.

Receive Conditions

An incoming call from the DCE will be signified by a BEL character preceded by two or more contiguous SYN characters. The 5294 then accepts the call (t = 1 and c + On) unless there is a call collision.

The 5294 will only receive X.21 network messages in the call establishment phase. Data will be received only if it was preceded by two or more contigious SYN characters and the 5294 is in the DTE waiting state (t = 1 and c = On), or if the 5294 transmit operation is active. Otherwise, the incoming data will be ignored.

The 5294 recognizes the first plus (+) character in the message as the end of data as shown below.



When Ready for Data state is received, the 5294 will switch automatically to the SNA/SDLC operation.

The SNA/SDLC operation will be terminated if 17 zeros have been received with i = Off (X.21 DCE Clear).

Transmit Conditions

X.21 is a full-duplex protocol; therefore, the 5294 transmit will not be enabled unless receive is active. This is necessary to receive and report network response to Call Request. When transmit is enabled, the 5294 will progress through the calling states: Call Request, Proceed to Select, Selection Signals, DTE Waiting. Following Proceed to Select, State 3 (r = plus characters and i = Off), the 5294 will typically transmit 2 SYN characters followed by the message characters or the select data, and the end of message delimiter (plus character). The 5294 will then transmit continuous ones (1s) that signal DTE Waiting State until either the Ready for Data State (r = 1 and i = On) or a Call Clear Command (r = 0 and i = Off) is signaled by the DCE.

If a direct call is initiated, the 5294 bypasses the Selection Signal State 4 and does not transmit SYN and other IA5 characters. In this case, the 5294 will immediately transmit continuous ones (1s) that signal DTE Waiting State. The Control circuit will be on for 24-bit times (c = 1) before the 5294 initiates data transfer (Circuit T held at t = 1).

DCE Clear

The DCE is required to respond to a 5294 Clear Request with a Clear Confirmation (r = 0 and i = Off) followed by a DCE Ready signal (r = 1 and i = Off).

For all DCE initiated clearing, DCE Clear Indication (r = 0 and i = Off), the 5294 responds with a DCE Clear Confirmation (t = 0 and c = Off).

Call Collisions

Call collisions can occur under the following conditions:

- A network incoming call is indicated concurrently with or immediately after the 5294 sends a Call Request.
- A network incoming call is indicated while the 5294 is processing an operator-initiated call.

If the DCE indicates an incoming call (r = SYN,SYN,BEL and i = Off) during or immediately after the 5294 has sent a call request (t = 0 and c = On), the 5294 takes no action. The DCE either drops the incoming call and proceeds with the Call Request selection sequence or attempts to establish the incoming call. If the DCE drops the incoming call, that call is not recognized. If the DCE attempts to establish the incoming call, the 5294 utilizes the Call Request sequence time out to initiate a call clearing action.

If the work station operator is in the process of making a call (Sys Req keystroke made and Call Request not yet sent to the DCE) and an incoming call is indicated, the 5294 will post an error to the operator and log the error. The 5294 will then send a Clear Request to the DCE (t = 0 and c = Off).

In the CCITT recommendation X.21, the condition of the interchange circuits determines what is happening at the interface. During a data communications operation, the DTE uses the transmit (T) and control (C) interchange circuits to signal the DCE what action to take. The DCE uses the receive (R) and indication (I) interchange circuits to signal the DTE what action to take.

Figure 2-24 lists the interface states that are defined by recommendation X.21.

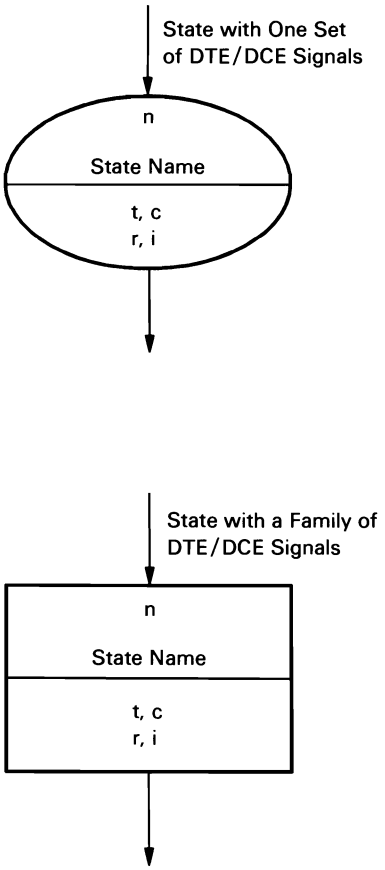
								Time-Limit/Time Out Transition		
State	State	DTE Circuits		DCE Circuits		DTE Transition	DCE Transition	To	Time-Limit/ Time Out	Terminated by
Number	Name	T	C	R	I	to State No.	State No.	State No.	No.	State No.
1	Ready	1	Off	1	Off	2,13S,14,24	8,13R,18	1	T7	8
2	Call request	0	On	1	Off	---	3,15	1	T1	3
3	Proceed to select	0	On	+	Off	4,15	---	19	T11,T12	4,5
4	Selection signal	IAS	On	+	Off	5	---	19	T13	EOS
5	DTE waiting	1	On	+	Off	---	6A,11,12	16	T2	7,10,12,19
6A	DCE waiting	1	On	SYN	Off	---	7,10,11,12	--	---	---
6B	DCE waiting	1	On	SYN	Off	---	10bis,11,12	--	---	---
7	Call progress signal	1	On	IA5	Off	---	6A,10,11,12	16	T3A	T3B 7,10,12,19
8	Incoming call	1	Off	BEL	Off	15,9	---	1	T14A,T14B	9,15
9	Call accepted	1	On	BEL	Off	---	6B,11,12,	16	T4	10bis,12,19
10	DCE provided information	1	On	IA5	Off	---	6A,11,12	--	---	---
10 bis	DCE provided information	1	On	IA5	Off	---	6B,11,12	--	---	---
11	Connection in progress	1	On	1	Off	---	12	--	---	---
12	Ready for data	1	On	1	On	---	13	--	---	---
13	Data transfer	D	On	D	On	13R	13S,DCE not ready	--	---	---
13R	Receive data	1	Off	D	On	13	1	--	---	---
13S	Send data	D	On	1	Off	7	13	--	---	---
14	DTE controlled not ready DCE ready	01	Off	1	Off	1,24	23	--	---	---
15	Call collision	0	On	BEL	Off	---	3	--	---	---
16	DTE clear request	0 (Note 1)	Off	X	X	---	17	18	T5	21
17	DCE clear confirmation	0	Off	0	Off	---	21	--	---	---
18	DTE ready DCE not ready	1	Off	0	Off	22	1	--	---	---
	DCE not ready	D	On	0	Off	---	1,13,13S	--	---	---
19	DCE clear indication	X (Note 1)	X	0	Off	20	---	24	T15	20
20	DTE clear confirmation	0	Off	0	Off		21	18	T6	21
21	DCE ready	0	Off	1	Off	1	---	24	T16	1
22	DTE uncontrolled not ready DCE not ready	0	Off	0	Off	18	24	--	---	---
23	DTE controlled not ready DCE not ready	01	Off	0	Off	18,22	14	--	---	---
24	DTE uncontrolled not ready DCE ready	0	Off	1	Off	1	22	--	---	---
Any State (Note 1)	---	X	X	X	X	16	19	--	---	---

Notes:
1. DCE clear indication (state 19) or DTE clear request (state 16) may be entered from any state except ready (state 1)
2. Other transitions are not considered valid.

Figure 2-24. X.21 Interface State Transitions and Applicable Time outs

Interface State Diagrams

Recommendation X.21 defines those transitions between interface states that are allowed by all telecommunications administrations. The recognized state transitions for each of the four phases of a data communications operation are shown by means of state diagrams. Figure 2-25 shows the definitions for the symbols that are used in the state diagrams. Figure 2-26 shows the states used for nonswitched operation (X.21 nonswitched public data network or X.25 packet-switched network). Figure 2-27, Figure 2-28, and Figure 2-29 show the states used for X.21 circuit-switched public data network operation.



n	=	State number
t	=	Signal on T circuit
c	=	Signal on C circuit
r	=	Signal on R circuit
i	=	Signal on I circuit
T	=	Transmit interchange circuit
C	=	Control interchange circuit
R	=	Receive interchange circuit
I	=	Indication interchange circuit
D	=	DTE or DCE data signals
0	=	Steady binary 0 condition
1	=	Steady binary 1 condition
01	=	Alternate binary 0 and binary 1
X	=	Any value
Off	=	Continuous off (binary 1)
On	=	Continuous on (binary 0)
IA5	=	Characters from International Alphabet Number 5 (CCITT Recommendation V.3)
BEL	=	IA5 character, 0/7
SYN	=	IA5 character, 1/6
+	=	IA5 character, 2/11
↓	=	Transition between states

Figure 2-25. Definitions of Interface State Diagrams

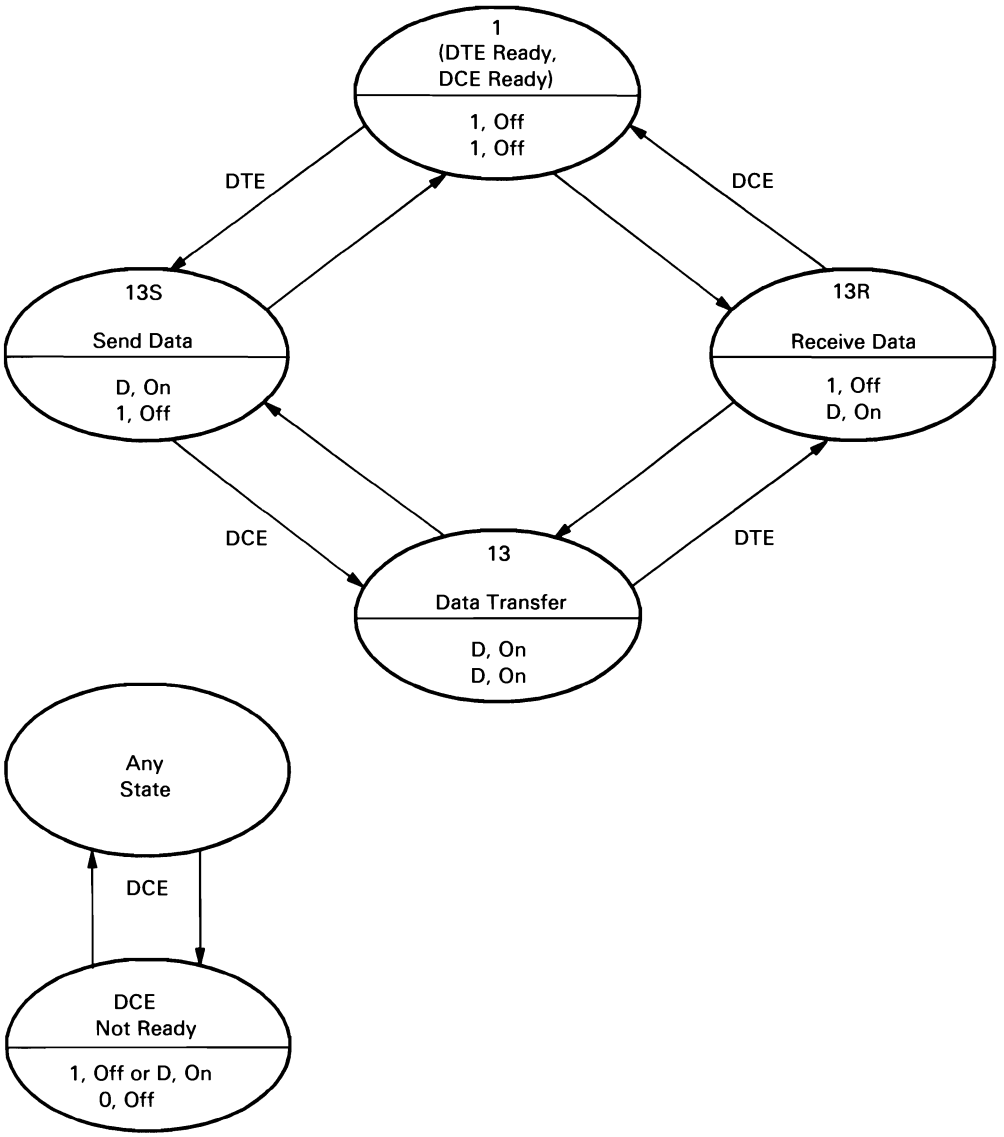
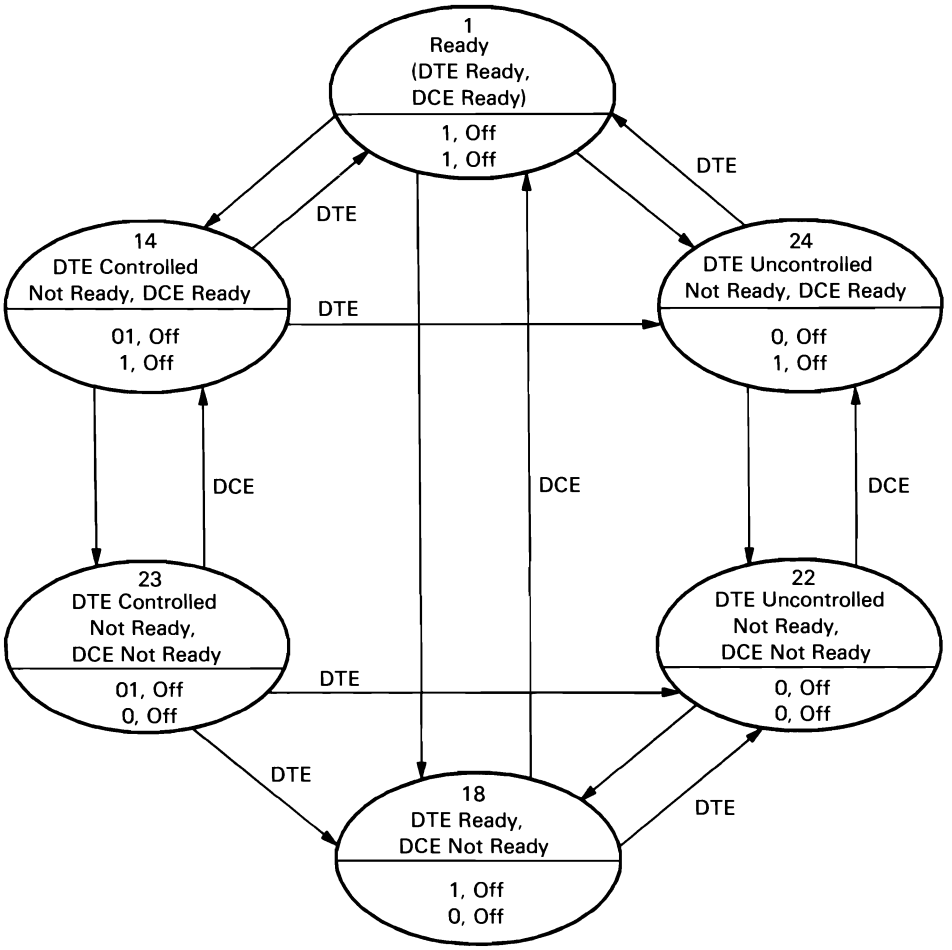


Figure 2-26. Data Transfer Phase Interface State Program: X.21 Nonswitched Public Data Network or X.25 Packet-Switched Network Operation with X.21 Electrical (X.24/X.27) Interface



Note: The DCE and DTE (5294) must signal each state for at least 24 bit-times or until the DCE or DTE indicates that the state has been recognized by changing states, whichever is less. The DTE (5294) must not change states as a result of the DCE changing state until the DCE-signaled state has existed for at least 16 bit-times.

Figure 2-27. Quiescent Phase Interface State Diagram: Circuit-Switched Operation

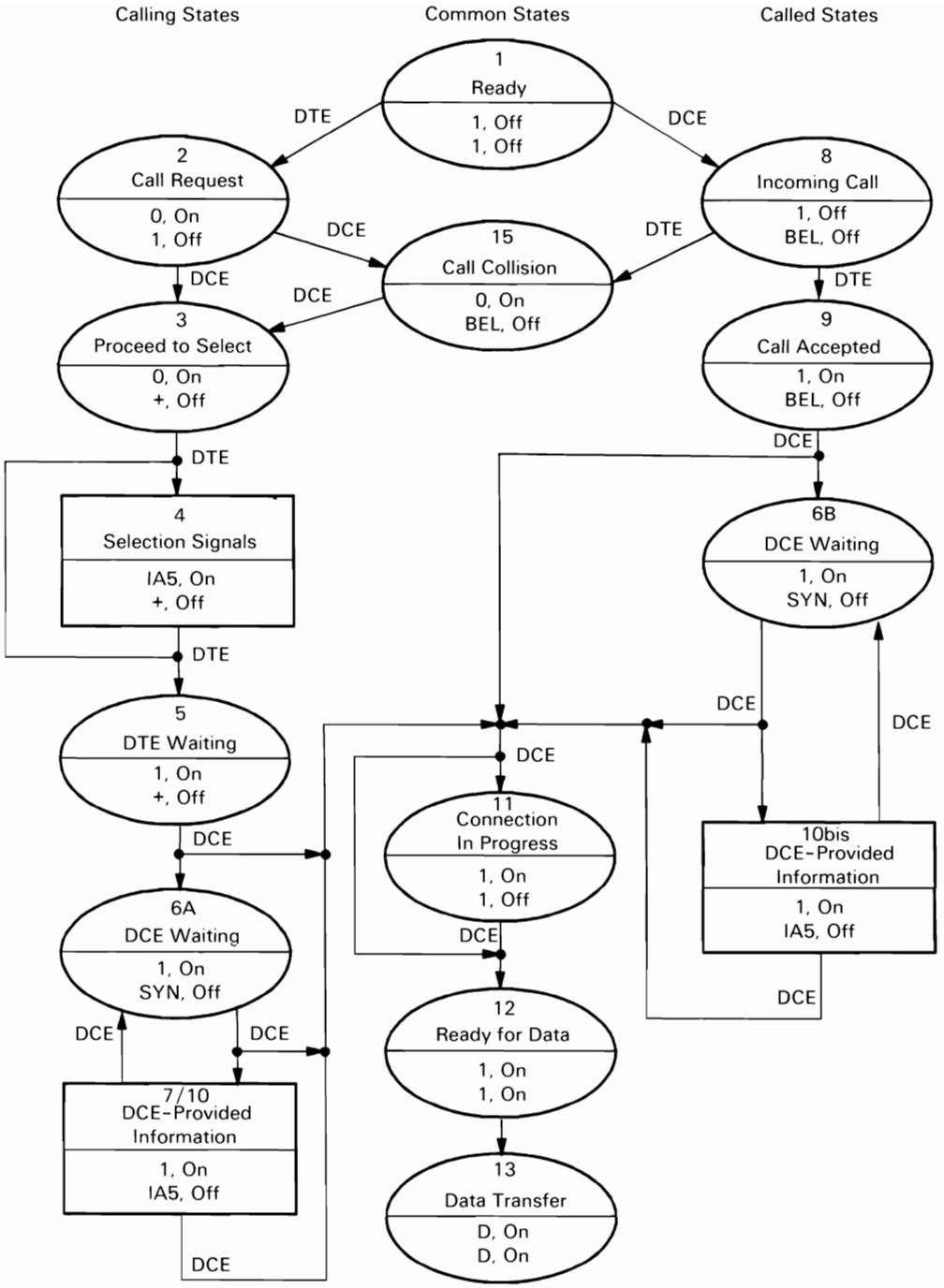


Figure 2-28. Call Establishment Phase and Data Transfer Phase Interface State Diagram: Circuit-Switched Operation

Switched Network Calling and Answering Sequences

The following table shows the sequence of states, pictured in the state diagrams on the preceding pages, that are used for calling and answering on an X.21 switched network. The condition of the transmit data, control data, receive data, and indicate lines for the X.24/X.27 (XLCA) interface between the 5294 and the DCE is also shown.

The sequence shown is for normal operation. Most states have time outs for error recovery. Figure 2-24 shows the time outs applicable to each state and the state entered if the time out expires without the expected state transition.

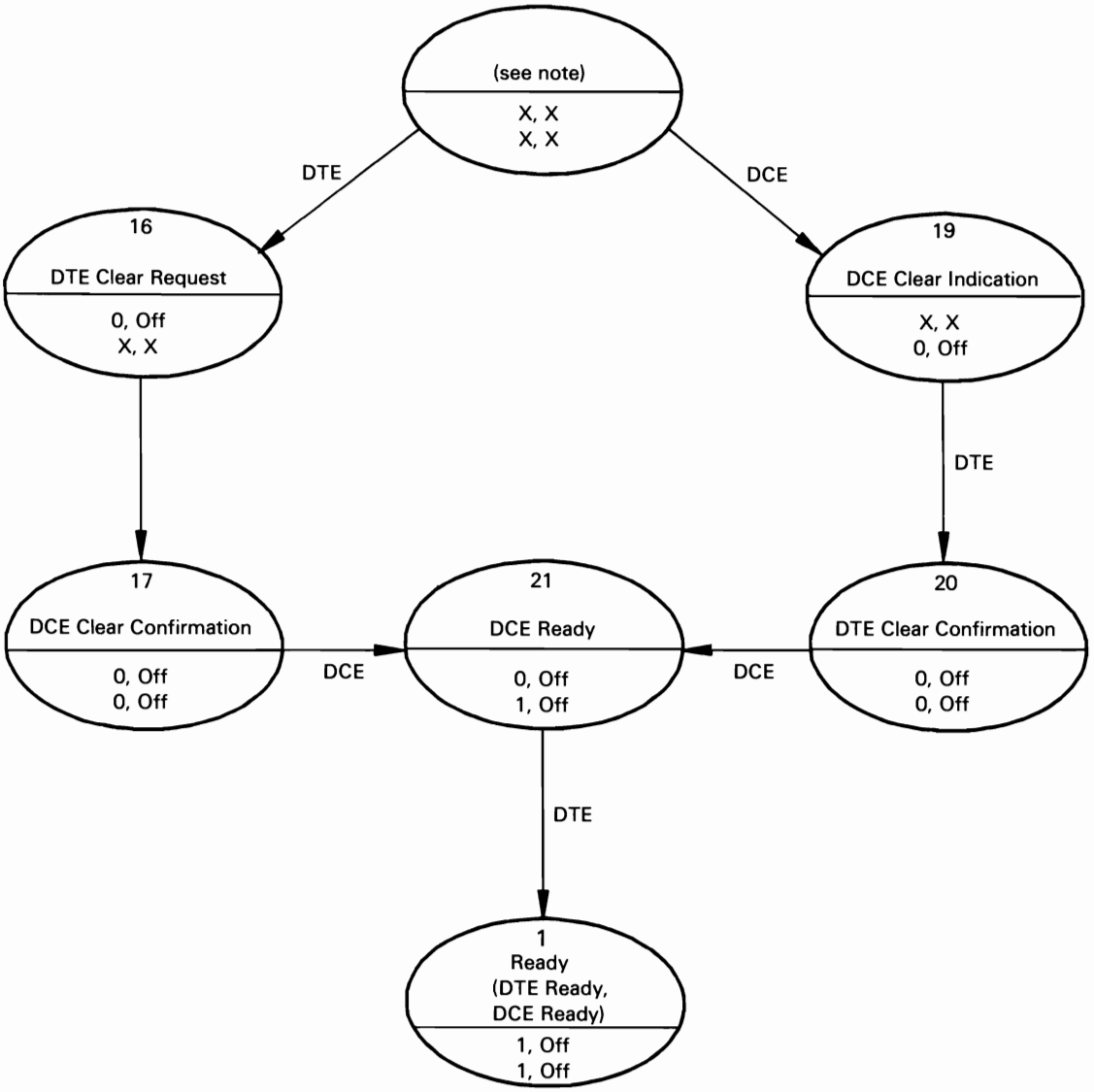
Switched Network Calling Sequence

State	Description	Transmit	Control	Receive	Indicate
1	The 5294 and the DCE are ready for transfer.	1	Off	1	Off
1	The 5294 asks the DCE to place a call.	0	On	1	Off
3	The DCE responds with a Proceed to Select signal.	0	On	SYN SYN +...	Off
4	The 5294 responds with selection signals. This state is bypassed for direct call.	SYN SYN selection signals +	On	+...	Off
5	DTE waiting.	1	On	+...	Off
6A	DCE waiting. This state may be bypassed for some calls.	1	On	SYN ...	Off
7-10	The DCE responds with a Call Progress signal. The DCE is placing a call to a remote station (optional state).	1	On	SYN SYN Call Progress +	Off
11	The DCE signals that the connection has started (optional state).	1	On	1	Off
12	The connection to the remote station is complete (ready for data).	1	On	1	On
13	The data transfer can start. Data transfer is performed using SNA/SDLC protocols in half-duplex mode. SDLC operation is the same as SDLC switched operation after a call is established.	Data	On	Data	On

Switched Network Answering Sequence

State	Description	Transmit	Control	Receive	Indicate
1	The 5294 and the DCE are ready.	1	Off	1	Off
8	The DCE indicates an incoming call.	1	Off	SYN SYN BEL...	Off
9	The 5294 accepts the incoming call.	1	On	BEL...	Off
6B	The DCE waits.	1	On	SYN SYN SYN...	Off
11	The DCE signals that the connection has started. This state may be bypassed.	1	On	1	Off
12	The connection to the host system is complete (ready for data).'	1	On	1	On
13	The data transfer can start. Data transfer is performed using SNA/SDLC protocols in half-duplex mode. SDLC operation is the same as SDLC switched operation after a call is established.	Data	On	Data	On

After data transfer is complete, the call clearing phase is entered (see Figure 2-29 and the *Switched Network Call Clearing Sequence* table following). The host system causes the 5294 to initiate call clearing by sending an SDLC Disconnect (DISC) command.



Note: This may be any state shown in Figure 2-24 except the ready state (1).

Figure 2-29. Clearing Phase Interface State Diagram (Circuit-Switched Operation)

Switched Network Call Clearing Sequence

The following figures show the sequence of states pictured in the state diagram on the preceding page that are used for call clearing on an X.21 switched network.

Note: The active levels for X.21 signals are:

0 for data lines

On for control lines.

Call Clearing after Normal Data Transfer Operation

State	Description	Transmit	Control	Receive	Indicate
13	The 5294 recognizes the end of data transfer as a result of receiving an SDLC DISC command from the host system.	1	On	Data (SDLC DISC)	On
16	The 5294 initiates call clearing by sending a clear request to the DCE.	0	Off	1	On
17	The DCE recognizes the end of the data transfer (acknowledgment of the Clear Request from the 5294).	0	Off	0	Off
21	The DCE returns to the ready state.	0	Off	1	Off
1	The 5294 returns to the ready state.	1	Off	1	Off

Call Clearing after Facility Registration or a 5294-Detected Error

State	Description	Transmit	Control	Receive	Indicate
XX	The 5294 recognizes that a call clearing is required due to facility registration complete or a detected error.				
16	The 5294 signals a Clear Request to the DCE.	0	Off	Can be 0/1	Can be On/Off
17	The DCE acknowledges the Clear Request from the 5294 (a DCE Clear confirmation).	0	Off	0	Off
21	The DCE returns to the ready state.	0	Off	1	Off
1	The 5294 returns to the ready state.	1	Off	1	Off

Call Clearing after a DCE/Network-Detected Error or a Clear Request by the Remote DTE (Host System)

State	Description	Transmit	Control	Receive	Indicate
XX	The DCE/network recognizes that a call clearing is required due to an error or a Clear Request by the remote (host system) DTE.				
19	The DCE signals a Clear Indication to the 5294.	Can be 0/1	Can be On/Off	0	Off
20	The 5294 acknowledges the Clear Indication from the DCE (a DTE Clear confirmation).	0	Off	0	Off
21	The DCE returns to the ready state.	0	Off	1	Off
1	The calling station returns to the ready state.	1	Off	1	Off

SDLC Counter Error Codes (X.21)

The 006X error codes are for SDLC. They are placed in the error log when the 5251 Model 2 or Model 12 counters that track SDLC transmission errors overflow or when the host system solicits the error log. The operator may display the counters that are formatted into these errors. See *Problem Determination Procedures* in the *IBM 5251 Display Station Models 2 and 12 Operator's Guide*, GA21-9323, or the *5294 Operator's Guide*, GA21-9370. See the index entries *errors, error log; errors, handling;* and *reqms command.*

The following chart describes each SDLC error code.

0060 Bad test counter
Used with the SDLC Test command for diagnostic purposes.

0061 Good test counter
Used with the SDLC Test command for diagnostic purposes.

0062 Communications adapter underrun counter

0063 Communications adapter overrun counter

0064 Carrier detect glitch counter
Occurs when the carrier detect line is unexpectedly inactive.

0065 Clear to send glitch counter
Occurs if the clear to send line is unexpectedly inactive.

0066 Data set ready glitch counter
Occurs if the data set ready line is unexpectedly inactive.

0067 Frame sequence error counter
Occurs when frame sequence errors occur.

0068 Transmit retry counter
Occurs each time an I frame must be retransmitted.

0069 CRC errors in FCS field
Occurs each time the FCS character does not match the expected FCS character.

006A Frame aborts received

006B XLCA card detected errors

006C Call collision detected

006D IA5 parity error

006E Number of I frames transmitted by the 5294 (4 bytes)

006F Number of I frames received by the 5294 (4 bytes).

Operator Error Codes (X.21 Switched Support Feature Only)

If the 5294 has the X.21 Switched Support feature and an error occurs during the keyboard entry of commands, or options, or parameters, a 6-digit error code (such as **20xxxx**, where **xxxx** represents 4 hexadecimal digits) is displayed. A description of these codes follows:

200000 A Call command is already in progress (not in session).

Wait until the Call command is complete, or an error code other than 200000 is displayed.

200100 The switched circuit has been successfully disconnected.

The operator may make another call.

200200 The operator attempted a Detach command while the Call command was in progress or no command was in progress.

Wait until the previous command completes; then try again. If no command was in progress, try to make a call.

201100 The host network is busy at the address keyed in.

Wait until the host system is not busy, or try a different address.

X.21 Communications Errors (X.21 Switched Support Feature Only)

If the 5294 Control Unit accepts the keyboard-entered options, but the network operation with the host system fails, a code that indicates the type of communications problem is displayed on the attached work stations.

The **21xx00** error codes occur when a call is in progress with the host system. The cause of the error is contained in the field **xx**. The codes that are valid follow:

210000 Reserved.

210100 The terminal called the host system.

Wait one minute or until an error code other than **20xx00** is displayed. This status is temporary.

210200 The call is being redirected.

Wait one minute or until an error code other than **20xx00** is displayed. This status is temporary.

210300 Connect when free.

Wait one minute or until an error code other than **20xx00** is displayed. This status is temporary.

212000 There is no connection.

Ensure that the number called is correct and try the operation again after one minute. This is a DCE or a network error.

212100 The number is busy.

Ensure that the number called is correct and try the call again. If the number is busy for longer than normal, call the host system to see if the system port for the number called is actually busy. If the host system port and the DCE for the number called is ready and not busy, there is a network problem.

212200 There is a procedure error in the selection signals sent to the network.

Ensure that the operating procedures are correct and try the operation again. If the same failure occurs, the problem is caused by the DCE or the network.

212300 There is a transmission error in the selection signals sent to the network.

Ensure that the number called is correct and try the operation again after one minute. This is a DCE or a network error.

214100 Access is barred to the network.

Ensure that the number called is correct and that the operating procedures and configuration are compatible with the network subscription for the 5294 and the host system locations. If the procedures and configuration are correct and compatible, the failure is a network problem.

214200 The number you are calling has changed.

Ensure that the number called is correct and that the operating procedures and configuration are compatible with the network subscription for the 5294 and the host system locations. If the procedures and configuration are correct and compatible, the failure is a network problem.

214300 The number you are calling cannot be reached.

Ensure that the number called is correct and that the operating procedures and configuration are compatible with the network subscription for the 5294 and the host system locations. If the procedures and configuration are correct and compatible, the failure is a network problem.

214400 The number you called is out of order.

Ensure that the number called is correct, that the called system and DCE are powered on and ready, and that the 5294 has been varied on. If both the host system and its attached DCE are powered on and ready, and the 5294 is varied on, then the failure is due to a network problem.

214500 Called DTE; controlled not ready.

Same as 214400.

214600 Called DTE; uncontrolled not ready.

Same as 214400.

214700 Called DTE; power off.

Same as 214400.

214800 The facility request code is not valid.

Ensure that the facility request code is correct and that the operating procedures and configuration are compatible with the network subscription for the 5294 and the host system locations. If all of the above are correct and compatible, the failure is a network problem.

214900 There is a network problem in the local loop at the DCE you called.

The problem is caused by the network or by the DCE.

215100 The number called cannot be obtained.

Ensure that the number called is correct. If the number called is correct, call the network information service to find out why the number called is temporarily not obtainable.

215200 The user class of service is not compatible.

Ensure that the number called is correct and that the operating procedures and configuration are compatible with the network subscription for the 5294 and the host system locations. If the procedures and configuration are correct and compatible, the failure is a network problem.

216000 There is no connection.

Ensure that the number called is correct and try the operation again after one minute. This is a host system DCE or network problem.

216100 The network is congested.

Ensure that the number called is correct and try the operation again after one minute. This is a network problem.

217100 There is long-term network congestion.

The failure is caused by a network problem.

217200 The Recognized Private Operating Agency (RPOA) is out of order.

Ensure that the number called is correct. The failure is caused by an RPOA or a network problem.

218100 The registration/cancellation is confirmed.

This is not an error. It is part of the procedure used to initialize a call and a confirmation of the facility registration/cancellation, not an error.

218200 The redirection of the call was activated.

This is not an error. It is a confirmation of the facility registration activation, not an error.

218300 The redirection of the call was deactivated.

This is not an error. It is a confirmation of the facility registration deactivation, not an error.

220000 An invalid XID was received.

Ensure that the number called was correct. There is a host system programming error or a configuration problem.

220100 An invalid XID was received.

Ensure that the number called was correct. If the number called was correct, there is a host system programming error or a configuration problem.

220200 The wrong XID was received.

Ensure that the number called was correct. If the number called was correct, there is a host system programming error or a configuration problem.

220300 A XID was required and was not the first thing received.

Ensure that the number called was correct. If the number called was correct, there is a host system programming error or a configuration problem.

220400 A DCE Clear was received during call selection.

The failure is caused by a network or DCE problem.

220500 There was a transition to SDLC during a message.

The failure is caused by a network or DCE problem.

220600 An X.21 message was too long for the buffer.

The failure is caused by a network or DCE problem.

220700 An attempt was made to send an X.21 message to the network in SDLC state.

Contact your 5294 Control Unit service representative and report the error code.

220800 An attempt was made to send an SDLC frame to the network in X.21 state.

Contact your 5294 Control Unit service representative and report the error code.

220900 An X.21 message was received in the not ready queue.

Contact your 5294 Control Unit service representative and report the error code.

221000 A time-out T1 was received for a Proceed-to-Select response.

The failure is caused by a network or DCE problem.

221102 A time-out T2 was received for a Selection signal response.

The failure is caused by a network or DCE problem.

221103 A time-out T3A or T3B was received for a Call Progress signal response.

The failure is caused by a network or DCE problem.

221104 A time-out T4 was received for a Call Accepted response.

The failure is caused by a network or DCE problem.

221300 A call collision error occurred.

Try the operation again. If the error occurs again, contact your 5294 Control Unit service representative and report the error code.

221400 A clear command was received from the network during an X.21 data transfer (SNA/SDLC mode).

Ensure that the number called is correct. If the number called is correct, there is a host system or network problem.

23xx00 A call progress signal was received from the network, but a call was not placed.

The failure is caused by a network or DCE problem.

240000 A call progress signal was received that was not valid.

The failure is caused by a network or DCE problem.

Appendix A. Acronym and Abbreviation List

+rsp	positive response
-rsp	negative response
A	address
Actlu	activate logical unit
ADM	asynchronous disconnect mode
Aid	attention identification
Alpha	alphabetic
ARM	asynchronous response mode
Attn	attention
AWFER	awaiting field exit required
B	binary
BIU	basic information unit
bps	bits per second
c	column
C	control field
CC	control character
CCITT	Consultative Committee on International Telephone and Telegraph
CD	change of direction
CF	Cluster feature
CF1	Cluster feature or first half of Dual Cluster feature
CF2	second half of Dual Cluster feature
Cmd	command
CMDR	command reject
cpi	characters per inch
CR	carriage return
CRC	cyclic redundancy check
CRT	cathode-ray tube
CU	clear unit
Dactlu	deactivate LU
DCE	data circuit terminating equipment
Del	delete
DFC	data flow control
DISC	disconnect
DM	disconnected mode
dsp	displacement
DSR	data set ready
DTE	data terminating equipment
Dual CF	Dual Cluster feature
Dup	duplicate
EB	end bracket
EIA	Electronic Industries Association
ERP	error recovery procedure
ESC	escape character
Exr	exception request
F	flag
FCS	frame check sequence
FCW	field control word
FDX	full duplex
FER	field exit required
FF	forms feed
FFW	field format word
FIC	first in chain
FM	function management
FMD	function management data
FMP	function management profile
Fmt	format
FOC	see FIC
HDX	half duplex
hex	hexadecimal
I	information
IC	insert cursor
ID	identification, identifier
I/O	input/output
IPDS	intelligent printer data stream
IPR	isolated pacing response
LAPD	link access protocol-balanced
LED	light-emitting diode
LF	line feed
LIC	last in chain
LOC	see LIC
lpi	lines per inch
LSID	local session identifier
LU	logical unit
Lustat	logical unit status
MDT	modify data tag
ME	mandatory enter
MF	mandatory fill
MIC	middle in chain
MOC	see MIC
MPL	maximum print line
MPP	maximum print position
NDM	normal disconnect mode
NL	new line
Nr	station receive
NRM	normal response mode
Ns	station send
NSA	nonsequenced acknowledgment

NSI	nonsequenced information
NUL	null
num	numeric
OEM	original equipment manufacturers
OIC	only in chain
PIU	path information unit
PP	print position
PTT	post telegraph telephone
PU	physical unit
PVC	permanent virtual circuit
QRI	queued response indicator
r	row
RA	repeat to address
rcvr	receiver
Rec Adv	record advance
Rec Bksp	record backspace
Recfms	record formatted maintenance statistics
RGA	remote go ahead
REJ	reject
req	request
Reqms	request maintenance statistics
RH	request/response header
RNR	receiver not ready
ROL	request on line
RQD	request definite
RQE	request exception
RR	receiver ready
Rshutd	request shutdown
RU	request/response unit
SARM	set asynchronous response mode
SBA	set buffer address
SC	system control, session control
SCS	standard character string
SDLC	synchronous data link control
SDT	start data transfer
SF	start of field
SGEA	set graphic error action
SHF	set horizontal format
SIM	set initialization mode
SNA	system network architecture
SNBU	switched network backup
Sndr	sender
SNRM	set normal response
SOH	start of header
SREJ	selective reject
SS	system services (control point), supervisory session
SSCP	system services control point
STSN	set and test sequence numbers
SVC	switched virtual circuit
SVF	set vertical format
S0,S1, S2	sense bytes
TH	transmission header
TS	transmission services
TSP	transmission services profile
WTD	write to display
X	hexadecimal
XID	exchange identifier
xx	variables
yy	variables
zz	variables

Glossary

-rsp (negative response). SNA coding that identifies an error. See the index entry *negative responses.*

+rsp (positive response). The return code that indicates that data has been received in a way acceptable to the receiving partner.

active field. A field in which the operator has begun entering data. Once the field is active, all field requirements must be satisfied before the operator is allowed to exit the field. See the index entry *fields.*

Aid codes (attention identification codes). A byte sequence that is generated when the operator presses certain function keys. See the index entry *aid generating keys.*

BIU (basic information unit). The RH and the RU. See index entries *RH* and *RU.*

CC (control characters). Formatting control of data for both the display and printer LUs. See the index entry *control characters.*

CD (change of direction). A bit in the RH that determines which SNA session partner has the right to transmit data. See the index entry *CD.*

CF (Cluster feature). A purchasable feature attachable to a 5251 Model 2 or Model 12. It allows the user to cable attach up to four work stations to the controller. See the index entry *cluster feature.*

Cable Thru. A special feature or standard function that allows multiple display stations and printers to be attached to a single cable path.

chaining. A process that allows the programmer to link RUs together. Bits in byte 0 of the RH identify the respective position of each RU within the chain. See *SNA Terminology Used in Describing the SNA Protocols* in Section 1 and index entry *RH.*

condensed printing. Making a standard 132-character line only eight inches long instead of 13.2 inches long. This allows use of all 132 print positions on standard 8-1/2 in by 11 in forms and an increase in line length from 132 characters to 198 characters.

controller. The 5251 Model 2 or Model 12 or 5294 Control Unit that is linked to the host system via an SDLC communications network and that has 5250 devices attached to it via cluster feature. It controls the operation of all work stations attached to it via Cluster feature.

controller station address. The 8-bit address that the host system uses to address the 5251 Model 2 or Model 12. The 5251 Model 2 or Model 12 scans the station address field of the SDLC frame for its address. 00 and FF are not acceptable as controller station addresses.

D zones (or dezones). Areas where the first 4 bits have been removed and replaced with bits 1101.

data circuit-terminating equipment (DCE). This term is used in Recommendation X.25 to refer to the equipment installed at the user's premises which provides:

- All the functions required to establish, maintain, and terminate a connection.
- The signal conversion and coding between the data terminal equipment (DTE) and the common carrier's line; for example, a modem.

The term DCE is also used to refer to functions performed by a carrier's network node.

data terminating equipment (DTE). This term is used in Recommendation X.25 to refer to any machine, such as the 5294 Control Unit or its host computer, that is connected to a network.

display. The information that the operator sees projected on the display screen.

Dual Cluster feature. A purchasable feature attachable to a 5251 Model 2 or Model 12. It allows the user to cable attach up to eight work stations to the controller.

FCW (field control word). A Write command parameter that controls resequencing and self-check (when installed) operations. See the index entry *field control word.*

FFW (field format word). A Write command parameter that defines the field type. See the index entry *field format word*.

flag. The unique bit pattern that SDLC uses to identify the beginning and end of the SDLC frames. See index entries *flag sequence* and *frames*.

frame. A 32-bit (minimum) format that SDLC uses for sending commands and data to and from the 5251 Model 2 or Model 12 and the host system. See the index entry *frames*.

Note: This term can also refer to the format used by the twinaxial commands and responses; in this case, the frame is 16 bits.

Home position. The position that the cursor seeks. It can be one of the following: (1) the address sent via the IC order, (2) the first nonbypass input field, or (3) row 1, column 1.

IC (insert cursor). A Write command parameter that controls the location of the cursor on the display. See the index entry *IC order.*

immediate commands. The display commands that are executed as soon as the controller receives them. See the index entry *display, commands*.

link access protocol-balanced (LAPB). LAPB is the X.25 recommended access protocol used to exchange data between a DTE and the network node to which it is connected. See also *protocol*.

local network address. This is the network address of the 5294. Some networks require this to be sent with the host network address on a call from the 5294 to the host system.

logical channel. A logical channel identifies a virtual connection between the 5294 and its network node. Permanent virtual circuits are assigned to logical channels at subscription time. Switched virtual circuits are assigned to logical channels each time a connection is set up. The 5294 can use only one virtual circuit at a time. A one-way logical channel outgoing facility allows the 5294 to call the host but will not allow the host to call the 5294. A one-way logical channel incoming facility allows the host to call the 5294 but will not allow the 5294 to call the host. (See also *Incoming Calls Barred* and *Outgoing Calls Barred.*)

logical channel identifier. This is a 12-bit number used to identify a logical channel. It consists of a 4-bit logical channel group number and an 8-bit logical channel number.

LSID (local session identifier). The distinct LU address contained in the TH. See the index entry *addressing*.

LU (logical unit). An SNA term that, in the 5250 configuration, refers to a work station attached to a 5251 Model 2 or Model 12 via cluster feature. See *Description of General SNA Terms Used in This Manual* under *Overview of the 5250 Implementation of SNA* in Section 1.

MDT (modify data tag). A bit that flags a field as having been altered by the operator. See the index entry *MDT bit*.

null. This is the hex 00 value, which displays as a blank.

pacing. The rate at which the SNA session partners have agreed to transmit data. See the index entry *pacing*.

packet. Information transmitted through a packet-switching network is divided up and inserted into packets. These usually consist of control information fields giving destination, sequence number, optional facilities, and often a user data area. Various kinds of packet are used to transmit error codes and supervise the virtual circuit.

packet size. The packet size is the maximum number of bytes allowed in the user data area of a data packet. A default value, usually 128 bytes, is assigned at subscription time. On some networks, the packet size can be altered from call to call.

packet switching. Packet switching is the transfer of data by means of addressed packets that occupy the network channel only during actual transmission. The channel is available for the simultaneous transfer of packets belonging to other network users. The network determines the optimum routing of each individual packet during, rather than prior to, the transmission from a DTE.

panel. The contents of one full display.

permanent virtual circuit (PVC). A permanent virtual circuit is the packet switching equivalent of a leased line. The 5294 and its host system appear to the user to be permanently connected.

PIU (path information unit). Consists of the TH followed by a BIU.

port. The hardware coupling used to attach work stations to the 5251 Model 2 or Model 12 Cluster features.

protocol. A series of rules used by SNA to provide a common hierarchy and architecture for programming in the 5251 Model 2 or Model 12 and host system.

Queued Response indicator. In a response header, the Queued Response indicator denotes whether the response is to be enqueued in transmission control queues or whether it is to bypass these queues. In a request header, it indicates what the setting of the QRI should be on the response.

regeneration buffer (regen buffer). The reserved area of storage within a display LU that holds the contents of the display and information about the field and screen attributes.

RH (request/response header). An SNA bit pattern that precedes the RU. It defines the RU type, response type requested, CD, and position in the chain. See the index entry *RH*.

RQD (request definite). The receiving partner is required to respond to the transmission from the other partner. See *Description of General SNA Terms Used in This Manual* under *Overview of the 5250 Implementation of SNA* in Section 1.

RQE (request exception). The receiving partner is required to respond only if the response is negative. See *Description of General SNA Terms Used in This Manual* under *Overview of the 5250 Implementation of SNA* in Section 1.

RU (request/response unit). The programming unit that contains all of the 5250 data streams. It is an SNA convention. See the index entry *RU*.

screen. The hardware device upon which the display is projected.

scan codes. Identification codes sent from the keyboard to the host system when the operator keys in data.

SDLC (Synchronous Data Link Control). A discipline for the management of information transfer over a half-duplex communications channel. The configuration can be point-to-point, multipoint, or loop. SDLC includes comprehensive detection and recovery procedures, at the data link level, for transmission errors that can be introduced by the data communications channel.

session. The logical connection of an LU to the host system's SS or an application program.

session partners. The host system and the controller in the 5251 Model 2 or Model 12 in the 5250 Information Display System. See the heading *Description of General SNA Terms Used in This Manual* under the heading *Overview of the 5250 Implementation of SNA* in Section 1.

SNA (System Network Architecture). The description of the logical structure, formats, protocols, and operational sequences for transmitting information units through the communications system.

SS (supervisory services). The network control program supervisor code that provides miscellaneous services, such as the communications adapter interface, starting channel outputs, controlling timer operations, and data manipulation and utility services.

switched virtual circuit. A switched virtual circuit is the packet switching service equivalent of a switched line. It allows communication between the 5294 Control Unit and one of several possible hosts. Switched virtual circuits are also known as *virtual calls.*

TH (transmission header). An SNA bit pattern that allows the host system to address data streams to the appropriate LU. See the index entry *TH*.

virtual circuit. A virtual circuit is a logical connection between two DTEs which enables them to exchange information according to a standard communications procedure with the sequence of information preserved. A virtual circuit occupies transmission capacity only when the data is actually being transmitted.

window. The window size is the maximum number of packets that the DTE is authorized to transmit and have outstanding at any given time. It is the basic flow control mechanism in X.25 and protects the network from accepting packets faster than they can be accepted by the remote DTE. The window can also be used by a DTE to prevent transmission of packets from the network if the DTE is unable or unwilling to queue them. A default window size, usually two, is assigned at subscription time. On some networks, this can be altered for a given virtual call.

work station. Either the display station or the printer.

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