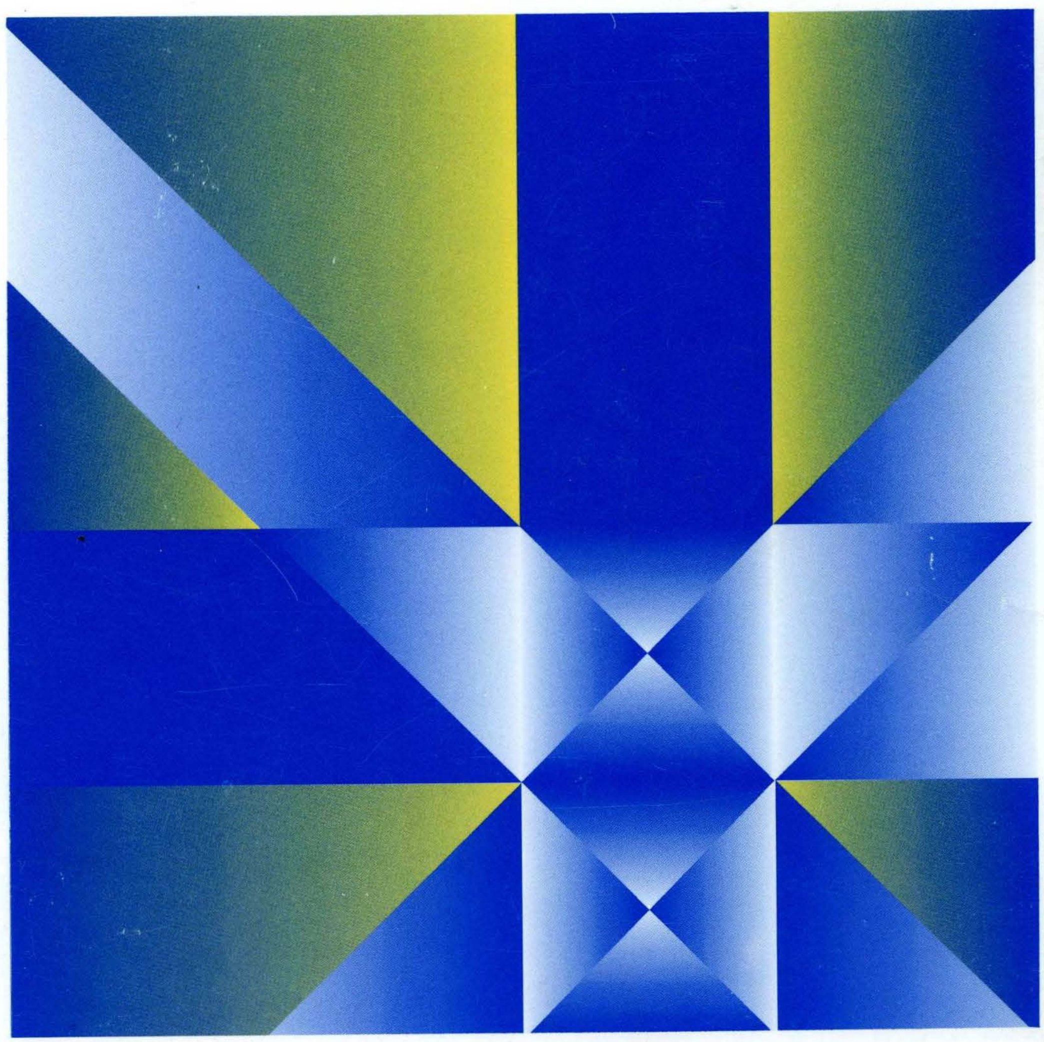
SC30-3533-02

# 5494 Remote Control Unit

## Functions Reference

Release 2.0



5494 Remote Control Unit Functions Reference Release 2.0 SC30-3533-02

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SC30-3533-02

## Functions Reference

Release 2.0

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# Contents

# Figures

# Tables

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# About This Book

This book describes how the IBM* 5494 Remote Control Unit uses Systems Network Architecture (SNA), Synchronous Data Link Control (SDLC), X.25, X.21, or Token-Ring protocols to communicate with the Application System/400* (AS/400*) system. In addition, this book describes how the 5494 manages the attached workstations and converts network data streams into protocols for 5250 workstations and printers.

This book supplies information about the 5494 required by the systems programmer to:

- Generate valid output data streams
- Process input data streams
- Evaluate network error conditions.

## Who Should Read This Book

This book is for the programmer who is familiar with SNA and communication protocols. This book does not contain a comprehensive overview of SNA, SDLC, X.25, X.21, or Token-Ring protocols. To find more information on these subjects, see "Related Publications" on page xxiv.

## How This Book Is Organized

**Chapter 1, Introduction to the 5494 Remote Control Unit**
This chapter briefly describes the 5494 and provides an overview of how the 5494 communicates with both the AS/400 system and workstations.

**Chapter 2, Synchronous Data Link Control Support**
This chapter describes the SDLC support provided by the 5494.

**Chapter 3, X.25 Packet Switched Network Support**
This chapter describes the X.25 support provided by the 5494.

**Chapter 4, X.21 Switched Public Data Network Support**
This chapter describes the X.21 support provided by the 5494.

**Chapter 5, V.25 bis Serial Automatic Calling Support**
This chapter describes the V.25 bis support provided by the 5494.

**Chapter 6, Token-Ring Support**
This chapter provides information about 5494 support for attachment to Token-Ring networks.

**Chapter 7, Type 2.1 Node Support**
This chapter provides information about 5494 support for the Type 2.1 (T2.1) node.

**Chapter 8, Nonprogrammable Workstation Support**
This chapter provides the functional details for nonprogrammable workstation (NWSs) attached to the 5494.

**Chapter 9, Programmable Workstation Support**
This chapter provides the functional details for programmable workstation (PWSs) attached to the 5494.

**Chapter 10, Systems Network Architecture Support**
This chapter describes the SNA support provided by the 5494.

**Chapter 11, Network Management Support**
This chapter discusses the 5494 SNA alert functions and the Response Time Monitor (RTM) features.

**Chapter 12, Display Data Streams**
This chapter describes the format of display data streams supported by the 5494.

**Chapter 13, Keyboard Functions**
This chapter describes the keyboard modes and functions supported by the 5494.

**Chapter 14, Display Pointer Device (Mouse) Support**
This chapter describes the pointer device (mouse) characteristics and functions supported by the 5494.

**Chapter 15, Printer Data Streams**
This chapter describes the format of printer data streams supported by the 5494.

**Chapter 16, Communications Interfaces**
This chapter describes the EIA 232D, X.21, V.35, and Token-Ring physical interfaces supported by the 5494.

**Appendix A, Ideographic Enhancements**
This appendix contains information about ideographic data entry and processing.

## Related Publications

- *IBM 5494 Remote Control Unit Planning Guide*, GA27-3936
- *IBM 5494 Remote Control Unit User's Guide*, GA27-3960
- *IBM 5494 Problem Determination Quick Reference*, GA27-3909
- *IBM 5494 Remote Control Unit Maintenance Information*, SY27-0327
- *IBM 5494 Remote Control Unit National Language Support for Arabic*, GA27-3910
- *IBM 5494 Remote Control Unit National Language Support for Hebrew*, GA27-3911
- *Application System/400 Control Language Reference*, SC41-0030
- *Application System/400 Workstation Customization Functions Programmer's Guide and Reference*, SC41-0056
- *Data Communications Concepts*, GC21-5169

- *Systems Network Architecture Advanced Peer-to-Peer Networking Architecture Reference*, SC30-3422
- *Systems Network Architecture Concepts and Products*, GC30-3072
- *Systems Network Architecture Formats*, GA27-3136
- *Systems Network Architecture Format and Protocol Reference Manual: Architectural Logic*, SC30-3112
- *Systems Network Architecture Management Services Reference*, SC30-3346
- *Systems Network Architecture LU 6.2 Reference Peer Protocols*, SN61-0102
- *Systems Network Architecture Technical Overview*, GC30-3073
- *Systems Network Architecture Format and Protocol Reference Manual: Architectural Logic for LU Type 6.2*, SC30-3269
- *Synchronous Data Link Control Concepts*, GA27-3093
- *The X.25 Interface for Attaching SNA Nodes to Packet Switched Data Networks, General Information Manual*, GA27-3345
- *The X.25 1984/1988 Interface for Attaching SNA Nodes to Packet Switched Data Networks, General Information Manual*, GA27-3761
- *IBM Implementation of X.21 Interface, General Information Manual*, GA27-3287
- *IBM Cabling System Planning and Installation Guide*, GA27-3361
- *IBM Local Area Network Technical Reference*, SC30-3383
- *IBM Token-Ring Network Architecture Reference*, SC30-3374.

# Summary of Changes

## Third Edition (November 1993)

This manual supports the IBM 5494 Remote Control Unit Release 2.0.

Throughout this manual, independent workstation (IWS) is changed to programmable workstation (PWS), and dependent workstation (DWS) is changed to nonprogrammable workstation (NWS).

Where applicable, information has been added for:

- Twinaxial Expansion Kit support for 56 workstations through 8 twinaxial ports on a Model 001 and Model 002
- Token-Ring Upgrade Kit support for up to 80 workstations on a Model 002
- AS/400 Version 2 Release 3 support
- Programmable workstation (PWS) Utility Program enhancements that allow the selection of Concurrent Diagnostics mode without input from the operator panel and the support of resetting and restarting the 5494 from a PWS
- Enhanced performance including a maximum request/response unit (RU) size of 1024 bytes
- Improved system availability through continuous logical session connection retries
- Support of AS/400-initiated PWS sessions between the AS/400 and a PWS attached to the 5494
- Farsi language support using the Arabic Keyboard Translation Table (KTT)
- Write Data structured field and Programmable Mouse Buttons structured field display data stream commands
- Word Wrap entry field and Ideographic Continued entry field capability in the display data stream
- 5494 support for 3486, 3487 and 3488 displays with a pointer device (mouse).

Technical changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

# Chapter 1. Introduction to the 5494 Remote Control Unit

This chapter briefly describes the IBM* 5494 Remote Control Unit and provides an overview of how the 5494 communicates with both the Application System/400* (AS/400*) system and workstations.

## Description of the 5494

The 5494 controls communication between the workstations and the AS/400 system. Using the 5494, one AS/400 system can serve the local site, as well as multiple remote sites.

In addition to being a communication controller, the 5494 is an editing controller. As an editing controller, the 5494 processes:

- Display data streams from the AS/400 system to workstation displays
- Keystrokes from the workstations
- Print data streams from the AS/400 system to printers
- Ideographic character data streams from ideographic workstations to the AS/400 system.

This local processing improves response time and reduces the processing load on the AS/400 system.

## 5494 Communication with the AS/400 System

The 5494 communicates with the AS/400 system through a Type 2.1 (T2.1) connection using any of the following physical interfaces:

- EIA 232D (V.24/V.28)
- V.35
- X.21
- Token-Ring.

The 5494 supports the following communication protocols for link establishment and end-to-end communication with the AS/400 system:

**X.21 switched** For automatic call establishment when using an X.21 physical interface.

**V.25 bis** For automatic call establishment when using an EIA 232D (V.24/V.28) physical interface.

**SDLC** For end-to-end link communication with the AS/400 system.

**X.25** For communication with the AS/400 system through a packet switched network.

**Token-Ring** For establishing communication using the Token-Ring interface.

**SNA** For exchange of information with the AS/400 system. The 5494 communicates with the AS/400 through Systems Network Architecture (SNA) LU 6.2 sessions. For programmable workstations (PWSs), the 5494 supports end node pass-through. For nonprogrammable workstations (NWSs), the

5494 encapsulates SNA LU 4 printer sessions and SNA LU 7 display sessions within SNA LU 6.2 sessions.

## Communications Network Options

For the 5494, the interface with the communications network includes transceiver electronics inside the 5494, a physical connector at the back of the 5494, a communications cable, and either a modem or data circuit-terminating equipment (DCE) that is external to the 5494. Although all models use the same 26-pin connector block at the back of the 5494, each type of communications cable has a different combination of signal lines. For the 5494 Model 002, a Token-Ring network interface includes an adapter card, a communications cable, and a multistation access unit that is external to the 5494.

The 5494 can attach to several different types of communication networks. All models are equipped with a communication cable that attaches the 5494 to a modem or DCE. Model 002 is also equipped with a Token-Ring cable. Table 1-1 shows the interface requirements, communication protocols, and corresponding 5494 cable type for each of these networks. The 5494 always uses SNA protocols in its operation. For more information about network services and requirements, contact individual network suppliers.

*Table 1-1. Networks Supported by the 5494*

| Network | Interface Requirements | Communication Protocol | 5494 Cable Type |
|---|---|---|---|
| Analog switched or leased | EIA 232D interface with synchronous modem | SDLC or V.25 bis/SDLC [1] | EIA 232D |
| X.21 Public Data Network switched or leased | EIA 232D interface with X.21 bis DCE | SDLC | EIA 232D |
| X.25 Packet Switched Network | V.24/28 interface with X.21 bis DCE | X.25 | EIA 232D |
| X.21 Public Data Network leased | X.21 interface with X.21 DCE | SDLC | X.21 |
| X.21 Public Data Network switched | X.21 interface with X.21 DCE | X.21/SDLC [2] | X.21 |
| X.25 Packet Switched Network | X.21 interface with X.21 DCE | X.25 | X.21 |
| High-Speed Analog | V.35 interface | SDLC | V.35 |
| Fractional T1 | V35 Interface with Fractional T1 Multiplexer | SDLC | V.35 |
| Dataphone Digital Service | V.35 interface with Data Service Unit (DSU) | SDLC | V.35 |
| X.21 Public Data Network switched or leased | V.35 interface with X.21 bis DCE | SDLC | V.35 |
| X.25 Packet Switched Network | V.35 interface with X.21 bis DCE | X.25 | V.35 |
| Token-Ring Network | Token-Ring IEEE 802.5 | Token-Ring IEEE 802.2 | Token-Ring |

[1] V.25 bis protocols establish connection with the AS/400 system. Synchronous Data Link Control (SDLC) protocols transfer data between the AS/400 system and the 5494.

[2] X.21 protocols establish connection with the AS/400 system. SDLC protocols transfer data between the AS/400 system and the 5494.

## Communication with Workstations

The 5494 Model 001 can have up to two Twinaxial Workstation Attachment cables with up to eight twinaxial ports for attaching 5250 workstations. A maximum of seven workstations can be attached to any port, for a maximum of 56 workstations. The 5494 Model 002 contains a Token-Ring adapter that allows either of the following:

- Attachment of the 5494 to a Token-Ring network that is attached to the AS/400 system (Token-Ring AS/400 Attachment configuration)
- Attachment of workstations on a Token-Ring network to a 5494 (Token-Ring Gateway configuration).

In a Token-Ring Gateway configuration, the 5494 Model 002 supports as many as 80 nonprogrammable workstations (NWSs) or programmable workstations (PWSs). As many as 56 of these workstations can be attached to the 5494 through twinaxial ports if the Twinaxial Expansion Kit is installed, or 28 workstations if it is not. The remainder (or all 80 workstations) can be attached to a Token-Ring Network. The Token-Ring Upgrade Kit is required for support of 80 devices. Otherwise, 40 devices are supported.

Refer to the *5494 Remote Control Unit Planning Guide* for information about suggested configurations and additional device support.

# Chapter 2. Synchronous Data Link Control Support

SDLC is a protocol that manages code-transparent, serial-by-bit information transfer between nodes that are joined by data links. SDLC supports data transmission in only one direction at a time (referred to as half-duplex transmission). The 5494 is always the secondary station and the AS/400 system is the primary station.

The link connection can be a point-to-point or multipoint configuration. A point-to-point link can be leased or switched. SDLC includes comprehensive detection and recovery procedures for transmission errors that may occur on the link.

This chapter describes only those components of SDLC implemented in the 5494. For a comprehensive description of SDLC, refer to *Synchronous Data Link Control Concepts*.

**Note:** In this book, all data strings are presented with the most significant byte on the left. Byte and bit numbers are also written from left to right beginning with byte 0 bit 0 as the most significant bit.

## Physical Line Attachment Considerations

The following information provides an overview of SDLC line attachment options.

## Physical Lines Supported

The 5494 supports SDLC over the following types of communications lines:

Leased through the following interfaces:

| Physical Interfaces | Line Speeds |
|---|---|
| EIA 232D (CCITT V.24/V.28) | 2400 through 19200 bps |
| CCITT V.35 | 2400 through 128000 bps |
| CCITT X.21 | 2400 through 128000 bps |

Switched through the following interfaces:

| Physical Interfaces | Line Speeds |
|---|---|
| EIA 232D (CCITT V.24/V.28)[1] | 2400 through 19200 bps |
| CCITT V.35 | 2400 through 128000 bps |
| CCITT X.21[2] | 2400 through 128000 bps |

1 Automatic call procedures using the V.25 bis protocol can be used to establish a connection on a switched line. Once the end-to-end connection is made, SDLC protocols are used for link communications. For a detailed description of V.25 bis auto-dial protocol support, see Chapter 5, "V.25 bis Serial Automatic Calling Support."

2 Automatic call procedures using the X.21 switched protocol are used to establish a connection. Once the end-to-end connection is made, SDLC protocols are used for link communications. For a detailed description of X.21 switched protocol support, see Chapter 4, "X.21 Switched Public Data Network Support."

## Zero-Bit Insertion

The 5494 communications adapter performs zero-bit insertion/deletion on transmitted and received frames in order to maintain the uniqueness of beginning and ending flags.

## DCE Support

The 5494 supports only synchronous DCEs (modems). Synchronous DCEs provide the transmit and receive clocks for the data terminal equipment (DTE).

## Transmission Encoding

The 5494 supports both non-return-to-zero (NRZ) and non-return-to-zero inverted (NRZI) encoding of transmitted and received data. NRZ/NRZI operation is set in user configuration.

NRZI encoding is needed for certain DCEs to prevent extended periods of transitionless data due to transmission of contiguous 0 bits. NRZ is recommended for use on digital networks and with digital DCEs.

For NRZ/NRZI considerations during V.25 bis call setup, see Chapter 5, "V.25 bis Serial Automatic Calling Support."

## Automatic Retraining Sequences

Certain DCEs (modems) drop their ready for sending (RFS) signal during an automatic retraining sequence.

The 5494 tolerates the loss of the RFS signal for up to 10 seconds on a duplex point-to-point line.

## Switched Network Considerations

The following sections discuss considerations for switched network communications.

## Operator Network Interface

SDLC is designed to provide end-to-end communication services and requires links between all participating stations to be active and in their data-transfer state.

SDLC does not provide switched-link call placement services. The 5494 does, however, support two forms of call placement to use with SDLC, depending on the network used, and the modem or DCE used to effect data transfer. These services are:

- X.21
- V.25 bis.

Table 1-1 on page 1-2 shows the configurations supporting each of these circuit-switched protocols. Chapter 4, "X.21 Switched Public Data Network Support" describes the functional and operational characteristics of the X.21 protocol. Chapter 5, "V.25 bis Serial Automatic Calling Support" describes those associated with the V.25 bis protocols.

For detailed information on using the operator network interface, refer to the *IBM 5494 Remote Control Unit User's Guide*.

## Switched Line Connection Sequence

The connection sequence occurs following startup and following any disconnection of the line.

The 5494 supports two switched network connection modes. The chosen mode is set during user configuration. The 5494 and the attached DCE must support the same connection modes.

**Data Terminal Ready (DTR) (108.2):** In this mode, the 5494 enables the DTR signal to indicate the 5494's readiness to accept a call or to enter a data-transfer state. The 5494 then monitors the line at 50-millisecond intervals for an enabled data set ready (DSR) signal that indicates entry into a data-transfer state. To guard against DSR bounce conditions, DSR operation is monitored for a minimum of 50 milliseconds.

**Connect Data Set to Line (CDSTL) (108.1):** In this mode, the 5494 waits for an enabled calling indicator (CI) that shows the presence of an incoming call, or for an enabled DSR that indicates the DCE's readiness to enter into the data-transfer state. After monitoring for a bounce condition (20 milliseconds for CI, 50 milliseconds for DSR), the 5494 enables the CDSTL line and waits for DSR, if DSR is not already on. DSR must be turned on within 10 seconds of the time that CI is turned on for a call to be accepted.

## Switched Line Disconnection

The 5494 drops DTR and request to send (RTS) to initiate a switched line disconnection in the following situations:

- Immediately after receiving an SDLC Disconnect (DISC) command and returning an unnumbered acknowledgment (UA) response.
- Following a Receive or Transmit inactivity timeout. For more information, see "Timeout Conditions" on page 4-6.
- Following the loss of the DSR signal from the DCE (modem).

## Echo Suppressors and Cancelers

A 500-millisecond line quiet period is provided before enabling the RTS signal each time a call is attempted on a half-duplex switched line. This is done to enable any echo suppressors used in the circuit.

A 500-millisecond white noise transmission period is provided after activating RTS and before transmitting data each time a call is attempted on a switched line. This is done to allow time for any echo cancelers in the transmission path to converge.

## X.21 Network Considerations

The following additional network considerations are valid for SDLC operation on an X.21 public network:

**Support Characteristics**: SDLC operation on an X.21 leased network through the X.21 or X.21 bis interface is supported through a duplex point-to-point or multipoint connection.

**Ready State**: The DCE-ready state or activation of the indicate (I) signal shows that the DCE is ready for operation. The 5494 presents the DTE-ready state to show that it is ready for operation and activates the control (C) signal to indicate readiness for transmission.

**Multipoint Operation**: For multipoint operation on an X.21 interface, the 5494 waits for a minimum of 24 bit-times between setting the control (C) signal active and transmission of data.

## SDLC Transmissions

All transmissions using SDLC are carried in frames. The frame contains all the commands, responses, and information that are being transmitted. Frames are transmitted one at a time or grouped together and sent in a sequence.

If frames are transmitted one at a time with the poll bit set, response frames are returned by the receiving station for each frame received. If a sequence of frames is transmitted, the poll bit is set only in the last frame and the receiving station responds only after receiving the last frame in the sequence.

When transmitting sequenced frames, the transmitting station counts and numbers each frame. This count is the Ns count. The station receiving the sequenced frames counts each error-free frame it receives. This count is the Nr count.

The Ns and Nr counters start at 0 and count through 7. When the counter is at 7 and another frame is counted, the counter advances to 0.

## Frame Format

Figure 2-1 shows the organization of an SDLC frame. The transmission frame is bounded by a unique flag sequence. The 5494 recognizes the transmission of continuous flags as interframe time fill.

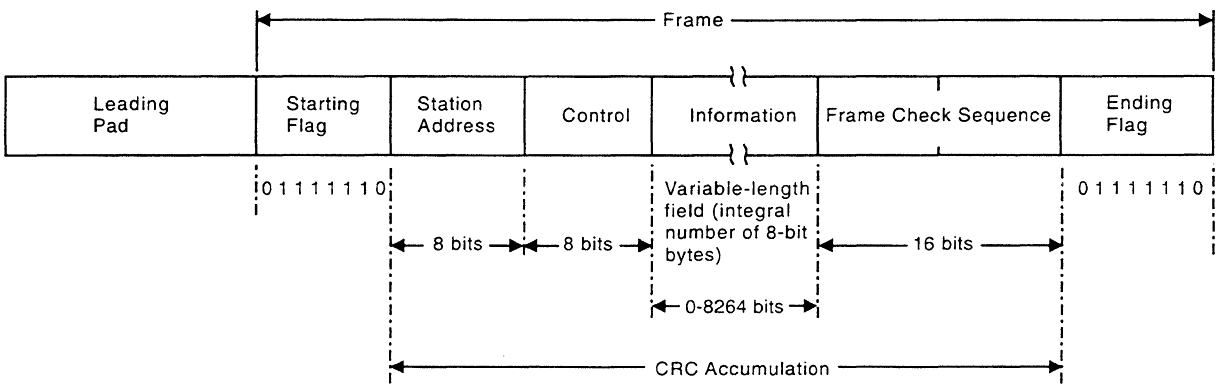



*Figure 2-1. SDLC Frame Organization*

## Leading Pad

This field, although not a part of the SDLC frame, is shown here because of its relationship with the frame. When the *leading pad required* bit is set in the configuration record, the SDLC adapter inserts a synchronization byte into the data stream before the starting flag sequence. The leading pad byte is used to obtain or maintain synchronization of the modem clock following a line turnaround.

## Starting Flag

The starting flag starts the frame. The starting flag also causes transmission error checking to start with the first nonflag character. It is made up of 8 bits with a configuration of X'7E' (B'01111110'). This flag serves as a reference to show the position of the address and the control fields.

## Address Field

The address (A) field of the SDLC frame always contains the network address of the 5494, whether the 5494 is transmitting to or receiving from the AS/400 system. The 5494 recognizes and responds to a broadcast address (all bits set) as well as to its own network address.

## Control Field

The control (C) field of an SDLC frame defines the frame's function. The 5494 supports three types of SDLC commands and responses:

- Unnumbered commands and responses
- Supervisory commands and responses
- Sequenced information (I) frames.

See "SDLC Commands" on page 2-7 for a description of the control field encoding for each of these frame types.

The 5494 supports modulo 8 frame numbering and an 8-bit control field. The 5494 does not support modulo 128 frame numbering or the extended (16-bit) control field format.

## Information Field

The information (I) field is not present in all frames. The I-field can be of variable length, but it is restricted to an integral number of 8-bit bytes and by the buffering limits of the stations communicating with each other. Maximum I-field length is specified in the XID command and response sequence (1033 bytes for the 5494). The I-field contains the data to be moved over the data link from place to place in the network. The data in this field is checked for validity by the frame check sequence field.

## Frame Check Sequence

SDLC uses a bit accounting method called cyclic redundancy check (CRC) to ensure data validity. The transmitting unit applies a mathematical formula to the A-, C-, and I-fields of the frame and places the 16-bit result in the frame check sequence (FCS) field prior to transmission. The receiving unit applies the same formula and compares the results. If the result differs from the transmitted FCS, the receiving unit discards the frame. The erroneous frame and all subsequent frames are retransmitted. Refer to *Synchronous Data Link Control Concepts* for the FCS-generating polynomial and its applications.

## Ending Flag

The ending flag ends the frame and transmission error checking. It is made up of 8 bits with a configuration of X'7E' (B'01111110'). When more than one frame is transmitted, the ending flag of one frame can also be the starting flag of the next frame.

## SDLC Commands

The 5494 supports three types of SDLC commands. Some commands contain information unique to the 5494.

## Supported Command Types

The 5494 supports the following types of SDLC commands:

**Unnumbered commands and responses**: These commands handle mode setting, reporting, and transmission tests.

**Supervisory commands and responses**: These commands are responsible for traffic management. They acknowledge sequenced I-frames and indicate when the receiving station is ready to accept additional frames.

**Information frames**: These frames carry the SNA information.

Figure 2-2 shows the control field format and application of each supported SDLC frame.

| Format[1] | Binary Configuration Sent Last | Poll/Final Bit | Sent First | Acronym | Command | Response | I-field Prohibited | Resets Nr and Ns | Confirms Frames Through Nr-1 | Definitions |
|---|---|---|---|---|---|---|---|---|---|---|
| U | 100 | P | 0011 | SNRM | X | | X | X | | Set Normal Response mode. |
| U | 000 | F | 1111 | DM | | X | X | | | Disconnected mode. This station is offline. |
| U | 010 | P | 0011 | DISC | X | | X | | | Disconnect. Enter Normal Disconnect mode (go on hook if switched). |
| U | 010 | F | 0011 | RD | | X | X | | | Request Disconnect. This station wants to disconnect. |
| U | 011 | F | 0011 | UA | | X | X | | | Unnumbered Acknowledgment. Acknowledge U commands. |
| U | 100 | F | 0111 | FRMR | | X | | | | Frame Reject. Invalid command received; must receive SNRM or DISC to reset FRMR condition. |
| U | 101 | P/F | 1111 | XID | X | X | | | | Exchange Station Identification. |
| U | 111 | P/F | 0011 | TEST | X | X | | | | Test. Used to test a link. The I-field may contain test data. |
| S | Nr | P/F | 0001 | RR | X | X | X | | X | Receive Ready. The sender is ready to receive. |
| S | Nr | P/F | 0101 | RNR | X | X | X | | X | Receive Not Ready. The sender is not ready to receive. |
| I | Nr | P/F | Ns 0 | I | X | X | | | X | Sequenced I-frame. |

[1] U = unnumbered, S = supervisory, I = information.

*Figure 2-2. SDLC Commands and Responses*

# Commands Containing 5494 Information

The XID, FRMR, TEST, and I-frame commands contain data that is unique to the 5494 in the information field.

## XID Command

The 5494 accepts a null XID command (that is, an XID command with no I-field) or an XID3 command, and responds with an XID3 response. For more information, see Chapter 7, "Type 2.1 Node Support."

## FRMR Command

Frames received with a valid FCS can still be erroneous. The 5494 considers frames not valid if:

- The C-field specifies a command that is unsupported or not valid
- The I-field was too long to fit into the receiving station buffers
- An I-field was included with a command in which I-fields are not allowed
- A sequenced I-frame was received with an unexpected sequence number.

After receiving a frame that is not valid, the 5494 returns a FRMR command stating the cause. The FRMR command is sent with a 3-byte description of the frame that is not valid immediately following the control field. Table 2-1 shows the format for the FRMR response.

*Table 2-1. FRMR Format*

| Byte | Description |
|---|---|
| 0 | The C-field of the rejected frame |
| 1 | B'Nr \0 \Ns \0':<br>Nr = The 3-bit receive count prior to the rejected frame<br>Ns = The 3-bit send count prior to the rejected frame |
| 2 | B'0000zyxw'<br>z = Sequencing error<br>y = I-field longer than that supported by the 5494 (>1033 bytes)<br>x = Illegal I-field is present<br>w = Unsupported command or command that is not valid has been received |

## TEST Command

The TEST command is sent by the AS/400 system to solicit a TEST response from the 5494. This command may contain an optional I-field (up to 521 bytes). The 5494 returns a TEST response containing a copy of this I-field.

## I-Frame Command

The I-frames contain the SNA path information units (PIU). For more information about the contents of the I-frame, see Chapter 10, "Systems Network Architecture Support."

## Timeout Error Recovery

The 5494 tracks the following SDLC timeout conditions:

**Receive Inactivity Timeout:** If 30 seconds elapse without receiving an SDLC frame, the 5494 checks the interface. The DSR signal and the clock signals are verified. If either is inactive, the 5494 goes to Normal Disconnected mode and posts an operator error.

**Transmit Inactivity Timeout:** If the 5494 is unable to transmit its response within 30 seconds because of a link problem (DSR, RFS or Clear to Send [or CTS], or clock signal inactive), it goes to Normal Disconnected mode and posts an operator error.

**Note:** Link recovery can be initiated by the primary station only.

For more information about SDLC, refer to *Synchronous Data Link Control Concepts*.

## Error Reporting

Because SDLC provides its own error recovery system, recoverable errors are not reported directly to the operator. However, the 5494 maintains statistical counters. The AS/400 system requests the counters and the 5494 reports them with the SNA commands REQMS and RECFMS, respectively. For more information on these commands, see Chapter 10, "Systems Network Architecture Support." For more information concerning the 5494 error handling strategy and error summary, refer to the *IBM 5494 Remote Control Unit User's Guide*.

## Operating Modes

SDLC supports two operating modes:

**Normal Response mode (NRM)**: The 5494 is in NRM after receiving a set normal response mode (SNRM) command from the AS/400 system. I-frames are exchanged in this mode.

**Normal Disconnected mode (NDM)**: The 5494 is in NDM after receiving a DISC command from the AS/400 system. Once in this mode, the 5494 responds only to SNRM, XID, DISC, and TEST commands. The 5494 returns a disconnected mode (DM) response to all other commands until an SNRM is received.

# Chapter 3. X.25 Packet Switched Network Support

X.25 uses a communications process called packet switching, which routes and transfers user data and control information. The information transmitted is contained in packets that identify the sender and receiver by a unique address. The communication line within the X.25 network is busy only during the transmission of a packet. Once this operation is accomplished, the line is released for the use of other packets.

Packet switched data networks (PSDNs), such as an X.25 network, allow multiple users to share communication lines or channels. PSDNs are an alternative to networks made up of lines dedicated to a pair of users or multiple users.

The 5494 includes support for attachment to X.25 PSDNs. Unless specifically stated in this book, the 5494 adheres to the following standards:

- CCITT Recommendation X.25 "Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Terminals Operating in the Packet Mode and Connecting to Public Data Networks by Dedicated Circuit," Geneva 1976 and 1980, Malga-Torremolinos 1984, Melbourne 1988
- *The X.25 Interface for Attaching SNA Nodes to Packet Switched Data Networks, General Information Manual*
- *The X.25 1984/1988 Interface for Attaching SNA Nodes to Packet Switched Data Networks, General Information Manual.*

**Note:** In this book, all data strings are presented with the most significant byte on the left. Byte and bit numbers are also written from left to right beginning with byte 0 bit 0 as the most significant bit.

## X.25 Functional Support

The X.25 PSDN uses four communication levels to facilitate the transport of user data and control information between DTE. The 5494 and the AS/400 system are referred to as DTEs in the PSDN's naming convention.

The four levels of an X.25 PSDN are responsible for the following functions:

**X.25 Physical Level**: The mechanical, electrical, functional, and procedural characteristics needed to activate, maintain, and deactivate the physical link between DTE and DCE.

**X.25 Link Level**: The link access procedure for the interchange of data across the link between DTE and DCE.

**X.25 Packet Level**: The packet format and control procedure for the exchange of packets containing control and user data between DTE and DCE.

**X.25 Logical Link Control (LLC) Level**: The level that provides enhanced capabilities above the packet level. These capabilities include link connection and disconnection between DTEs, link test, operational mode selection, and identification exchange between DTEs.

## X.25 Optional Facilities

The 5494 supports the following X.25 optional facilities:

- Throughput class negotiation
- One-way logical channel outgoing
- One-way logical channel incoming
- Incoming calls barred
- Outgoing calls barred
- Closed user group selection
- Reverse charge acceptance
- Extended packet sequence numbering
- Flow control parameter negotiation
- Nonstandard default packet sizes
- Nonstandard default window sizes
- Local charging prevention
- Network user identifier
- Hunt group
- Call redirection
- Called line address modified notification
- Call redirection notification
- Recognized private operating agency (RPOA) selection.

As needed, the 5494 supports the following facilities:

- Reverse charge acceptance
- Closed user group selection
- Throughput class negotiation
- Minimum transit delay selection and indication
- Calling DTE address extension
- Called DTE address extension
- Priority.

## X.25 Physical Level

The 5494 supports the following X.25 physical interfaces and line speeds:

| Physical Interfaces | Line Speeds |
|---|---|
| V.24/V.28 (X.21 bis) | 2400 through 19200 bps |
| V.35 (X.21 bis) | 2400 through 128000 bps |
| X.24/X.27 (X.21) | 2400 through 128000 bps |

## X.25 Link Level

The link-level procedure used to control the state of the DTE to DCE interface is link access protocol-balanced (LAPB). LAPB is a subset of high-level data link control (HDLC) as specified by the International Organization for Standardization (ISO), Class BA with options 2 and 8. Figure 3-1 on page 3-3 shows the format of a LAPB frame. The flag and frame check sequence fields are functionally equivalent to the same components of an SDLC frame. See "Frame Format" on page 2-5 for a description of these fields. The station address and control fields for X.25 are defined in the following sections. When a data packet contains an LLC information frame, the LLC data field contains an SNA PIU. For more information about the PIU, see "SNA LU 4 and LU 7 Path Information Unit" on page 10-12.

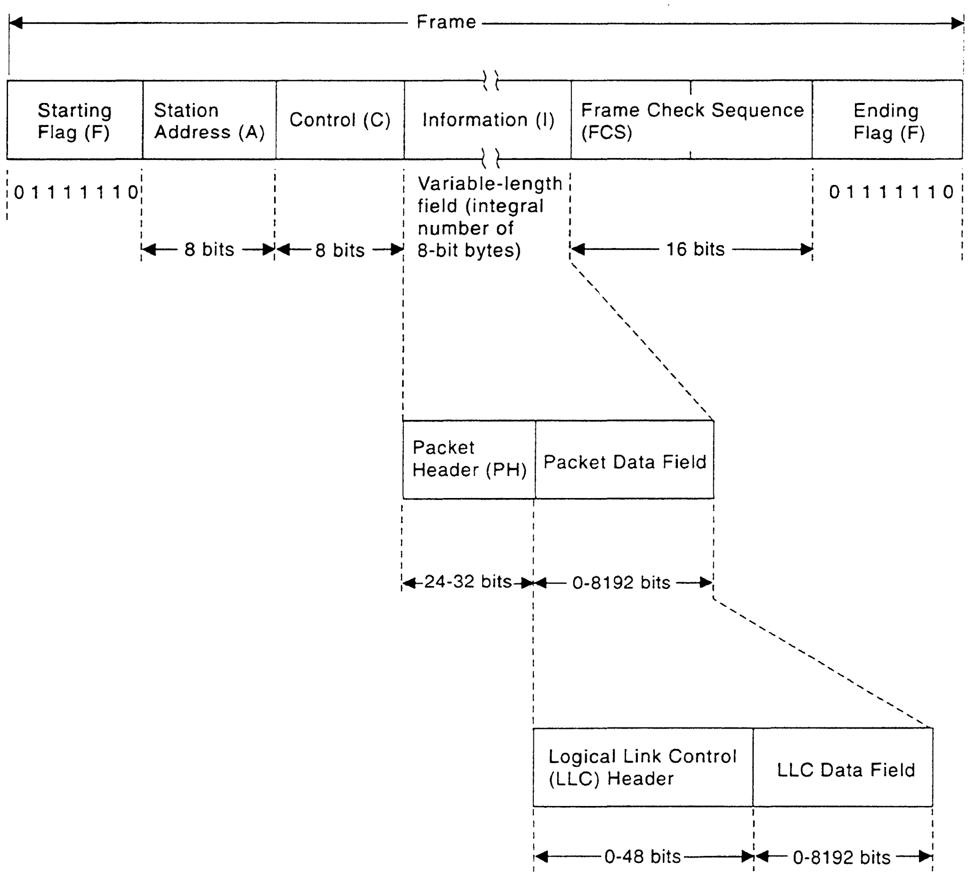



*Figure 3-1. LAPB Frame Format*

# LAPB Addressing

Because the LAPB exchange is between the 5494 and its DCE, the address field is used differently than in SDLC. The 5494 transmits a frame with X'01' in the address field if it is a command and X'03' if it is a response. The DCE transmits an address field of X'03' with commands and X'01' with responses.

# LAPB Commands

At the link level, the 5494 supports three types of frames. These are:

- Unnumbered frames
- Supervisory frames
- Information frames.

These frame types are similar to SDLC frame types. However, they govern only the exchange of information between the 5494 and its DCE. End-to-end logical link control is handled at the LLC layer and is transparent to the LAPB commands and responses. The LAPB commands are encoded into the control field as they are in SDLC. Figure 3-2 on page 3-4 lists the supported LAPB commands and responses and provides the control field encoding for the LAPB frames.

| Format[1] | Binary Configuration Sent Last | Poll/Final Bit | Sent First | Acronym | Command | Response | I-field Prohibited | Resets Nr and Ns | Confirms Frames Through Nr-1 | Definitions |
|---|---|---|---|---|---|---|---|---|---|---|
| U | 001 | P | 1111 | SABM | X | | X | X | | Set Asynchronous Balanced mode. |
| U | 000 | F | 1111 | DM | | X | X | | | Disconnected mode. This station is in disconnected state. |
| U | 010 | P | 0011 | DISC | X | | X | | | Disconnect. Enter normal disconnect mode. |
| U | 011 | F | 0011 | UA | | X | X | | | Unnumbered Acknowledgment. Acknowledge U commands. |
| U | 100 | F | 0111 | FRMR | | X | | | | Frame Reject. Invalid frame received, Nr count out of range, I-field too long, or I-field present when not allowed. |
| S | Nr | P/F | 0001 | RR | X | X | X | | X | Receive Ready. The sender is ready to receive. |
| S | Nr | P/F | 0101 | RNR | X | X | X | | X | Receive Not Ready. The sender is not ready to receive. |
| S | Nr | P/F | 1001 | REJ | X | X | X | | X | Reject. Request retransmission of I-frames, starting with frame numbered Nr. |
| I | Nr | P | Ns 0 | I | X | | | | X | Sequenced I-frame. |

[1] U = unnumbered, S = supervisory, I = information.

*Figure 3-2. LAPB Command Summary*

# Link Initialization and Reconnection

The 5494 can be configured to initialize a link at startup, wait for an operator action, or wait for the network to initialize the link.

If your configuration parameters indicate single permanent virtual circuit (PVC) or switched virtual circuit (SVC) Answer-Only with no manual options, the 5494 starts the link initialization sequence without any operator action. For other configurations, the operator must manually start the initialization sequence.

Table 3-1 shows how the 5494 starts link initialization for each of several different DCE polling conditions.

*Table 3-1. Link Initialization Sequence under Different DCE Polling Conditions*

| Polling Condition | Link Initialization Sequence |
|---|---|
| DCE does not poll | 5494 waits T1 [1] seconds, then sends one or more SABMs. [2] Upon UA response, 5494 is in link active state. |
| DCE polls with SABM [2] | 5494 sends UA response and goes to link active state. |
| DCE polls with DM (final bit=0) | 5494 sends SABM. [2] Upon UA response, 5494 is in link active state. |
| DCE polls with DISC | 5494 sends DM response, then waits T1 [1] seconds. If no response, 5494 sends SABM. [2] Upon UA response, 5494 is in link active state. |

1 T1 is a configurable time interval.
2 The 5494 continues sending set asynchronous balanced mode (SABM) commands at a configurable time interval until the DCE responds or the configured retry value expires.

The 5494 also starts link initialization to reconnect the link whenever the link layer goes down due to one of the following conditions:

- The link is in an active state, and the 5494 receives a DISC command.
- The link is in an active state, and the 5494 receives a disconnect mode (DM) response.
- The link is in a disconnected state, and both of the following occur:
  - The 5494 receives a UA/F, DM/F, or SABM.
  - The 5494 is not configured for multiple PVCs or SVCs.

## X.25 Packet Level

The X.25 packet is carried in the information field of a LAPB I-frame. (See Figure 3-1 on page 3-3.) The 5494 supports several different packet types that are used for establishing and clearing calls, recovering from errors, and transferring data to and from the AS/400 system. Supported packet sizes include 64, 128, 256, 512, and 1024 bytes.

At the packet level, two classes of services are defined:

**PVC**: These circuits appear to the DTE as dedicated or leased lines.

**SVC**: These circuits appear to the DTE as switched lines and allow the placement of virtual calls to other DTEs on the network.

# Basic Structure of Packets

Packets transferred across the DTE/DCE interface consist of at least three *octets*. An octet is a unit of information consisting of eight binary digits. These three octets contain a general format identifier (GFI), a logical channel identifier (LCI), and a packet-type identifier (PTI). Other fields are appended to packets as required.

**Note:** In this book, all data strings are presented with the most significant byte on the left. Byte and bit numbers are also written from left to right beginning with byte 0 bit 0 as the most significant bit.

Figure 3-3 shows the general structure of an X.25 packet.

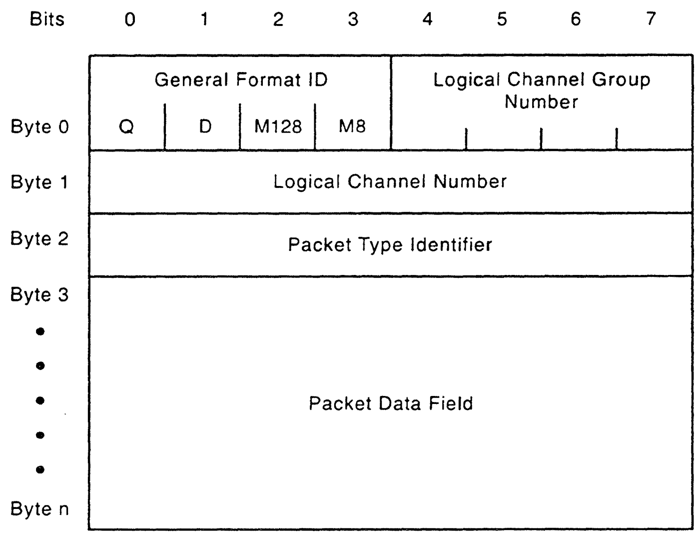



*Figure 3-3. General Packet Structure*

# General Format Identifier

**Bit 0 (Q Bit)** is used only when qualified logical link control (QLLC) is selected. This bit is set to 1 to denote a logical control packet. The Q bit is always 0 when other LLC protocols such as enhanced logical link control (ELLC) are used.

**Bit 1 (D Bit)** indicates Delivery Confirmation Requested. IBM DTEs do not support delivery confirmation. This bit is always set to 0 in packets sent by the 5494. If a packet is received with the D bit set, a Clear Request or Reset Request packet is sent with diagnostic code X'E9' (D bit setting is not valid).

**Bits 2 and 3 (M128 and M8 Bits)** are used to indicate that either modulo 128 or modulo 8 sequence numbering is being used at the packet level. This is a customer setup parameter. Bit 2 is set for modulo 128 operation, and bit 3 is set for modulo 8 operation. Bit 2 and bit 3 are mutually exclusive.

## Logical Channels

The 5494 can communicate over only one virtual circuit (either PVC or SVC) at a time. Packets received by the 5494 on any channel other than the one currently in use are discarded with no response. The 5494 does not support data transfer on channel 000.

## Packet Type Identifier

Table 3-2 summarizes the packet types supported by the 5494 and provides the PTI encoded in byte 2.

*Table 3-2. Supported Packet Types*

| DCE to DTE | | DTE to DCE | | Service | |
|---|---|---|---|---|---|
| **PTI** | **Packet Type** | **PTI** | **Packet Type** | **SVC** | **PVC** |
| X'0B' | Incoming Call | X'0B' | Call Request | X | |
| X'0F' | Call Connected | X'0F' | Call Accepted | X | |
| X'13' | Clear Indication | X'13' | Clear Request | X | |
| X'17' | DCE Clear Confirmation | X'17' | DTE Clear Confirmation | X | |
| X'xx' 1 | DCE Data | X'xx' 1 | DTE Data | X | X |
| X'x1' 2 | Receive Ready (RR) | X'x1' 2 | RR | X | X |
| X'x5' | Receive Not Ready (RNR) | | | X | X |
| X'1B' | Reset Indication | X'1B' | Reset Request | X | X |
| X'1F' | Reset Confirmation | X'1F' | Reset Confirmation | X | X |
| X'FB' | Restart Indication | X'FB' | Restart Request | X | X |
| X'FF' | Restart Confirmation | X'FF' | Restart Confirmation | X | X |
| X'F1' | Diagnostic | X'F1' | | X | X |

1 See Figure 3-4 on page 3-12 and Figure 3-5 on page 3-12 for these values.
2 If modulo 128, bits 0 through 6 represent the P(R) value (the packet receive sequence number). For modulo 8, bits 0 through 2 represent the P(R) value and bits 3 through 6 are set to 0.

The following packet types are not supported by the 5494:

- Interrupt
- Interrupt Confirmation
- Reject
- Registration Request
- Registration Confirmation.

If an Interrupt or Interrupt Confirmation packet is received, the 5494 responds with a Clear Request packet (for SVC) or a Reset Request packet (for PVC) with the X'AA' diagnostic code. If a Reject or Registration packet is received, the 5494 responds with a Clear Request packet (for SVC) with the X'17' diagnostic code or a Reset Request packet (for PVC) with the X'1B' diagnostic code.

## Packet Data Field

The packet data field can contain additional information such as DTE addresses, facility information, cause and diagnostic codes, and call user data.

For more information on data that can be included in the different packet types, refer to *The X.25 Interface for Attaching SNA Nodes to Packet Switched Data Networks, General Information Manual.*

# Packet-Level Functions

The following functions are done at the packet level:

- Call establishment
- Call clearing
- Restart
- Reset
- Information transfer.

## Call Establishment

Call establishment is done through an incoming or outgoing call. Call establishment applies only to SVC operations.

***Incoming Call Packet:*** The DCE indicates an incoming call to the 5494 by transferring an Incoming Call packet across the DTE-to-DCE interface.

If an Incoming Call packet is received while the 5494 is waiting for a response from the DCE to a Call Request packet, the incoming call is discarded.

You may specify a specific logical channel when establishing a link to answer a call. If you specify a specific logical channel through customer setup (CSU) or in the link establishment request, incoming calls on other logical channels are ignored. If you do not specify a specific logical channel, the incoming call is received on the logical channel that was used for the call.

***Call Accepted Packet:*** The 5494 accepts an incoming call by sending a Call Accepted packet that specifies the logical channel indicated in the Incoming Call packet. User data is not included in the Call Accepted packet. The network user identification (NUI) facility is the only facility that may be included in the Call Accepted packet.

If the NUI facility is not included, a calling or called address length and facility field length of X'00' is transmitted.

If the call is not accepted, a Clear Request packet is sent with a cause code of X'80' (or X'00' for CCITT diagnostic codes) and a diagnostic code indicating the reason for clearing.

***Call Connected Packet:*** The 5494 receives a Call Connected packet from the DCE in response to a Call Request packet. The Call Connected packet is received when the call is connected to the AS/400 system.

The 5494 uses the facilities specified in the Call Connected packet. The 5494 does not clear the call if the Call Connected packet facilities do not match the Call Request packet facilities.

If the Call Connected packet is not valid, a Clear Request packet is sent with a cause code of X'80' (or X'00' for CCITT diagnostic codes) and a diagnostic code indicating the reason for clearing.

***Call Request Packet:*** The 5494 initiates a call by issuing a Call Request packet following an operator request. The request can include optional parameters such as window size, packet size, and optional user facilities.

After the 5494 issues a Call Request packet, the circuit remains in the opening state for 200 seconds while waiting for a Call Connected packet from the DCE. If a Call Connected packet is not received in this time period, an error indication is passed to the higher levels and the circuit is cleared. When the circuit is cleared, a Clear Request packet is sent with the diagnostic code X'31' indicating that a Call Connected packet was not received within 200 seconds.

***Call Collision:*** If an Incoming Call packet is received when the 5494 has placed the circuit in the opening state, the 5494 discards the Incoming Call packet and does not issue a Call Accepted packet. After the Incoming Call packet is discarded, the 5494 places the circuit in the call-collision state.

## Call Clearing

Call clearing applies only to SVC operations.

***DTE Clear Request Packet:*** The 5494 issues a clear indication to the DCE by sending a Clear Request packet indicating the logical channel to be cleared. The Clear Request packet is sent with the cause code X'80' indicating DTE-originated clear. If the 5494 is configured for 1980 SNA or ISO, the Clear Request packet is sent with the cause code X'00'. A diagnostic code is sent indicating the reason for clearing.

After issuing a Clear Request packet, the 5494 remains in the clearing state for 200 seconds while waiting for a Clear Confirmation packet from the DCE. If a Clear Confirmation packet is not received in this time period, the Clear Request packet is issued again. If a Clear Confirmation packet is not received the second time, an error indication is passed to the higher levels and a Restart Request packet is issued.

While in the clearing state, the 5494 ignores all packets except the Clear Confirmation and Clear Indication packets.

***DCE Clear Indication Packet:*** When the Clear Indication packet is received from the DCE, the 5494 responds with a Clear Confirmation packet and passes the cause code and diagnostic code to the higher levels.

If the ELLC protocol is used, all cause codes except X'80' (or X'00' for CCITT diagnostic codes) initiate error recovery.

If the QLLC protocol is used, the packet layer is reset and no further action is taken.

***DTE Clear Confirmation Packet:*** This packet is used to acknowledge DCE Clear Indication packets.

***DTE Clear Collision:*** A clear collision occurs when both the 5494 and the DCE simultaneously issue clear packets. When a clear collision occurs, the 5494 does not respond to a Clear Indication packet and continues to wait for a Clear Confirmation packet from the DCE. The circuit returns to the ready state when the Clear Confirmation packet is received.

## Restart

Restarting is used to simultaneously clear all virtual calls and reset all virtual circuits.

***DTE Restart Request Packet:*** A Restart Request packet is transmitted by the 5494:

- After link-level initialization if no Clear or Reset Confirmation packet is received following a Clear or Reset Request packet and retry
- After frame-level resetting is done.

After issuing a Restart Request packet, the 5494 waits for 200 seconds for a Restart Confirmation packet from the DCE. If a Restart Confirmation packet is not received in this time period, the Restart Request packet is issued again. If a Restart Confirmation packet is not received the second time, an error indication is passed to the higher levels and the circuit is disconnected.

The Restart Request packet is sent with the cause code X'80' (indicating DTE-originated clear). The diagnostic code is not used and is always set to X'00'. The cause code is the same as in the Clear Request packet.

After sending a Restart Request packet, the 5494 ignores all packets except the Restart Confirmation and Restart Indication packets.

***DCE Restart Indication Packet:*** The DCE indicates a restart by sending a Restart Indication packet across the interface. The 5494 reports the cause code and diagnostic code in the Restart Indication packet to the higher levels. The 5494 sends a Restart Confirmation packet to the DCE in response to a Restart Indication packet.

If the ELLC protocol is used, all cause codes except X'80' (or X'00' for CCITT diagnostic codes) initiate recovery for PVCs.

***Restart Collision:*** A restart collision occurs when both the 5494 and the DCE simultaneously issue restart packets. When a restart collision occurs, the 5494 does not respond to a Restart Indication packet and does not wait for a Restart Confirmation packet in response to the issued Restart Request packet. The packet level enters the ready state.

## Reset

Resetting is used to reinitialize a PVC. Reset removes all Data packets and resets the packet sequence numbers to 0.

***DTE Reset Request Packet:*** The 5494 uses the Reset Request packet when a packet-level error is detected on a PVC circuit.

After issuing a Reset Request packet, the 5494 remains in the resetting state for 200 seconds while waiting for a Reset Confirmation packet from the DCE. If a Reset Confirmation packet is not received in this time period, the Reset Request packet is issued again. If a Reset Confirmation packet is not received the second time, an error indication is passed to the higher levels and the circuit is returned to the ready state.

The Reset Request packet is sent with the cause code X'80' (indicating DTE-originated clear). If the 5494 is configured for 1980 SNA or ISO, the Reset Request packet is sent with the cause code X'00' and a diagnostic code indicating the reason for resetting.

After sending a Reset Request packet, the 5494 ignores all packets except the Reset Confirmation and Reset Indication packets.

***DCE Reset Indication Packet:*** The DCE indicates a reset to a specified logical channel along with cause code and diagnostic code by sending a Reset Indication packet across the interface. The 5494 reports the cause and diagnostic codes in the Reset Indication packet to the higher levels.

If the ELLC protocol is used, all cause codes except X'80' (or X'00' for CCITT diagnostic codes) initiate recovery for PVCs.

If ELLC recovery is not initiated, the circuit is terminated. If the Reset Indication packet was received on a SVC, the 5494 clears the call with the diagnostic code X'EA' (Reset Indication on Virtual Call).

***Reset Collision:*** A reset collision occurs when both the 5494 and the DCE simultaneously issue reset packets. When a reset collision occurs, the 5494 does not expect a Reset Confirmation packet in response to the issued Reset Request packet. If ELLC is not used, the circuit is returned to the ready state.

## Information Transfer

The following packets are used during information transfer.

***Receive Ready Packet:*** The 5494 sends an RR packet when a data packet is received and no other data packets are waiting to be transmitted. The RR packet also resets a previous busy indication from a received RNR packet.

***Receive Not Ready Packet:*** The 5494 does not send a RNR packet. If the 5494 receives a RNR packet, the 5494 recognizes that the DCE is in a not-ready state and does not send packets until a RR packet is received.

***Data Packet:*** The 5494 sends data packets when the packet-level window is open and the AS/400 system has not sent a RNR packet.

Figure 3-4 shows the format of the data packet when modulo 8 is being used.

| Bits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Byte 0 | General Format ID | | | | Logical Channel Group Number | | | |
| | Q | D | 0 | 1 | | | | |
| Byte 1 | Logical Channel Number | | | | | | | |
| Byte 2 | P(R) [1] | | | M [2] | P(S) [3] | | | 0 |
| Byte 3 | User Data | | | | | | | |

*Figure 3-4. Data Packet Format in Modulo 8*

[1] P(S) = Packet transmitted sequence number used to provide packet-level acknowledgment. Retransmission of acknowledged packets is not supported.

[2] P(R) = Packet receive sequence number used to provide packet-level acknowledgment. Retransmission of acknowledged packets is not supported.

[3] M = More data bit (used for segmentation.)

Figure 3-5 shows the format of the data packet when modulo 128 is being used.

| Bits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Byte 0 | General Format ID | | | | Logical Channel Group Number | | | |
| | Q | D | 1 | 0 | | | | |
| Byte 1 | Logical Channel Number | | | | | | | |
| Byte 2 | P(S) [1] | | | | | | | 0 |
| Byte 3 | P(R) [2] | | | | | | | M [3] |
| Byte 4 | User Data | | | | | | | |

*Figure 3-5. Data Packet Format in Modulo 128*

[1] P(S) = Packet transmitted sequence number used to provide packet-level acknowledgment. Retransmission of acknowledged packets is not supported.

[2] P(R) = Packet receive sequence number used to provide packet-level acknowledgment. Retransmission of acknowledged packets is not supported.

[3] M = More data bit (used for segmentation.)

## Logical Link Control

The 5494 provides the following forms of LLC for use with X.25 PSDNs:

**QLLC**: QLLC employs the qualified data indicator or 'Q bit' in data packets to identify when a QLLC header is present. For data packets that contain end user data (SNA PIUs), a QLLC header is not present and therefore the Q bit is off.

**ELLC**: ELLC uses extended formats in data packets to provide error detection facilities and optional retransmission recovery procedures.

These LLCs are contained only in data packets and provide end-to-end link-level support (similar to SDLC) to the SNA layer.

The type of LLC used during a session is determined in one of the following ways:

- The 5494 operator specifies the LLC type when entering a Call or Answer Request (for SVC) or an Open request (for PVC).
- The default LLC is used when not specified in an Open, Call, or Answer Request. The default LLC is selected during customer setup procedures.

Figure 3-6 lists all of the supported commands and responses for each LLC type and indicates which are transmitted and received by the 5494. Commands and responses with similar functions are listed on the same line along with their SDLC equivalents. For example, LSABME, QSM, and SNRM all control link activation.

| Cmd | | **ELLC** | Resp | | Cmd | | **QLLC** | Resp | | **SDLC Equivalent** |
|---|---|---|---|---|---|---|---|---|---|---|
| T | R | | T | R | T | R | | T | R | |
| √ | √ | LI | | | √ | √ | DATA | √ | √ | I |
| | √ | LSABME | | | | √ | QSM | | | SNRM |
| | √ | LDISC | | | | √ | QDISC | | | DISC |
| | √ | LXID | √ | | | √ | QXID | √ | | XID |
| | √ | LTEST | √ | | | √ | QTEST | √ | | TEST |
| | | LUA | √ | | | | QUA | √ | | UA |
| √ | √ | LRR | √ | √ | | √ | QRR | | | RR |
| | √ | LRNR | | √ | | | | | | RNR |
| | √ | LREJ | √ | √ | | | | | | REJ |
| | | LDM | √ | √ | | | QDM | √ | | DM |
| | | LPDUR | | √ | | | | | | FRMR |

T = Packet transmitted by the 5494
R = Valid data packets received by the 5494

*Figure 3-6. Logical Link Control Summary*

**Note:** For details about XID SEND and RECEIVE, see Chapter 7, "Type 2.1 Node Support." For details on other commands and responses, see Chapter 2, "Synchronous Data Link Control Support."

*The X.25 Interface For Attaching SNA Nodes To Packet Switched Data Networks, General Information Manual* contains a comprehensive discussion of usage and format for each LLC type.

## Operator Network Interface

Operation of workstations attached to the 5494 is based on interactive workstation support and depends on the communications link. A call must be placed and a communications link established for workstations to operate. The AS/400 system or the 5494 operator can initiate the call or call clearing.

If a communications link is not established, the 5494 operator may initiate call placement using link establishment.

### SVC Call Placement

The 5494 allows the workstation operator to initiate an SVC call request. The operator selects destination, logical channel, and optional X.25 network facilities.

The *IBM 5494 Remote Control Unit User's Guide* provides procedures for SVC call placement.

### SVC Call Answering

The operator can indicate to the 5494 how a call is to be answered by using link establishment. If the 5494 is configured for Single SVC Answer-Only and manual options are not allowed, no operator action is needed to establish the link. In this case, the 5494 does not check the connection password in the incoming call packet. The *IBM 5494 Remote Control Unit User's Guide* provides procedures for SVC call answering.

### Opening a PVC

The operator can indicate to the 5494 how to open a PVC by using the Open command in link establishment. If the 5494 is configured for Single PVC and manual options are not allowed, no operator action is required to establish the link. The first data packet received establishes the logical channel number, and default values determine other circuit parameters. The *IBM 5494 Remote Control Unit User's Guide* provides procedures for opening a PVC.

### Disconnecting a Circuit

When the workstation operator chooses to disconnect a circuit, a Disconnect command is issued at the link level. This is valid whenever the LLC link with the AS/400 system is inactive. The LLC is in the mode equivalent to the SDLC Normal Disconnect mode.

The *IBM 5494 Remote Control Unit User's Guide* provides procedures for disconnecting a circuit.

# Chapter 4. X.21 Switched Public Data Network Support

CCITT Recommendation X.21 describes the DTE to DCE interface for attaching to circuit-switched X.21 Public Data Networks. This recommendation covers the interface states and the rules for making transitions from one state to another. The interface states and transition rules govern the following:

- Physical link establishment
- Call placement
- Error detection and handling at the physical link level
- Call clearing.

When the 5494 is connected to an X.21 circuit-switched line, the interface states and transition rules supply a formal structure for establishing a circuit to the AS/400 system. Once this circuit is established and the interface enters the data transfer state, the 5494 uses SDLC and SNA protocols for transmission of user data.

When the 5494 is connected to an X.21 leased line, the interface remains in the data transfer state. As a result, the 5494 does not require the X.21 state transition rules. SDLC and SNA serve as the operative protocols during all phases of operation.

When the 5494 is attached to an X.21 Public Data Network through an X.21 bis DCE, the 5494 does not support circuit switching and uses only SDLC and SNA for transmission of user data. For circuit-switching support, the X.21 bis DCE must provide the switching capability.

See Chapter 16, "Communications Interfaces," for more information on interfaces.

See Chapter 2, "Synchronous Data Link Control Support," for more information on SDLC.

See Chapter 10, "Systems Network Architecture Support," for more information on SNA.

**Note:** In this book, all data strings are presented with the most significant byte on the left. Byte and bit numbers are also written from left to right beginning with byte 0 bit 0 as the most significant bit.

## Supported Facilities

The 5494 supports the following X.21 facilities:

- 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
- Recognized Private Operating Agency (RPOA).

The workstation operator can register for, cancel, or inquire about facilities online as described in the *IBM 5494 Remote Control Unit User's Guide.* Contact your network supplier to determine the format of the facility registration parameters.

## Operator Network Interface

Operation of workstations attached to the 5494 is based on interactive workstation support and depends on the communications link. A call must be placed and a communications link established for workstations to operate. With X.21 switched networks, the 5494 supports automatic call establishment and automatic call clearing. The AS/400 system or the 5494 operator can initiate the call or call clearing.

If a communications link is not established, the 5494 operator can initiate call placement. For call establishment procedures, refer to the *IBM 5494 Remote Control Unit User's Guide.*

### Address Call

Call addressing information can be configured into the 5494 for one primary and up to three alternate AS/400 systems. This information includes the connection number of the AS/400 system site. The *IBM 5494 Remote Control Unit User's Guide* describes how to configure call addressing information into the 5494 and how to establish communication with the AS/400 system through an address call.

### Direct Call

If direct call is specified in the configuration of the 5494, communication is established with the AS/400 system through a direct call. When the operator places a direct call, the connection number of the AS/400 system site is provided by the network from a prestored subscription. The *IBM 5494 Remote Control Unit User's Guide* describes how to configure and establish communication with the AS/400 system through a direct call.

### Call Clearing

Calls are cleared (disconnected) in one of the following ways:

- The 5494 initiates call clearing with a DTE clear request sequence as part of an error or timeout recovery procedure.
- The workstation operator clears the call when the 5494 is in the data transfer phase and in Normal Disconnected mode (NDM) by entering a Disconnect operator command. For Disconnect command procedures, refer to the *IBM 5494 Remote Control Unit User's Guide.*
- The DCE issues a clear indication to the 5494.
- The AS/400 system issues an SDLC Disconnect (DISC) command. The 5494 responds with a UA and initiates a DTE clear request sequence.

## 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 5494 supports SHM but will not initiate an SHM session. The AS/400 system determines and controls the SHM operation.

To start an SHM session, either the AS/400 system or the 5494 initiates a call to the network. The call then proceeds as any other X.21 call. When the interface reaches the ready-for-data state and the SDLC operation starts, the AS/400 system sends a null XID or activation XID command (see Table 7-1 on page 7-2). The 5494 returns an XID3 response, which indicates secondary station status and specifies SHM compatibility. The AS/400 system then sends an activation XID command specifying SHM operation and the 5494 confirms with an XID3 response.

After SHM is selected by the XID exchange, the AS/400 system sends an SDLC set normal response mode (SNRM) command to start the SHM session. If the AS/400 system does not have any frames to transmit or acknowledge at any time during the session, the AS/400 system can clear the connection. The 5494 does not initiate call clearing. The 5494 interprets a clear request received from the AS/400 system during a normal response mode (NRM) as an SHM line disconnect. The 5494 disconnects the line and maintains the SNA session in progress. Either the AS/400 system or the 5494 can call to reestablish the connection. For information about the general format of the XID command, see Chapter 7, "Type 2.1 Node Support."

## Short Hold Mode XID Format

The 5494 responds to a Format 3 XID command, but does not issue the command. The 5494 always responds with a Format 3 XID response. See Table 7-2 on page 7-3.

The AS/400 system sends the XID command to solicit an XID response from the 5494 when a session is to be established or reconnected.

## Short Hold Mode Retries

The 5494 can retry reconnection attempts that fail because of network events. The interval between retries and the number of retries are determined from setup parameters. If the 5494 exhausts the retry counter, it posts the reason for the last retry failure to the operator, logs a permanent link error, and ends the SHM session.

The following events result in SHM retries:

- A call progress signal (CPS) is received.

  All 2x and 6x CPSs cause retries. Other CPSs cause retries if they were specified during customer setup. Receipt of CPSs that are not valid causes retries.

- A recoverable timeout condition is detected by the 5494.
- A DCE-clear-indication is received during call reconnection.
- A parity error is detected during call reconnection.

## Communications Codes

The 5494 using X.21 circuit-switched functions receives messages and exchanges information with the network using the International Alphabet No. 5 (IA5) 7-bit code. The 5494 supports the receipt of decimal digits 0 through 9 and colon (:) as well as the control codes listed in Table 4-1.

The 5494 recognizes DCE-defined CPSs such as number busy, access barred, and changed numbers. The 5494 also recognizes CPSs starting with shift-in (SI) characters. The 5494 discards other DCE network information received and posts no operator messages.

The 5494 supports the transmission of all IA5 codes to accommodate the network registration facility usage, but it does not check message syntax. Data entered by the operator is translated from extended binary-coded decimal interchange code (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 5494 translates that entry to a NUL character.

The 5494 makes sure that the transmitted network messages are appended with a + character delimiter. The delimiter is either entered by the operator or is automatically added. Table 4-2 lists the control codes used in messages sent to the network.

*Table 4-1. Control Codes Received*

| Code | Definition |
|---|---|
| BEL | Indicates an incoming call when preceded by a minimum of 2 SYN characters and the 5494 is in state 1. |
| SYN | A character that precedes all transmission and may be embedded within transmission 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 of DCE-provided information. Must be preceded by SYN SYN and information must be followed by a +. |
| * | Indicates the start of DCE-provided calling and called line identification. Must be preceded by SYN SYN and information must be followed by a +. |

*Table 4-2 (Page 1 of 2). 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 5494 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 +. |

*Table 4-2 (Page 2 of 2). Control Codes Sent*

| Code | Definition |
|---|---|
| , | 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/cancelation signals within a facility registration/cancelation block that contains two or more facility registration/cancelation signals. |
| / | Used to separate fields (request code, indicator, parameter, or address) within a facility registration/cancelation signal. |
| – | Terminating delimiter of facility request or facility registration/cancelation blocks. Must be followed by a +. |
| + | Ending delimiter used to indicate the EOT. Used for all transmissions. |
| *nnn* | If preceded by SYN SYN and ended by a +, the sequence *nnn...n* is an address selection sequence. If preceded by SYN SYN and ended by a – and then a +, the sequence *nnn...n* is a facility block. |

# X.21 Network States

The 5494 recognizes the X.21 network interface states defined in *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, 1980, 1984, and 1988).

The circuit reference conditions used to describe the 5494 operations are shown in Table 4-3.

*Table 4-3. Circuit Reference Conditions*

| 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 the power-on sequence, the 5494 is initialized to a DCE-uncontrolled-not-ready state with circuits t = 0 and c = Off. The 5494 maintains this state during initialization. The 5494 does not check the state of the DCE during this period. Circuits R and I can be in any condition. The 5494 then presents ready to the DCE (t = 1 and c = Off) and waits for a DCE-ready (r = 1, i = Off).

# Receive Conditions

A BEL character preceded by 2 or more adjacent SYN characters signals an incoming call from the DCE. The 5494 then accepts the call (t = 1 and c = On) unless there is a call collision.

The 5494 receives X.21 network messages only in the call establishment phase. For an incoming call, the messages must be preceded by the following sequence of characters:

Two or more SYN characters, followed by
One or more BEL characters, followed by
Two or more SYN characters.

For an outgoing call, the 5494 must be in the DTE-waiting state (state 5), and the message must be preceded by 2 or more SYN characters.

The 5494 recognizes the first plus (+) character in the message as the end of the message.

When the 5494 unit reaches the ready-for-data state, the 5494 switches automatically to the SDLC operation.

The SDLC operation is ended if an X.21 DCE-clear (16 zeros with i = Off), is detected.

## Transmit Conditions

X.21 is a duplex protocol; therefore, the 5494 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 5494 will progress through the calling states: call-request, proceed-to-select, selection-signals, and DTE-waiting. Following proceed-to-select state 3 (r = plus (+) character and i = Off), the 5494 will typically transmit 2 SYN characters followed by the message characters or the select data and the end of message delimiter (plus [+] character). The 5494 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 state (r = 0 and i = Off) is signaled by the DCE.

If a direct call is initiated, the 5494 bypasses the selection-signal state 4 and does not transmit SYN or other IA5 characters. In this case, the 5494 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 5494 initiates data transfer (circuit T held at t = 1).

## Timeout Conditions

The 5494 detects timeout conditions T1, T2, T3A, T3B, T4B, T5, and T6 as specified in the CCITT Recommendation X.21. Refer to the CCITT Recommendation X.21 for more information.

## DCE-Clear-Confirmation

When the 5494 signals DTE-clear-request (t = 0 and c = Off), T5 timeout is set and is not cleared unless a DCE-clear-confirmation (r = 0 and i = Off) followed by a DCE-ready (r = 1 and i = Off) is received.

## DCE-Controlled-Not-Ready

The 5494 handles the DCE-controlled-not-ready (CNR) state in two ways:

- If the 5494 receives the DCE CNR during the call-control phase, it handles the DCE CNR as a DCE clear condition.
- If the 5494 receives the DCE CNR during the data transfer phase, it ignores the DCE CNR. Normal SDLC protocol actions handle error recovery as necessary.

## Call Collisions

Call collisions can occur under the following conditions:

- A network incoming call is indicated at the same time as or immediately after the 5494 sends a call-request.
- A network incoming call is indicated while the 5494 is processing an operator-initiated call.
- A network incoming call is indicated while the 5494 is in SHM, and the workstation operator has taken an action requiring the 5494 to reconnect the link.

If the DCE indicates an incoming call (r = SYN,SYN,BEL and i = Off) during or immediately after the 5494 has sent a call-request (t = 0 and c = On), the 5494 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 5494 utilizes the call-request sequence timeout to end its call-request.

If the workstation operator is in the process of making a call (call sequence completed but call-request not yet sent to the DCE) and an incoming call is indicated, the 5494 posts an error to the operator and logs the error. The 5494 then sends a clear-request to the DCE (t = 0 and c = Off).

If the 5494 is in SHM and the workstation operator is in the process of reestablishing the link, the 5494 cancels the call, increments the call-collision counter, and responds to the incoming call.

## Call Progress Signals

The 5494 supports all call progress signals (CPS) specified in the CCITT Recommendation X.21.

If a CPS is received during an incoming call, the call is cleared and a permanent link error is posted and logged.

If a CPS is received during an operator-initiated (outgoing) call, the recovery depends on the CPS received:

**Group 0 CPS (0x)**: If the DCE takes no action within 60 seconds, a DTE-clear-request is issued and a permanent link error is posted and logged.

**All other CPS groups**: If a DCE-clear-indication is not received within 6 seconds, a DTE-clear-request is issued and a permanent link error is posted and logged.

See “Short Hold Mode Retries” on page 4-3 for information on the effect of CPSs during SHM reconnection.

## Interface State Diagrams

Recommendation X.21 defines the 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 state diagrams. These diagrams are available in the *IBM Implementation of X.21 Interface, General Information Manual.*

# Chapter 5. V.25 bis Serial Automatic Calling Support

CCITT Recommendations V.24 and V.25 bis define interface and functional characteristics for serial automatic calling. The 5494 implements these protocols in conjunction with SDLC to provide data transfer to and from the AS/400 system. The 5494 must attach to a V.25 bis modem to use the V.25 bis protocol. The *IBM 5494 Remote Control Unit Planning Guide* lists supported modems. The V.25 bis protocol uses EIA 232D (CCITT V.24/V.28) signal lines between the 5494 and the DCE. Chapter 16, "Communications Interfaces," describes the signal line characteristics. "Interface States" on page 5-4 describes those characteristics unique to the V.25 bis protocol.

## Supported Facilities

The 5494 supports the following V.25 bis-defined facilities:

- Addressed call
- Synchronous bit-oriented format for commands and indications
- Call Request command with number provided (CRN)
- Call Request command with number and identification provided (CRI)
- Call failure indication
- Delayed call indication
- Call not valid indication
- Valid call indication
- Incoming calls on CI (circuit 125).

"Commands" on page 5-2 describes the supported commands and indications.

The 5494 does not support the following optional V.25 bis-defined facilities:

- Direct call
- Asynchronous and character-oriented formats
- Call Request command with memory address provided (CRS)
- Call Request command with double dial-up required (CRD)
- Program commands
- List Request commands and indications
- Disregard or Connect Incoming Call commands
- Incoming Call Indication message.

## Operator Network Interface

Operation of workstations attached to the 5494 is based on interactive workstation support and depends on the communications link. A call must be placed and a communications link established for workstations to operate. The AS/400 system or the 5494 operator can initiate the call or *call clearing*.

If a communications link is not established, the 5494 operator may initiate call placement. For network link establishment procedures, refer to the *IBM 5494 Remote Control Unit User's Guide*.

## Address Call

Call address information can be configured into the 5494 for one primary and up to three alternate AS/400 systems. This information includes the connection number of the AS/400 site and (if required) the connection number of the 5494 site. The *IBM 5494 Remote Control Unit User's Guide* describes how to configure call addressing information into the 5494.

## Call Retries

The workstation operator makes each call attempt. The number of retry attempts and interval between retries is determined by operator actions and DCE response. The 5494 does not automatically attempt call retries.

## Call Clearing

Calls are cleared in one of the following ways:

- The 5494 initiates a call clearing process as a result of a call establishment timeout or as part of an error recovery procedure.
- The workstation operator initiates a call clearing when the 5494 is in the data transfer state and in Normal Disconnected mode (NDM) by entering a Disconnect operator command. The 5494 proceeds with a clearing sequence to disconnect the link. For Disconnect command procedures, refer to the *IBM 5494 Remote Control Unit User's Guide.*
- The DCE initiates a call disconnection process while in data transfer by deactivating the DSR signal.
- The AS/400 system initiates call clearing with the SDLC Disconnect (DISC) command. When a Disconnect command is received in data transfer, the 5494 sends the appropriate SDLC unnumbered response to the AS/400 system and then clears the call.

# Call Information Messages

The 5494 and the V.25 bis DCE exchange call information messages during the call establishment procedure using Unnumbered Information (UI) frames with the Poll bit set and a broadcast station address (X'FF'). The information field contains the message consisting of IA5 characters (7-bit codes plus 1 odd parity bit). The 5494 sends *commands* and receives *indications.*

## Commands

The 5494 supports only the Call Request command. If the user enters a 5494 connection number during the 5494 configuration, the 5494 uses the CRI command and includes both the called AS/400 system and the calling 5494 connection numbers in the call request; otherwise, the 5494 sends a CRN with the called number only. The 5494 translates the user data from EBCDIC to International Alphabet (IA5) codes with odd parity. If the 5494 finds a character that has no IA5 equivalent, it translates that character to a NUL.

## Indications

The following indications are supported by the 5494:

**CFI - Call failure**
The DCE sends this indication with parameters indicating the cause for the failure as defined in Table 5-1.

*Table 5-1. Indication Parameters*

| Parameter | Description |
|---|---|
| ET | Engaged tone |
| CB | Local DCE busy |
| RT | Ring tone (timeout) |
| AB | Abend call (timeout) |
| NT | Answer tone not detected |
| FC | Forbidden call (for nationally dependent parameters) |

**Note:** Some DCEs define and use other parameters. Refer to the documentation for your DCE.

**DLC - Delayed call**
The DCE sends this indication to the 5494 after repeated unsuccessful attempts to place the call. The DCE includes a parameter to indicate the number of minutes the DTE must wait before attempting the next retry.

**INV - Call not valid**
The DCE sends this indication to the 5494 if it receives a command that is not valid or a command that it cannot perform. The 5494 does not process parameters sent with this indication.

**VAL - Valid call**
The DCE optionally sends this indication to the 5494 after processing a valid call request. The 5494 does not process parameters sent with this indication.

If the received indication is CFI, DLC, or INV, the 5494 clears the call and posts a call indication message. If more than one parameter is received from the DCE in a single indication, the 5494 posts only the last one. Indications other than those specified are ignored.

## Interface States

The 5494 uses the CCITT V.24 100-series circuit references shown in Table 5-2 to define the interface states supported.

*Table 5-2. CCITT V.24 100-series Signal Lines*

| Label | Circuit | Description | Conditions |
|---|---|---|---|
| Tx [1] | 103 | Transmitted Data | 0 or 1 |
| Rx [1] | 104 | Received Data | 0 or 1 |
| RTS | 105 | Request to Send | On or Off |
| RFS | 106 | Ready for Sending | On or Off |
| DSR | 107 | Data Set Ready | On or Off |
| DTR | 108.2 | Data Terminal Ready | On or Off |
| RLSD | 109 | Received Line Signal Detect | On or Off |
| CI | 125 | Calling Indicator | On or Off |

[1] The ANSI-EIA 232D reference labels these lines TD and RD, respectively. All other names, labels, and signal line characteristics are the same in both references.

## Initial Condition

After the power-on reset (POR) sequence, the 5494 sets DTR=Off and maintains this condition throughout diagnostics and diskette load operations. During this time (approximately 40 seconds), the 5494 does not check the status of the DCE. After the diskette load is complete, the 5494 attempts to establish DTE-to-DCE dialog.

## Establishing DTE to DCE Dialog

The 5494 attempts to communicate with the DCE in the following sequence:

1. The 5494 verifies that there is not an incoming call by monitoring the CI line. If the CI signal remains inactive for 10 seconds, the 5494 proceeds to the next step.
2. The 5494 verifies that DSR=Off. If this condition does not exist, the 5494 waits 350 milliseconds, then rechecks this condition. If the condition still does not exist, the 5494 posts an error code to all active workstations, and rechecks the line at 5-second intervals.
3. After verification, the 5494 sets DTR=On and waits for the DCE to set RFS=On. If this does not happen within 30 seconds, the 5494 posts an error code, sets DTR=Off, and reattempts to establish DTE-to-DCE dialog (step 1).
4. The 5494 and the DCE reach dialog state when RFS=On. The 5494 is then ready to receive incoming calls or place operator-initiated outgoing calls.

## Incoming Calls

The DCE indicates an incoming call to the 5494 by setting CI=On. If the 5494 and DCE are in dialog state and the 5494 is not processing an operator-initiated outgoing call, then the 5494 waits for the DCE to set the call-connected state (RFS=Off and DSR=On). Otherwise, the 5494 clears the call by setting DTR=Off. If, after a period of time (specified at configuration), the DCE does not signal the call-connected state, the 5494 posts an error to all active workstations and sets DTR=Off, clearing the call.

## Outgoing Calls

After receiving an operator request for an outgoing call, if the 5494 and DCE are in the dialog state, the 5494 sends a UI frame to the DCE containing the Call Request command. See "Commands" on page 5-2. If the DCE does not indicate the call-connected state after a period of time (specified at CSU), the 5494 clears the call by setting DTR=Off, and posts an error code to all active workstations, indicating a call-connected timeout.

## Call Collision

The 5494 can have a call collision when:

- The 5494 is processing an operator-initiated outgoing call but has not yet sent the Call Request command to the DCE, and the DCE sets CI=On (incoming call).
- The 5494 has sent the Call Request command and the DCE signals an incoming call.

In both cases, the call is cleared by setting DTR=Off and posting an error code to all active workstations.

## Call-Connected State

The call-connected state occurs when the DCE sets RFS=Off and DSR=On after either an outgoing or incoming call operation. The DCE may set these lines in any order as long as both are set before the timer expires (set at CSU).

## Transmission Encoding

The 5494 uses NRZ encoding/decoding for transmission and reception of call information messages during the call establishment procedure in V.25 bis. After reaching the call-connected state, the 5494 uses the transmission encoding method specified during configuration (NRZ or NRZI).

# Chapter 6. Token-Ring Support

This chapter provides information about 5494 support for attachment to Token-Ring networks. This chapter does not contain information about Token-Ring communication protocols or the Token-Ring transmission subsystem. For information on these, refer to the following books:

- *IBM Token-Ring Network Architecture Reference*
- *IBM Token-Ring Network Problem Determination Guide*
- *IBM Local Area Network Technical Reference.*

## Overview

The 5494 Model 002 allows programmable workstations (PWSs) attached to a Token-Ring network to communicate with an AS/400 system through the 5494. This is called a *Token-Ring Gateway configuration* because the 5494 serves as a gateway between Token-Ring-attached workstations and an AS/400 system.

You can also attach the 5494 as a station on a Token-Ring network connected to an AS/400 system. This arrangement permits 5250 workstations attached to the 5494 to communicate with an AS/400 system through the Token-Ring network. This is called *Token-Ring AS/400 Attachment configuration* because the Token-Ring network is the connection for the 5494 to the AS/400 system.

In either configuration, the 5494 supports:

- Token-Ring bridges
- Token-Ring data rates of 4 and 16 Mbps
- Logical link control IEEE 802.2
- Token-Ring IEEE 802.5.

## Token-Ring Gateway Configuration

The 5494 Model 002 supports as many as 80 workstations in a Token-Ring Gateway configuration. As many as 56 of these workstations can be attached to the 5494 through the twinaxial ports. The remainder (or all 80 workstations) can be attached to a Token-Ring network.

The 5494 serves as a "pass-through" control unit for communication between Token-Ring PWSs and an AS/400 system. As the data is passed from the AS/400 system to the Token-Ring network, the 5494 strips the host communication protocol (SDLC, X.21, and X.25) and replaces it with Token-Ring protocol. For information passing from the Token-Ring network to the AS/400 system, the 5494 strips the Token-Ring protocol and replaces it with the appropriate host communication protocol. The 5494 makes only minor SNA addressing changes to the LU 6.2 frames. All other information passing between an AS/400 system and a Token-Ring network in an LU-LU session remains unchanged.

A 5494 in a Token-Ring Gateway configuration sends generic alerts for Token-Ring errors to the AS/400 system and it forwards alerts from Token-Ring workstations to the AS/400 system.

For information about generic alerts that are generated, see "Token-Ring Gateway Error Recovery" on page 6-5. For information about alert forwarding, see "Alert Forwarding" on page 9-3.

## Initialization and Link Establishment

When the 5494 is turned on in normal mode (not configuration mode), it opens the Token-Ring adapter and waits for a Token-Ring PWS connection. The actual connection sequence is shown in Figure 6-1.

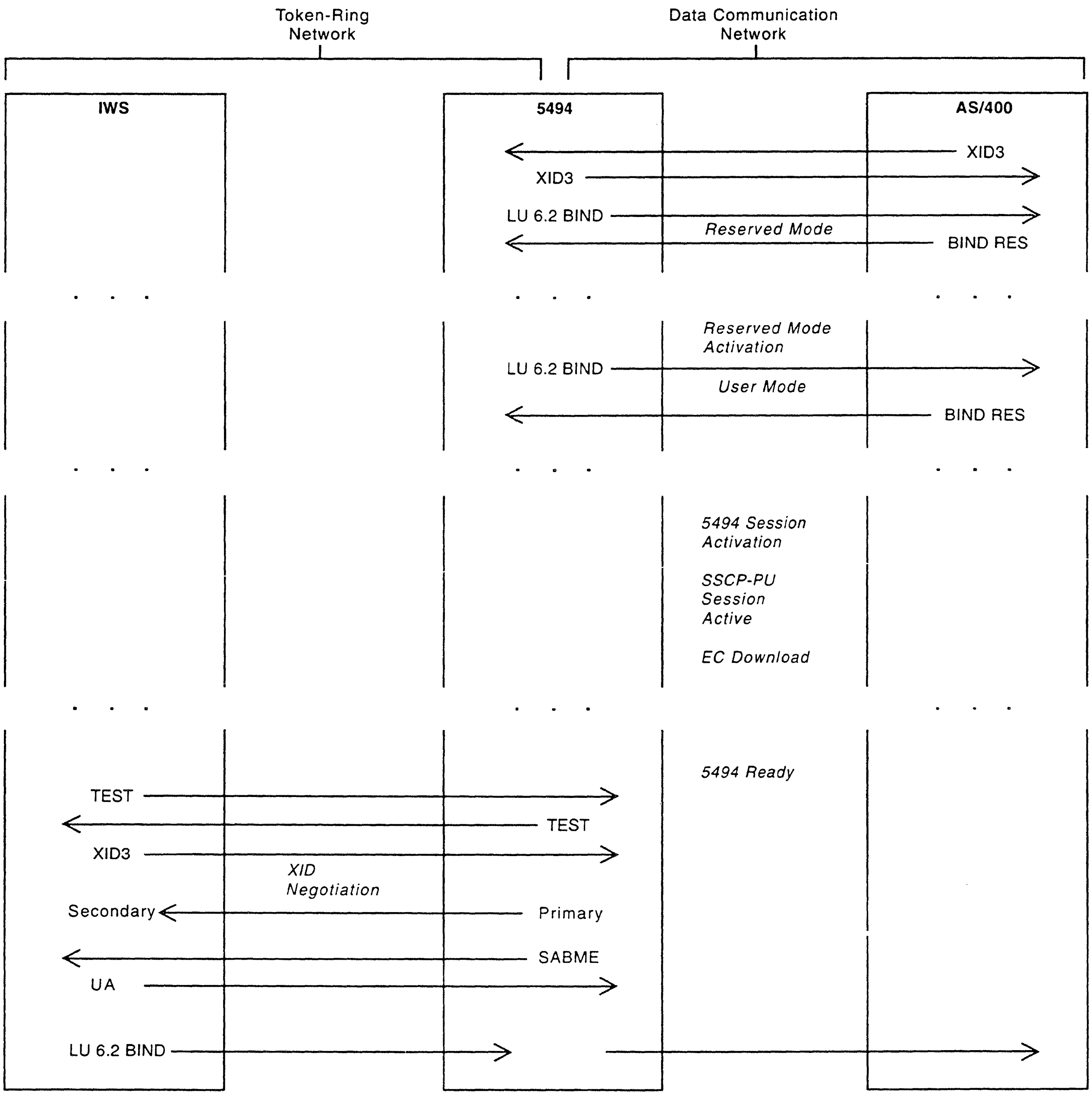



*Figure 6-1. Token-Ring Gateway Initialization and Link Establishment*

# Token-Ring Gateway Parameters

In any Token-Ring configuration, an attached PWS is considered a *link station.* When the Token-Ring Gateway configuration is selected, certain configurable parameters must be set to help regulate communication between the 5494 and link stations on the Token-Ring network. The following sections describe these parameters.

## 5494 Token-Ring Address

This is the Token-Ring address of the 5494. Valid values are 0 through 9 and A through F. The first four character positions must contain X'4000'. The default value is 40005494E000.

The 5494 uses a locally administered address rather than the universally administered address encoded on the Token-Ring adapter.

## 5494 Service Access Point (SAP)

This is the Token-Ring SAP of the 5494 that is used in the connection between the PWS and the 5494. Valid values are X'04' through X'FC' that are multiples of X'04'. The default value is X'04'.

## Response Timer (T1)

Whenever an I-format logical protocol data unit (LPDU) or a command LPDU with the poll bit set to B'1' is sent, the 5494 starts a response timer (T1). If the 5494 response timer expires before a response is received, the 5494 checks the status of the receiving link station by sending a supervisory command LPDU with the poll bit set to B'1'. Therefore, the 5494 response timer must be set to a value greater than the accumulated delays that the frame can incur at the sending node, in the network, and at the receiving node.

Valid values are 1 through 20 (seconds). The default value is 1. A setting of 1 to 2 seconds is typical. Setting the response timer higher than 2 seconds can cause noticeable delays in responses that must be retransmitted.

## Inactivity Timer (Ti)

Whenever the response timer is not running, the 5494 inactivity timer (Ti) is running. If this timer expires, the communications link can be lost. If so, the 5494 attempts to reestablish communications.

Valid values are 1 through 99 (seconds). The default value is 30. The inactivity timer should be set to a value that is at least 10 times greater than the response timer (T1) setting.

## Acknowledgment Timer (T2)

Whenever an I-format LPDU is received, the 5494 starts an acknowledgment timer (T2). This timer stops when either of the following occurs:

- An acknowledgment is sent with an outgoing frame.
- The maximum out (TW) value is reached. See "Maximum Out (TW)."

When the acknowledgment timer expires, the 5494 must send an acknowledgment as soon as possible. The acknowledgment timer must be set to a value that is less than the response timer (T1) setting at the sending link station. This ensures that the sending link station receives an acknowledgment before its response timer expires.

Valid values are 1 through 999 (milliseconds). The default value is 30. A setting of 30 to 255 milliseconds is typical.

## Retry Count (N2)

The retry count (N2) is the maximum number of times the 5494 will check the status of a receiving link station after the 5494 response timer (T1) expires. This prevents continual retransmission of the same I-frame. The retry count setting should be coordinated with the response timer setting to allow for error detection and recovery on the network.

Valid values are 1 through 99 (retries). The default value is 8. A setting of 10 retries or less is typical.

## Maximum Out (TW)

The maximum out (TW) is the maximum number of I-format LPDUs the 5494 may send before it must stop transmitting to wait for an acknowledgment.

This value must be at least twice the value of maximum in (N3) at the receiving PWS. Otherwise, network response time can be severely degraded.

Valid values are 2 through 8 (frames). The default value is 2. A setting of 2 frames is typical.

## Maximum In (N3)

The maximum in (N3) is the maximum number of I-format LPDUs the 5494 may receive before it must send an acknowledgment. Because very little network overhead or 5494 processing is required to send or receive acknowledgment frames, you can send an acknowledgment for every I-format LPDU received.

This value must not be more than half of the maximum out (TW) value at the sending link station.

Valid values are 1 through 4 (frames). The default value is 1. A setting of 1 frame is typical.

## Error Logging and Recovery

When an error causes the Token-Ring link to go down, the 5494 logs an error and attempts to reopen the Token-Ring adapter if the link failure closed the adapter. If the Token-Ring adapter fails to reopen, the 5494 continues attempting to open the adapter at 30-second intervals.

**Note:** Some Token-Ring errors require operator intervention to reopen the Token-Ring adapter. See "Token-Ring Gateway Error Recovery."

The *IBM 5494 Remote Control Unit User's Guide* describes all system reference codes (SRCs) that the 5494 issues as the result of an error.

### Token-Ring Gateway Error Recovery

The 5494 internally logs errors by date and time. For the following problems, the 5494 issues generic alerts if there is an AS/400 connection:

**Lobe Problem during Insertion**: The Token-Ring adapter detected a problem in its lobe during the wrap-test portion of the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Beaconing Problem during Insertion**: The Token-Ring adapter detected a beaconing condition on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Duplicate Station Address on Ring during Insertion**: The Token-Ring adapter detected a duplicate address on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Remove Ring Station Medium Access Control (MAC) Frame Received during Insertion**: The Token-Ring adapter received a Remove Ring Station MAC frame during the insertion process. The insertion process did not complete. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**Undefined Error during Insertion**: The Token-Ring adapter detected an undefined error on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Wire Fault on Ring**: The Token-Ring adapter of the reporting link station detected a wire-fault condition on the Token-Ring network. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Adapter Off Ring under Beacon Auto-Recover Process**: The Token-Ring adapter of the reporting link station has left the Token-Ring network as part of the beacon automatic recovery process. This means that the reporting station's adapter is a member of the beacon's fault domain and that the adapter removed itself from the network to do a self-test, which was unsuccessful. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**REMOVE ADAPTER Command Received**: The Token-Ring adapter of the reporting link station has left the Token-Ring network as a result of a REMOVE ADAPTER command from a LAN manager. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**Ring Beaconing Timeout**: The hard error detection timer expired while the Token-Ring network was beaconing. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

## Token-Ring AS/400 Attachment Configuration

The 5494 supports as many as fifty-six 5250 workstations if the Twinaxial Expansion Kit is used, (or 28 workstations if it is not used) in a Token-Ring AS/400 Attachment configuration. All of these workstations are attached to the 5494 using twinaxial cable or any cable that supports 5250 data stream communication.

The 5494 Model 002 allows PWSs and nonprogrammable workstations (NWSs) attached to the 5494 to communicate with an AS/400 system through a Token-Ring network.

## Initialization and Link Establishment

When the 5494 is turned on in normal mode (not configuration mode), it opens the Token-Ring adapter and sends a TEST command through the Token-Ring network to the AS/400 system to determine whether the system has a Token-Ring line available. If the 5494 receives no response to the TEST command, the 5494 resends the command at 30-second intervals until a response is received. This allows automatic bring-up of a Token-Ring link connection when the AS/400 system opens a Token-Ring line. The actual connection sequence is shown in Figure 6-2 on page 6-7.

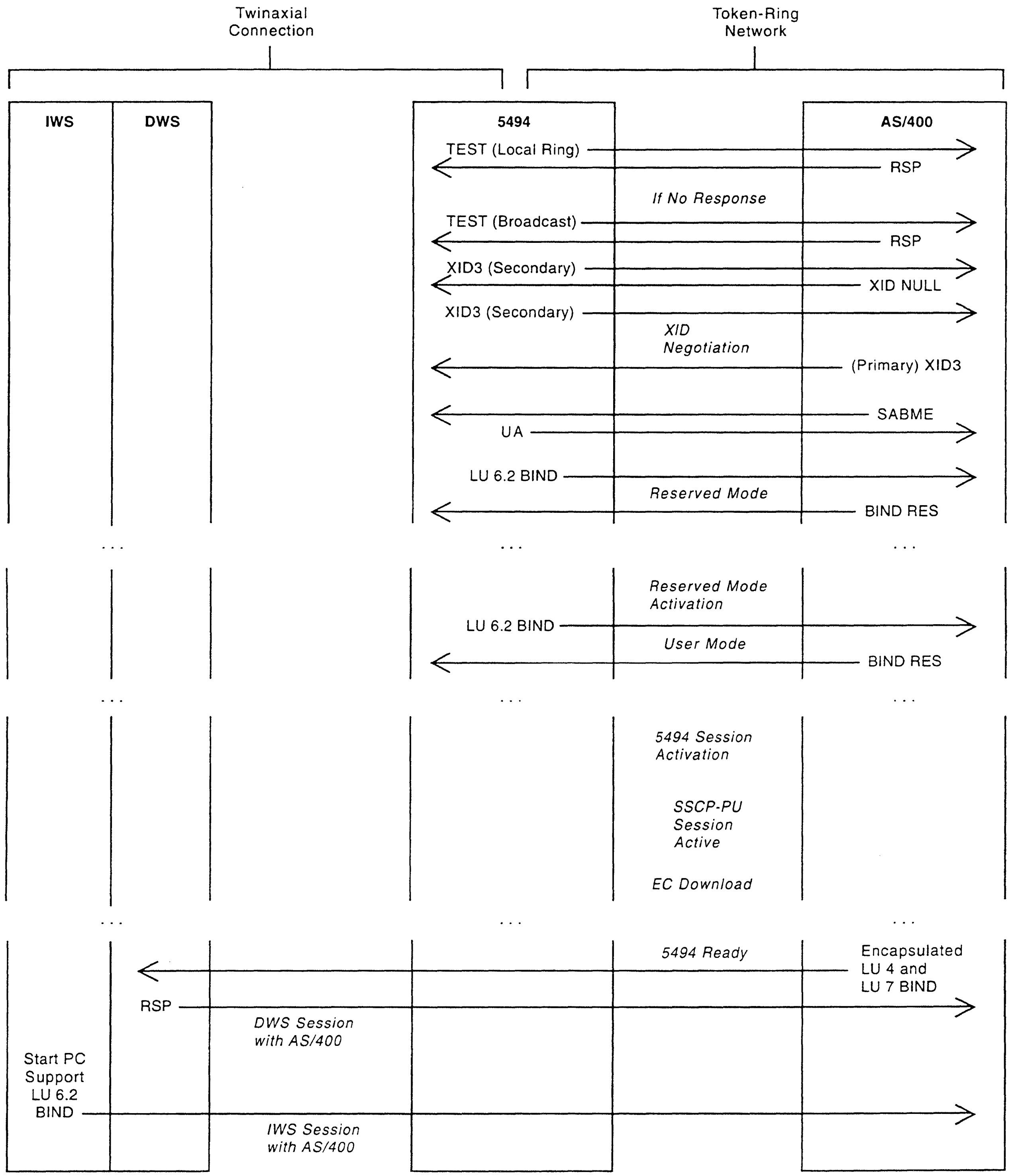



*Figure 6-2. Token-Ring AS/400 Attachment Initialization and Link Establishment*

## Alternate AS/400 System

The 5494 supports preconfiguration for as many as four AS/400 systems. No action is required to establish a communications link through a Token-Ring network to the primary AS/400 system. If a Token-Ring line is available and the AS/400 Workstation Controller is varied on, the 5494 automatically establishes communication with the system designated in your configuration parameters as H1 AS/400 System 1.

The 5494 communicates with only one AS/400 system at a time. You must end communication with one system and manually initiate communication with an alternate system. (For more information about network link establishment, refer to the *IBM 5494 Remote Control Unit User's Guide.*)

## Token-Ring AS/400 Attachment Parameters

When the communications mode is set to Token-Ring AS/400 Attachment, certain configurable parameters must be set to help regulate communication between the 5494 and the AS/400 system. The following sections describe these parameters.

### 5494 Token-Ring Address

This is the Token-Ring address of the 5494. Valid values are 0 through 9 and A through F. The first four character positions must contain X'4000'. The default value is 40005494E000.

The 5494 uses a locally administered address rather than the universally administered address encoded on the Token-Ring adapter.

### 5494 SAP

This is the Token-Ring SAP of the 5494. The SAP is used in the Token-Ring connection between the 5494 and the AS/400 system.

Valid values are X'04' through X'FC' that are multiples of X'04'. The default value is X'04'.

### AS/400 Token-Ring Address

This is the Token-Ring address of the AS/400 system. Valid values are 0 through 9 and A through F.

### AS/400 SAP

This is the Token-Ring SAP of the AS/400 system. The SAP is used in the Token-Ring connection between the 5494 and the AS/400 system.

Valid values are X'04' through X'FC' that are multiples of X'04'. The default value is X'04'.

### Response Timer (T1)

Whenever an I-format LPDU or a command LPDU with the poll bit set to B'1' is sent, the 5494 starts a response timer (T1). If the timer expires before a response is received, the 5494 checks the status of the AS/400 system by sending a supervisory command LPDU with the poll bit set to B'1'. Therefore, the response timer must be set to a value greater than the accumulated delays that the frame can incur at the sending node, in the network, and at the receiving node.

Valid values are 1 through 20 (seconds). The default value is 1. A setting of 1 to 2 seconds is typical. Setting the response timer higher than 2 seconds can cause noticeable delays in responses that must be retransmitted.

### Inactivity Timer (Ti)

Whenever the response timer is not running, the 5494 inactivity timer (Ti) is running. If this timer expires, the communications link can be lost. If so, the 5494 attempts to reestablish communications.

Valid values are 1 through 99 (seconds). The default value is 30. The inactivity timer should be set to a value that is at least 10 times greater than the response timer (T1) setting.

### Acknowledgment Timer (T2)

Whenever an I-format LPDU is received, the 5494 starts an acknowledgment timer (T2). This timer stops when an acknowledgment is sent with an outgoing frame.

When the acknowledgment timer expires, the 5494 must send an acknowledgment as soon as possible. The acknowledgment timer must be set to a value that is less than the response timer (T1) setting at the AS/400 system. This ensures that the AS/400 system receives an acknowledgment before its response timer expires.

Valid values are 1 through 999 (milliseconds). The default value is 30. A setting of 80 to 256 milliseconds is typical.

### Retry Count (N2)

The retry count (N2) is the maximum number of times the 5494 will check the status of the AS/400 system after the 5494 response timer (T1) expires. This prevents continual retransmission of the same I-frame. The retry count setting should be coordinated with the response timer setting to allow for error detection and recovery on the network.

Valid values are 1 through 99 (retries). The default value is 8. A setting of 10 retries or less is typical.

### Maximum Out (TW)

The maximum out (TW) is the maximum number of I-format LPDUs the 5494 can send before it must stop transmitting to wait for an acknowledgment.

This value must be at least twice the value of maximum in (N3) at the receiving PWS. Otherwise, network response time can be severely degraded.

Valid values are 2 through 8 (frames). The default value is 2. A setting of 2 frames is typical.

### Maximum In (N3)

The maximum in (N3) is the maximum number of I-format LPDUs the 5494 can receive before it must send an acknowledgment. Because very little network overhead or 5494 processing is required to send or receive acknowledgment frames, you can send an acknowledgment for every I-format LPDU received.

This value must not be more than half of the maximum out (TW) value at the sending link station.

Valid values are 1 through 4 (frames). The default value is 1. A setting of 1 frame is typical.

# Error Logging and Recovery

When an error causes the Token-Ring link to go down, the 5494 logs an error and attempts to reopen the Token-Ring adapter if the link failure closed the adapter. If the Token-Ring adapter fails to reopen, the 5494 continues attempting to open the adapter at 30-second intervals.

**Note:** Some Token-Ring errors require operator intervention to reopen the Token-Ring adapter. See "Token-Ring Error Recovery."

The *IBM 5494 Remote Control Unit User's Guide* describes all SRCs that the 5494 issues as the result of an error.

## Token-Ring Error Recovery

The 5494 internally logs the following errors by date and time:

**Lobe Problem during Insertion**: The Token-Ring adapter detected a problem in its lobe during the wrap-test portion of the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Beaconing Problem during Insertion**: The Token-Ring adapter detected a beaconing condition on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Duplicate Station Address on Ring during Insertion**: The Token-Ring adapter detected a duplicate address on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Remove Ring Station MAC Frame Received during Insertion**: The Token-Ring adapter received a Remove Ring Station MAC frame during the insertion process. The insertion process did not complete. The 5494 operator must reopen the adapter by entering a command at the 5494 operator panel. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**Undefined Error during Insertion**: The Token-Ring adapter detected an undefined error on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Wire Fault on Ring**: The Token-Ring adapter of the reporting link station detected a wire-fault condition on the Token-Ring network. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Adapter Off Ring under Beacon Auto-Recover Process**: The Token-Ring adapter of the reporting link station has left the Token-Ring network as part of the beacon automatic recovery process. This means that the reporting station's adapter is a member of the beacon's fault domain and that the adapter removed itself from the network to do a self-test, which was unsuccessful. The 5494 operator must reopen the adapter by entering a command at the 5494 operator panel. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**REMOVE ADAPTER Command Received**: The Token-Ring adapter of the reporting link station has left the Token-Ring network as a result of a REMOVE ADAPTER command from a LAN manager. The 5494 operator must reopen the adapter by entering a command at the 5494 operator panel. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**Ring Beaconing Timeout**: The hard error detection timer expired while the Token-Ring network was beaconing. The 5494 operator must reopen the adapter by entering a command at the 5494 operator panel. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

## Token-Ring Statistics and Logs

The 5494 maintains Token-Ring adapter and data link control statistics and logs internally. You can access these statistics and logs by entering a command at the 5494 operator panel.

Statistics are maintained for each link station. These include:

- Transmit I-frames
- Receive I-frames
- Transmit errors
- T1 expired.

Log statistics are maintained for the 5494 attachment to the Token-Ring network. These include:

- Line errors
- Internal errors
- Burst errors
- Address Recognized/Frame Copied errors
- Abort delimiters
- Retransmitted frames
- Receive congestion
- Frame copy errors
- Frequency errors
- Token errors.

Token-Ring errors are logged in the 5494 error log.

## Token-Ring Network LAN Management

The 5494 supports a LAN manager for management of the Token-Ring network. For large Token-Ring networks, LAN manager is recommended for effective management of the network and for full Token-Ring status visibility.

# Chapter 7. Type 2.1 Node Support

This chapter provides information about 5494 support for the T2.1 node. The T2.1 node allows peer-to-peer connection of distributed processors (for example, AS/400 system and 5494) and provides the physical and session-level connectivity required for support of independent type 6.2 logical units (LU 6.2).

The 5494 implements T2.1 node support as described in the *Systems Network Architecture Advanced Peer-to-Peer Networking Architecture Reference*.

The 5494 supports a single independent LU used for management of NWSs (displays and printers). This LU supports parallel sessions and can send or receive BINDs. No dependent LUs are supported by the 5494. For more information on how the 5494 provides NWS support, see Chapter 8, "Nonprogrammable Workstation Support." For more information on LU session management, see "SNA LU 6.2 Support" on page 10-1.

For PWSs connected to the 5494, the LUs are contained in the PWSs, and the 5494 simply passes all LU 6.2 LU-LU traffic through for the PWS LUs. See "Pass-Through Function" on page 9-1 for more information on the PWS pass-through function.

The Address Space Manager (ASM) in the control point of the 5494 maintains a single address space of 17-bit local-form session identifiers (LFSIDs) for the single instance of data link control (DLC) that is supported. Because the 5494 is the secondary link station, the LU 6.2 frames for all sessions initiated by the 5494 or by a PWS attached to the 5494 contain an origin address field/destination address field (OAF/DAF) assignor indicator (ODAI) bit = B'1' when flowing on the link to the adjacent link station (ALS). The LU 6.2 frames for all sessions initiated by the AS/400 system contain an ODAI bit = B'0' when flowing on the link to the ALS.

The 5494 begins assigning LFSIDs to sessions initiated by itself or by an attached PWS with ODAI bit = B'1', session identifier high (SIDH) = X'02', and session identifier low (SIDL) = X'00'. Subsequent sessions initiated by the 5494 are assigned the lowest available SIDH/SIDL value above X'0200'.

The 5494 must handle LFSIDs assigned by the adjacent link station (ALS) with ODAI = 0 for the the following LU 6.2 sessions:

- NWS session (one for each NWS)
- PWS sessions that are initiated by the AS/400.

The 5494 can handle a maximum of 1336 sessions with ODAI = 0. The maximum includes 56 NWS sessions and 1280 PWS sessions.

All T2.1 nodes must support an XID3 exchange. This allows node characteristics to be determined dynamically.

# XID Command

The XID command is issued by the primary link station to solicit the identification of the 5494. The 5494 checks received XID commands to verify the validity of the I-field if present, and to ensure that the ALS and the 5494 are compatible. In addition, the 5494 checks for protocol errors and returns an XID negotiation error (X'22') control vector in the I-field of its XID response if an error condition is detected in the received XID command. The 5494 checks for the error conditions listed in Table 7-1. The byte and bit values listed in Table 7-1 are those used in the XID negotiation error control vector in Table 7-2 on page 7-3.

*Table 7-1. XID Command I-field Error Conditions*

| Byte | Bit | Description |
|---|---|---|
| 256 | 0 | XID I-field > 255 bytes |
| 0 | 0 | Format of I-field ≠ X'3' (must be Format 3 XID) |
| 1 | 0 | XID I-field length ≠ length of received frame |
| 1 | 0 | XID I-field length < 29 bytes |
| 9 | 4 | XID exchange state = B'00' (ESI not supported), or protocol (state) error |
| 17 | 0 | DLC type ≠ X'01' (must be SDLC) |
| 19 | 1 | ABM support = B'0' (must not support ABM if not X.25 ELLC)<br><br>ABM support = B'1' (must support ABM if X.25 ELLC) |
| 19 | 2 | Link station role = B'00' (ALS must not be secondary), or protocol (role) error |
| 21 | 1 | Max BTU length the XID sender can receive < X'0109' (Primary must support at least 265 byte BTUs) |
| 23 | 4 | SDLC profile ≠ X'0' (must support SNA link profile) |
| 27 | 1 | Max I-frames XID sender can receive before acknowledgment is sent = X'00' or > X'07' (X'00' is not valid and > X'07' requires modulo 128) |
| **XID Negotiation Error Control Vector** | | |
| | 0 | Control vector present in received XID3 (byte value points to start of control vector received) |

**Note:** Reserved bits are not checked. Additional control vectors contained in the XID3 command are ignored and do not cause an error.

Key: X = hexadecimal B = binary ≠ = not equal.

The XID response is transmitted by the 5494 only in response to an XID command from the primary link station. The XID exchange is valid in both Disconnected mode and Normal Response mode.

Table 7-2 on page 7-3 defines the I-field contents sent in the XID response by the 5494.

*Table 7-2 (Page 1 of 3). XID Response Format*

| Bytes | Bits | Value | Description |
|---|---|---|---|
| 0 | 0-3 | X'3' | I-field format is Format 3 - variable format |
| | 4-7 | X'2' | PU Type 2 |
| 1 | 0-7 | X'xx' | XID I-field length; range = 60-79 |
| 2-5 | 0-11 | X'073' | 5494 block number |
| | 12-31 | X'000xx' | xx = station address |
| 6-7 | 0-15 | X'0000' | Reserved |
| 8-9 | 0 | B'1' | INIT-SELF not supported |
| | 1 | B'0' | BIND accepted by 5494 |
| | 2 | B'1' | Will not send BIND segments |
| | 3 | B'1' | Cannot receive BIND segments |
| | 4-7 | B'0000' | Reserved |
| | 8 | B'1' | No SSCP-PU session |
| | 9-11 | B'000' | Reserved |
| | 12-13 | | XID exchange states: |
| | | B'01' | Negotiation proceeding |
| | | B'11' | Nonactivation |
| | 14-15 | B'00' | Reserved |
| 10 | 0-1 | B'00' | Adaptive BIND pacing (send and receive) not supported |
| | 2-7 | B'000000' | Reserved |
| 11-16 | 0-47 | X'000000000000' | Reserved |
| 17 | 0-7 | X'01' | DLC type = SDLC |
| 18 | 0-7 | X'0B' | Length of DLC section = 11 |
| 19 | 0 | B'0' | Reserved |
| | 1 | B'0' | ABM not supported |
| | | B'1' | ABM supported (X.25 ELLC only) |
| | 2-3 | B'00' | Station role: 5494 is secondary station |
| | 4-5 | B'00' | Reserved [1] |
| | 6-7 | B'00' | Send/Receive capability: Half-duplex |
| 20 | 0-7 | X'00' | Reserved |
| 21-22 | 0 | B'0' | Format flag: Bits 1-15 contain maximum BTU length |
| | 1-15 | X'0409' | Max BTU length the 5494 can receive is 1033 |
| 23 | 0-3 | X'0' | Reserved |
| | 4-7 | X'0' | SDLC profile: SNA link profile supported |
| 24 | 0-1 | B'00' | Reserved |
| | 2 | B'0' | Initialization mode: SIM and RIM not supported |
| | 3-7 | B'00000' | Reserved |
| 25-26 | 0-15 | X'0000' | Reserved |

*Table 7-2 (Page 2 of 3). XID Response Format*

| Bytes | Bits | Value | Description |
|---|---|---|---|
| 27 | 0 | B'0' | Reserved |
| | 1-7 | X'07' | Max I-frames 5494 can receive before acknowledgment is sent = 7 |
| 28 | 0-7 | X'00' | Reserved |
| **Product Set ID Control Vector** | | | |
| 29 | 0-7 | X'10' | CV key: Product set ID control vector |
| 30 | 0-7 | X'17' | CV length = 23 |
| 31 | 0-7 | X'00' | Retired |
| 32 | 0-7 | X'16' | Length of product ID subvector = 22 |
| 33 | 0-7 | X'11' | Key of product ID MS common subvector |
| 34 | 0-3 | X'0' | Reserved |
| | 4-7 | X'1' | Product class = IBM hardware |
| 35 | 0-7 | X'13' | Hardware product ID subfield length = 19 |
| 36 | 0-7 | X'00' | Hardware product ID subfield key |
| 37 | 0-7 | X'12' | Format type |
| 38-41 | 0-31 | C'5494' | Machine type = 5494 |
| 42-44 | 0-23 | C'00n' | Model: 001 or 002 |
| 45-46 | 0-15 | C'nn' | Plant of manufacture |
| 47-53 | 0-42 | C'00nnnnn' | Serial number |
| **Network Name Control Vector** | | | |
| 54 | 0-7 | X'0E' | CV key: Network name control vector |
| 55 | 0-7 | X'xx' | CV length: Range = 4-18 |
| 56 | 0-7 | X'F4' | Network name type: Qualified CP name |
| 57-n | | C'c...c' | Network-qualified CP name: 3-17 bytes in format "network_name.cp_name" where each name can be from 1-8 characters |
| **Negotiation Error Control Vector** [2] | | | |
| 0 | 0-7 | X'22' | CV key: Specifies that an XID negotiation error has occurred |
| 1 | 0-7 | X'03' | CV length = 3 [3] |
| 2-3 | | X'xxxx' | Error byte offset: 0 origin |
| 4 | 0-7 | X'xx' | Error bit offset: 0 origin |
| 5-8 | | X'xxxxxxxx' | Sense data [4] |
| **Short Hold Mode Control Vector** [5] | | | |
| 0 | 0-7 | X'32' | CV key |
| 1 | 0-7 | X'xx' | CV length |
| 2 | 0-7 | X'00' | Reserved |
| 3-n | | | Dial digits of XID sender |

*Table 7-2 (Page 3 of 3). XID Response Format*

| Bytes | Bits | Value | Description |
|---|---|---|---|
| 3 | 0-7 | X'xx' | Number of dial digits (valid range = 4-14) |
| 4-n | | X'x...x' | Dial digits packed (2 hex digits per byte); if number of digits is odd, low-order bit of last byte is X'C' |
| n+1-p | | | Connection identifier |
| n+1 | 0-7 | X'xx' | Length (valid range = 0-8) |
| n+2-p | | X'x...x' | Connection ID |
| p+1-q | | | Short Hold mode token |
| p+1 | 0-7 | X'00' | Length (valid range = 0-8; 0 for XID sent by 5494) |
| p+2-q | | X'x....x' | Short Hold mode token |

1 For Short Hold mode, bit 4 of byte 19 is a status indicator (B'0' = Short Hold mode active; B'1' = Short Hold mode reset); bit 5 of byte 19 is a Short Hold indicator (B'0' = XID sender incapable of Short Hold mode; B'1' = XID sender capable of Short Hold mode).

2 The negotiation error control vector is appended only if a format or protocol violation is detected in the received XID command.

3 If a Short Hold mode error occurs, CV length = 7 (X'07').

4 This sense data field is present only when a Short Hold mode error occurs.

5 The Short Hold mode control vector is appended only when an XID3 command or response for Short Hold mode is issued.

| | | | |
|---|---|---|---|
| Key: | X = hexadecimal | B = binary | C = EBCDIC character |
| | x = hex digit | b = bit | c = alphanumeric EBCDIC character |
| | | | a = alphabetic EBCDIC character |
| | | | n = numeric character |

# Chapter 8. Nonprogrammable Workstation Support

This chapter provides the functional details for nonprogrammable workstations (NWSs) attached to the 5494. See Chapter 10, "Systems Network Architecture Support," for more information on SNA.

AS/400 system support for the NWSs is maintained using the 5250 data stream commands and SNA LU 4 and LU 7 commands. These commands are encapsulated in LU 6.2 headers.

Figure 8-1 shows the SNA path information units (PIUs) LU 6.2, LU 4, and LU 7 as they appear in the SDLC frame.

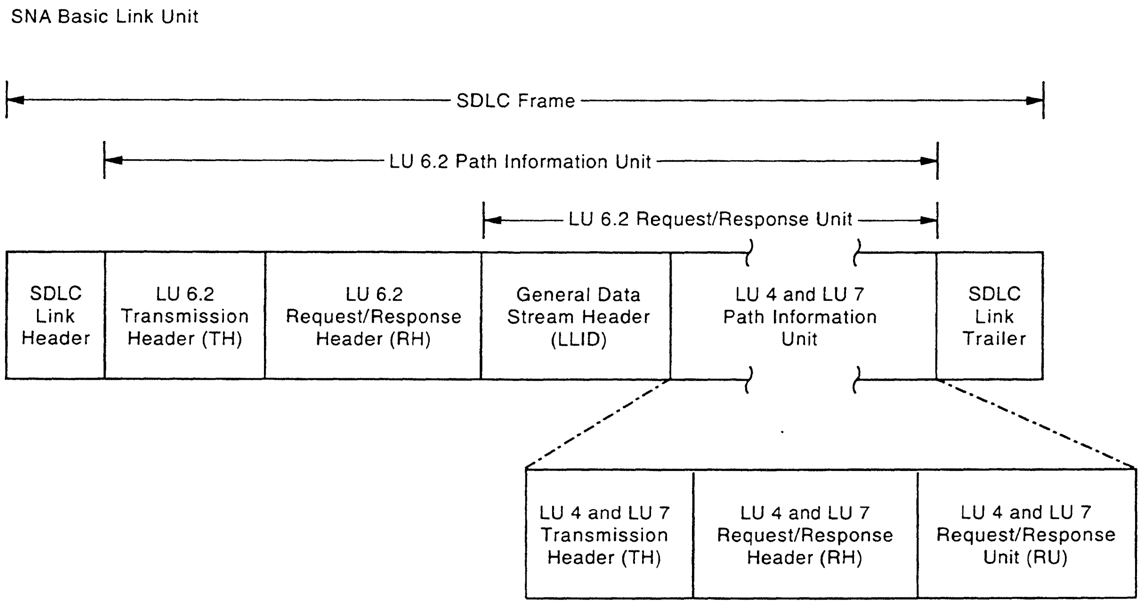



*Figure 8-1. SNA SDLC Path Information Unit*

LU 6.2 sessions must be established between the selected AS/400 system and the 5494. These sessions serve as pipelines for the encapsulated data. The 5494 implements an LU 6.2 closed application program interface (API) whose purpose is to support this encapsulation. No additional LU 6.2 support is provided for NWSs. For information about the X.25 PIU, see Figure 3-1 on page 3-3.

The 5494 implements a single LU with parallel sessions for the support of all attached NWSs. One session is a controller session used for maintenance information, statistics, product information, and code upgrade. In addition, there is one session per active NWS. The BIND for the controller session is sent by the 5494, and the BINDs for the NWS sessions are sent by the AS/400 system.

## Bring-up Operations

In order for the 5494 to establish or reestablish a logical connection with the selected AS/400 system, three steps (collectively called *bring-up operations*) must be taken to activate the session. These steps are:

1. Initialize session limits
2. Activate the controller session
3. Activate the workstation sessions.

The 5494 connection attempts are triggered by one of the following:

- Initial code load of the 5494 and successful physical link activation with one or more powered-on workstations
- Connect operation by workstation operator when the controller session is not already active
- Power-on of a device when no connection is already active
- Recovery following abnormal end of connection.

For more specific information on the connect operation, refer to the *IBM 5494 Remote Control Unit User's Guide*.

## Initializing Session Limits

Session limits are established through a function called Change Number of Sessions (CNOS) that runs prior to establishing the controller session. Information is exchanged with the AS/400 system to establish the maximum number of sessions allowed for the 5494. This information exchange is based on the mode name configured in the 5494.

The mode name configured in the 5494 matches a mode description on the AS/400 system, and that mode description sets the limit on the number of sessions allowed. The mode name also controls certain session parameters such as maximum request/response unit (RU) size and pacing.

If there is failure in the CNOS exchange, the 5494 performs retries if it is configured to do so. The number of retries and the delay between retries is selected during configuration. The reason for the CNOS failure is logged in the 5494 error log. If all retry attempts fail, an SRC is displayed on all active NWSs.

After the retry count is exhausted, retries will continue at 10-minute intervals, if the 5494 is configured for continuous retries. Continuous retries continue until connection is established or an unrecoverable error occurs.

## Activating the Controller Session

After successful CNOS negotiation, the 5494 establishes the controller session with the selected AS/400 system. The 5494 can then receive code upgrades from the selected AS/400 system and can send product information about its attached workstations.

The controller session remains active to serve as a pipeline for maintenance, statistics, and product information.

## Activating the Workstation Sessions

When an NWS is turned on, a notification identifying the device is sent to the AS/400 system on the controller session. After verifying that the device description is valid and the device has been brought online, the AS/400 system establishes an LU 6.2 session for the device. The standard LU 4 and LU 7 sessions are then established within the LU 6.2 session. Figure 8-1 on page 8-1 shows a complete frame as it appears on the AS/400 system link.

## Bring-down Operations

When an NWS is turned off or when its LU 4 and LU 7 sessions end, the AS/400 system ends the LU 6.2 connection to that device.

The controller session is ended when the 5494 is taken offline at the AS/400 system or when there are no active NWSs or PWSs.

## Error Recovery Operations

Abnormal termination of an NWS LU 6.2 session results in an system reference code (SRC) being displayed at the failing workstation. The AS/400 system is responsible for attempting recovery of these sessions.

If the controller session abnormally terminates, the 5494 attempts to recover the session. The number of retries and the delay between retries are selected during configuration. The reason for the session failure is logged in the 5494 error log.

If all retry attempts fail, an SRC is displayed on all active NWS displays. If there are active NWS sessions, they are immediately ended. However, all PWS sessions are maintained.

## Workstation Customization Support

The workstation customization support (WSC) feature enables you to customize any NWS with keyboard translation tables (KTT) and to customize ASCII printers attached to models 3486, 3487, 3488 and models HA, HC, HD, and HG of the 3477 display. WSC also supports font and code correction downloading to the 3486, 3487 and 3488 displays. The WSC support feature includes the following download functions:

**Keyboard Translation Table (KTT)**
A customized KTT enables you to tailor a keyboard to your specific needs. You can create a KTT on the AS/400 system using the AS/400 Workstation Customization utility. The KTT can then be downloaded to the 5494 for use on any NWS.

**Printer Definition Table (PDT)**
A customized PDT enables you to attach non-IBM ASCII printers to supported displays. You can create a PDT on the AS/400 system using the AS/400 Workstation Customization utility. The PDT can then be downloaded to the 5494 for use on a 3486, 3487, 3488, and models HA, HC, HD, and HG of the 3477 display.

**3486, 3487 or 3488 Display Font Table**

You can choose the 3486, 3487 or 3488 font table on the AS/400 system and download them to the 5494 for use on these displays. No hardware change for this display is necessary.

**3486, 3487 or 3488 Code Correction Table**

You can download the code correction table to the 3486, 3487 or 3488 display. This enables support personnel to fix display code problems and distribute request price quotations (RPQs) for the display from the AS/400 system without the hardware having to change.

For complete information on workstation customization, refer to the *Application System/400 Workstation Customization Functions Programmer's Guide and Reference.*

# Chapter 9. Programmable Workstation Support

This chapter provides the functional details for the support of programmable workstations (PWSs) attached to the 5494.

## Pass-Through Function

A PWS communicates with the AS/400 system through multiple LU 6.2 LU-LU sessions. The 5494 supports this communication by acting as a *pass-through* control unit.

The PWS pass-through function tracks the status of the LU 6.2 LU-LU sessions, passes LU-LU data between the AS/400 system and the PWS, and performs session cleanup when sessions are ended abnormally.

The number of sessions a PWS can establish is determined by the following:

- Each PWS is limited to a maximum of 32 sessions.
- The total number of PWS sessions that the 5494 supports for all PWSs attached to it is 1280. This is an average of 16 sessions per PWS if 80 PWSs are attached to the 5494.
- Each PWS is guaranteed a minimum of 10 sessions.

## PWS-Initiated Sessions

When the PWS initiates a session by sending a BIND, the local form session identifiers (LFSIDs) assigned by the PWS to each session are unique for that PWS. However, because one 5494 might have multiple PWSs attached, the LFSID assigned by the PWS would not be unique on the link to the adjacent link station (ALS). The frames, therefore, cannot be passed through the 5494 with the LFSID assigned by the PWS. The 5494 must map the LFSIDs assigned by the PWS to an LFSID that is unique for that session on the link to the ALS. This mapping is performed for all frames flowing from the PWS.

For frames flowing to the PWS, the LFSID is mapped from the LFSID used on the ALS link to the LFSID assigned to the session by the PWS.

Unique LFSIDs for the link to the ALS are obtained from the Address Space Manager (ASM) in the T2.1 node Control Point. When a session is ended, the LFSID used by that session on the link to the ALS is freed so it can be used for new sessions.

## Host-Initiated Sessions

When the host initiates the SNA LU 6.2 session by sending the BIND request to the PWS through the 5494, the host is the primary logical unit (PLU) and assigns an LFSID to that session for use on the link between the host and the 5494, assuming the host is the ALS. The LFSIDs assigned by the host to each session are unique for the link between the host and the 5494.

For the link to the PWS, the 5494 selects an LFSID with ODAI = 0 that is unique for all host-initiated PWS sessions for all PWSs attached to the 5494. As frames pass through the 5494 on these host-initiated sessions, the 5494 performs LFSID mapping, just as with the PWS-initiated sessions.

## BIND Handling

PWSs may be brought up as soon as the 5494 completes its power-on sequence. Handling of BINDs received from a PWS varies depending on the state of the connection to the AS/400 system:

- If the PWS sends a BIND to establish an LU-LU session with an AS/400 system before the 5494 establishes the communication link to the ALS, the BIND is rejected by the 5494.
- If the PWS sends a BIND to establish an LU-LU session with an AS/400 system after the 5494 establishes the communication link to the ALS, but before the controller session is established with the AS/400 system, the BIND is held by the 5494 until the controller session is established, and then passed-through to the ALS.
- If the PWS sends a BIND to establish an LU-LU session with an AS/400 system after the controller session is established with the AS/400 system, the BIND is immediately passed-through to the ALS.

The 5494 does not support segmentation of SNA frames and, therefore, must ensure that sessions between a PWS and a host do not attempt to use segmenting. It must also ensure that the frames flowing on these sessions fit within the BTU size supported by the PWS and the ALS. The following adjustments are made to the contents of host-initiated and PWS-initiated BINDs and positive response BINDs (+rsp{BIND}s) as they pass through the 5494:

- The whole basic information units (BIUs) required indicator (RU byte 6 bit 0) in rq(BIND) RUs and +rsp(BIND) RUs is set to B'1', segmentation not supported.
- For rq(BIND) RUs, if the maximum RU size sent by the secondary half-session (BIND RU byte 10) and the maximum RU size sent by the primary half-session (BIND RU byte 11) will not fit within the smaller of either the BTU size supported by the ALS or the BTU size supported by the PWS, then the 5494 reduces the maximum RU sizes (BIND RU bytes 10 and 11) such that the frames fit within the smaller BTU size. If the link to the ALS is X.25, the RU size is further reduced by 32 bytes so that the SNA transmission header (TH), the SNA frame, and X.25 packet header all fit within the smaller BTU size.

## Session Tracking

The PWS pass-through function tracks the status of the LU 6.2 sessions established between the PWS and the host by monitoring the flow of BIND and UNBIND requests and responses. The session status is tracked so that the LFSID used on the ALS link can be assigned and freed as required, and the 5494 can perform any necessary session cleanup when a session is ended abnormally. BIND requests for PWS sessions may originate from either the PWS or the host.

## Alert Forwarding

The 5494 forwards PWS-issued alerts to the AS/400 system on the system services control point and a physical unit (SSCP-PU) session encapsulated in the LU 6.2 controller session. The 5494 does not modify these alerts in any way; they arrive at the AS/400 system in the same form as when they left the PWS. When the AS/400 system issues a response to an alert, the 5494 forwards this response to the PWS without change.

Because of information added to encapsulate the alert on the controller session, the maximum RU size for an alert is:

- 247 bytes when the link to the ALS supports 265-byte frames
- 503 bytes when the link to the ALS supports 521-byte frames
- 1015 bytes when the link to the ALS supports 1033-byte frames.

The 5494 rejects PWS alerts that exceed these length restrictions. The 5494 also rejects network management vector transports (NMVTs) that do not contain alert major vectors.

# Chapter 10. Systems Network Architecture Support

This chapter describes Systems Network Architecture (SNA) as it relates to the 5494. For a complete description of SNA, refer to *Systems Network Architecture Technical Overview.*

**Note:** In this book, all data strings are presented with the most significant byte on the left. Byte and bit numbers are also written from left to right beginning with byte 0 bit 0 as the most significant bit.

## SNA LU 6.2 Support

This section describes the following specific LU 6.2 support details for the 5494:

- Change number of session (CNOS) support
- Transmission control functions
- Presentation services
- Session manager and resource manager
- SNA LU 6.2 commands and responses.

## CNOS Support

The 5494 supports a source CNOS session to set the limits for a single mode. Only one mode name can be configured. The limits cannot be renegotiated after the initial limits are set. The CNOS negotiation occurs before controller session activation, reactivation, or error recovery.

## Transmission Control Functions

The transmission control functions of the 5494 are as follows:

- Transmission subsystem (TS) profile 7 is supported.
- Fixed pacing (in the sending and receiving direction) is supported.
- Cryptography is not supported.
- Segmentation of RUs is not supported.

The maximum RU size is between 256 and 1024, depending on the size allowed by the selected AS/400 system configuration.

## Presentation Services

The 5494 is a closed system; that is, there is no API to the LU 6.2 architecture. Function Management (FM) Profile 19 is supported with the following exceptions:

- FMH12 (Security) is not supported.
- The Ready to Receive (RTR) DFC command is not supported.
- Contention winner/loser polarity is not negotiable; the BIND sender is the contention winner.
- Only the following combinations of request exception response (RQE), request definite response (RQD), change direction (CD), and conditional end bracket (CEB) are allowed:

For requests:

| | | |
|---|---|---|
| RQE1 | CD | ¬CEB |
| RQE1 | ¬CD | CEB |
| RQD1 | ¬CD | CEB |

For responses:

| | | |
|---|---|---|
| RQE | CD | ¬CEB |
| RQE1 | ¬CD | CEB |
| RQD | ¬CD | CEB |

- Alternate code set is not supported.

For more information on the presentation services, refer to *Systems Network Architecture Formats* and *SNA LU 6.2 Reference Peer Protocols*.

## Session Manager and Resource Manager

The 5494 supports two logical units (LUs):

- NWS LU
- Local LU.

The first LU supports NWS communication with the AS/400 system. The second LU supports communication with the PWS Utility Program.

Both LUs support extended BINDs and nonextended BINDs. Incoming BINDs are accepted if the BIND specifies PLU (the BIND sender) as the contention winner.

The NWS LU uses the configuration fields to specify the following:

- 5494 LU name and network name
- AS/400 system LU name and network name
- Mode name.

The NWS LU supports parallel sessions. This allows one session for each NWS and for the controller. The controller session is bound with the PLU (5494) as the contention winner.

A local LU exists for a session between the 5494 Utility Program and the 5494. The Local LU does not support parallel sessions. The default LU name is LOCL5494. This name cannot be changed. Network names included in BINDs sent to the Local LU are ignored. The Local LU accepts BINDs, but never initiates a BIND.

# SNA LU 6.2 Path Information Unit (PIU)

The SNA LU 6.2 PIU consists of 3 fields: the transmission header (TH) consisting of 5 bytes, the request/response header (RH) consisting 3 bytes, and the request/response unit (RU) consisting of 0 to 1024 bytes. These fields are shown in Figure 10-1.

| | | |
|---|---|---|
| LU 6.2 Transmission Header (TH) | LU 6.2 Request/Response Header (RH) | LU 6.2 Request/Response Unit (RU) |

*Figure 10-1. SNA LU 6.2 Path Information Unit*

## Transmission Header

Table 10-1 shows the format for the transmission header (TH). Bits 0 through 5 of byte 0 never change for any communications involving the 5494. These values indicate that the format identification (FID) is FID2 and that segmenting is not permitted.

*Table 10-1. LU 6.2 Transmission Header Format*

| Byte | Bits | Code | Description |
|---|---|---|---|
| 0 | 0-3 | B'0010' | Format Identifier. FID-2 |
| | 4-5 | B'11' | Mapping field. Always 11 for 5494 (no segmenting) |
| | 6 | | Origin Address Field (OAF)-Destination Address Field (DAF) Assignor Indicator |
| | | B'0' | OAF-DAF assigned by primary link station (as indicated in XID) |
| | | B'1' | OAF-DAF assigned by secondary link station (as indicated in XID) |
| | 7 | B'0' | Normal flow indicator |
| | | B'1' | Expedited flow indicator |
| 1 | | | Reserved |
| 2 | | X'nn' | DAF |
| 3 | | X'nn' | OAF |
| 4–5 | | X'nnnn' | Sequence Number Field |

**Note:** The 5494 is always the secondary link station when communicating with the AS/400 system. Thus, for sessions between the 5494 and the AS/400 system started by the 5494, byte 0 is X'2F' or X'2E'. For sessions started by the AS/400 system, byte 0 is X'2D' or X'2C'.

## Request/Response Header

Tables 10-2 and Table 10-3 on page 10-5 show the format for the request/response header (RH). This 3-byte field determines how the RU is interpreted. For more details, refer to *System Network Architecture Formats*, *SNA LU 6.2 Reference Peer Protocols*, and *System Network Architecture Advanced Peer-to-Peer Networking Architecture Reference*.

Table 10-2 (Page 1 of 2). Request Header Format

| Byte | Bits | Description |
|---|---|---|
| 0 | 0 | Request/response indicator<br>0 = Request |
| | 1-2 | Request/response unit category<br>00 = FM data<br>01 = Network control (not supported by 5494)<br>10 = Data flow control<br>11 = Session control (not supported by 5494) |
| | 3 | Reserved |
| | 4 | Format indicator (FI)<br>For SC and DFC RUs:<br>1 = Format 1 (only valid value for 5494)<br>For FMD RUs, LU-LU session:<br>0 = No FM header present<br>1 = FM header follows |
| | 5 | Sense Data Included indicator<br>0 = Not included<br>1 = Included |
| | 6 | Begin Chain indicator<br>0 = Not first in chain<br>1 = First in chain |
| | 7 | End of Chain indicator<br>0 = Not last in chain<br>1 = Last in chain |
| 1 | 0 | Definite Response 1 (DR1) indicator<br>0 = not DR1<br>1 = DR1 |
| | 1 | Length-Checked Compression indicator<br>0 = RU is not compressed (only value supported by the 5494) |
| | 2 | Definite Response 2 (DR2) indicator<br>0 = Not DR2<br>1 = DR2 |
| | 3 | Exception Response indicator<br>If DR1 or DR2 is set on, then:<br>0 = Definite-response requested<br>1 = Exception-response requested<br>Otherwise:<br>No response requested |
| | 4 | Reserved |
| | 5 | Request Larger Window indicator<br>0 = Larger pacing window not requested (only value supported by the 5494) |

*Table 10-2 (Page 2 of 2). Request Header Format*

| Byte | Bits | Description |
|---|---|---|
| | 6 | Queued Response indicator<br>0 = Response bypasses TC queues<br>1 = Enqueue response in TC queues |
| | 7 | Pacing indicator<br>0 = Not pacing<br>1 = Pacing |
| 2 | 0 | Begin Bracket indicator<br>0 = Not beginning a bracket<br>1 = Beginning a bracket |
| | 1 | End Bracket indicator<br>0 = Not ending a bracket<br>1 = Ending a bracket |
| | 2 | Change Direction indicator<br>0 = Do not change direction<br>1 = Change direction |
| | 3 | Reserved |
| | 4 | Code Selection indicator<br>0 = Code 0 (only value supported by 5494) |
| | 5 | Enciphered Data indicator<br>0 = RU is not enciphered (only value supported by the 5494) |
| | 6 | Padded Data indicator<br>0 = RU is not padded (only value supported by the 5494) |
| | 7 | Conditional End Bracket indicator<br>0 = Not conditional end bracket<br>1 = Conditional end bracket |

*Table 10-3 (Page 1 of 2). Response Header Format*

| Byte | Bits | Description |
|---|---|---|
| 0 | 0 | Request/Response indicator<br>1 = Response |
| | 1-2 | Request/Response unit category<br>00 = FM data<br>01 = Network control (not supported by the 5494)<br>10 = Data flow control<br>11 = Session control |
| | 3 | Reserved |
| | 4 | Format (FM) indicator<br>0 = No FM header<br>1 = FM header follows |
| | 5 | Sense Data Included indicator<br>0 = Not included<br>1 = Included |

*Table 10-3 (Page 2 of 2). Response Header Format*

| Byte | Bits | Description |
|---|---|---|
| | 6 | Begin Chain indicator<br>1 = First in chain (only valid value for response) |
| | 7 | End Chain indicator<br>1 = Last in chain (only valid value for response) |
| 1 | 0 | Definite Response 1 (DR1) indicator<br>0 = Not DR1<br>1 = DR1 |
| | 1 | Reserved |
| | 2 | Definite Response 2 (DR2) indicator<br>0 = Not DR2<br>1 = DR2 |
| | 3 | Response Type indicator<br>0 = Positive<br>1 = Negative |
| | 4 | Reserved |
| | 5 | Reserved |
| | 6 | Queue Response indicator<br>0 = Response bypasses TC queues<br>1 = Enqueue response in TC queues |
| | 7 | Pacing indicator<br>0 = Not pacing<br>1 = Pacing |
| 2 | | Reserved |

# SNA LU 6.2 Commands and Responses

This section provides a summary of the SNA LU 6.2 commands and responses of the 5494 and describes the BIND request in detail. Table 10-4 lists the SNA LU 6.2 commands supported by the 5494. Table 10-5 on page 10-7 shows the format of the LU 6.2 BIND request and response for the 5494.

*Table 10-4. SNA LU 6.2 Command Summary*

| Command | RU Code Point | Number of RU Bytes | Type Session | Type Flow | To/From 5494 | Required Space Character (RSP) Type |
|---|---|---|---|---|---|---|
| BIND | X'31' | Variable | LU-LU | Expedited | To/From | RQD |
| BIS | X'70' | 1 | LU-LU | Normal | To/From | RQD, CD |
| LU Status (LUSTAT) | X'04' | 5 | LU-LU | Normal | To/From | RQE1, CD |
| SIGNAL | X'C9' | 5 | LU-LU | Expedited | To/From | RQD |
| UNBIND | X'32' | Variable | LU-LU | Expedited | To/From | RQD |

*Table 10-5 (Page 1 of 3). LU 6.2 BIND Request and Response RU Format for the 5494*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0 | 0-7 | Request code | X'31' | BIND command |
| 1 | 0-3 | Format [1] | X'0' | Format 0 |
| | 4-7 | Type [1] | X'0' | Cold (negotiable) |
| 2 | 0-7 | FM profile | X'13' | FM profile 19 |
| 3 | 0-7 | TS profile | X'07' | TS profile 7 |
| 4 | | **FM Usage (primary)** | | |
| | 0 | Chaining use | B'1' | Multiple RU chains allowed |
| | 1 | Request mode | B'0' | Immediate Request mode |
| | 2-3 | Chain response | B'11' | Definite or exception response |
| | 4-6 | Reserved | B'000' | |
| | 7 | Send end bracket | B'0' | Will not send EB |
| 5 | | **FM Usage (secondary)** | | |
| | 0 | Chaining use | B'1' | Multiple RU chains allowed |
| | 1 | Request mode | B'0' | Immediate Request mode |
| | 2-3 | Chain response | B'11' | Definite or exception response |
| | 4-6 | Reserved | B'000' | |
| | 7 | Send end bracket | B'0' | Will not send EB |
| 6 | | **FM Usage (common)** | | |
| | 0 | Whole BIUs required | B'1' | No segmentation |
| | 1 | FM headers | B'1' | FM headers allowed |
| | 2 | Bracket reset | B'0' | Reset state is in-bracket |
| | 3 | Bracket termination rule | B'1' | Rule 1 (conditional) |
| | 4 | Code set | B'0' | No alternate code set |
| | 5-6 | Reserved | B'00' | Not available |
| | 7 | BIND queuing indicator | B'0' | No BIND queuing |
| 7 | 0-1 | FM Transaction mode | B'10' | Half-duplex flip-flop (HDX-FF) |
| | 2 | Recovery responsibility | B'1' | Symmetric |
| | 3 | Brackets contention winner or loser [1] | B'1' | Primary is winner |
| | 4-5 | Reserved | B'00' | |
| | 6 | Control vectors indicator | B'1' | Control vectors included |
| | 7 | HDX-FF reset state | B'1' | BIND sender reset to send state |
| | | **TS Usage (8-13)** | | |
| 8 | 0 | Staging indicator (secondary) | B'0' | One-stage pacing |
| | 1 | Reserved | B'0' | |
| | 2-7 | Secondary send pacing count [1] | B'xxxxxx' | [2] |
| 9 | 0 | Adaptive pacing support | B'0' | Not supported |
| | 1 | Reserved | B'0' | |
| | 2-7 | Secondary receive pacing count | B'xxxxxx' | [2] |
| 10 | 0-7 | Max RU size sent by secondary on normal flow [1] | X'xx' | 1024 bytes max |
| 11 | 0-7 | Max RU size sent by primary on normal flow [1] | X'xx' | 1024 bytes max |
| 12 | 0 | Staging indicator (primary) | B'1' | One-stage pacing |
| | 1 | Reserved | B'x' | [2] |
| | 2-7 | Primary send pacing count | B'xxxxxx' | [2] |
| 13 | 0-1 | Reserved | B'00' | |
| | 2-7 | Primary receive pacing count | B'xxxxxx' | [2] |
| | | **PS Profile (14-25)** | | |
| 14 | 0 | PS usage format | B'0' | Basic format |

*Table 10-5 (Page 2 of 3). LU 6.2 BIND Request and Response RU Format for the 5494*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| | 1-7 | LU type | B'0000110' | LU type 6 |
| 15 | 0-7 | LU 6 level | X'02' | LU 6.2 |
| 16-22 | 0-7 | Reserved | X'00' | |
| 23 | 0-2 | Reserved | B'000' | |
| | 3 | Conversation-level security | B'0' | Not supported |
| | 4-5 | Reserved | B'00' | |
| | 6 | Already-verified function | B'0' | Not supported |
| | 7 | Reserved | B'0' | |
| 24 | 0 | Reserved | B'0' | |
| | 1-2 | Synchronization level | B'01' | Confirm |
| | 3-5 | Reserved | B'000' | |
| | 6 | Parallel sessions | B'1' | Supported |
| | 7 | CNOS generalized data stream (GDS) variable | B'1' | Supported |
| 25 | 0-7 | Reserved | X'00' | |
| 26 | 0-7 | Cryptography options [1] | X'00' | No cryptography |
| | | **Primary LU Name** | | BIND request only |
| 27 | | Length | X'xx' | Length=1-17 |
| | | | X'00' | In BIND response |
| 28-m | | Name [1] | C'c...c' | network name.LU name |
| | | **User Data Fields** | | |
| m+1 | | Length [1] | X'xx' | |
| m+2 | | User data key | X'00' | Structured subfields follow |
| | | *Mode Name Subfield* | | |
| | | Length [1] | X'xx' | Length=1-9 |
| | | Subfield name | X'02' | Mode name |
| | | Mode name [1] | C'SNASVCMG' | Reserved mode name |
| | | | or 'cccccccc' | User mode name from configuration |
| | | *Network-Qualified PLU/SLU Network Name Subfield* | | |
| | | Length | X'xx' | Length=3-17 |
| | | Subfield key | X'04' | Request=PLU name |
| | | | X'05' | Response=SLU name |
| | | PLU/SLU name [1] | C'c...c' | network name.LU name |
| n+1 | | **User Request Correlation Field** | | |
| | | Length | X'xx' | No unit reference code (URC) present |
| (n+2)-r | | **Secondary LU Name** | | BIND request only |
| n+2 | | Length | X'xx' | Length=1-17 |
| | | | X'00' | In BIND response |
| (n+3)-r | | Name | C'c...c' | network name.LU name |
| (r+1)-s | | **Control Vectors** | | |
| | | *Fully Qualified PCID Vector* | | |
| | | Vector key | X'60' | FQPCID |
| | | Vector data length [1] | X'xx' | Length=12-26 |
| | | PCID | X'xx...xx' | Format 5 PCID (8 bytes) |
| | | Length of CP name | X'xx' | Length=3-17 |

*Table 10-5 (Page 3 of 3). LU 6.2 BIND Request and Response RU Format for the 5494*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| | | Network-qualified CP name | C'c...c' | network name.CP name |

1 An UNBIND or negative response is generated if a value that is not valid is specified in this field of a received BIND request.

2 For BINDs sent from the 5494, all pacing count fields are set to 0. When the 5494 receives the BIND response, it uses the primary send pacing count as the send pacing window, and the primary receive pacing count as the receive pacing window.

For BINDs received by the 5494, the primary receive pacing count is used as the send pacing window, and the secondary receive pacing count is used as the receive pacing window.

| | | | |
|---|---|---|---|
| Key: | X = hexadecimal | B = binary | C = EBCDIC character |
| | x = hex digit | | c = alphanumeric EBCDIC character |
| | | | a = alphabetic EBCDIC character |
| | | | n = numeric character |

## SNA LU 6.2 Negative Responses

For information about LU 6.2 negative responses, refer to *Systems Network Architecture Format and Protocol Reference Manual: Architectural Logic for LU Type 6.2.*

## SNA LU 4 and LU 7 Support

This section describes the following specific LU 4 and LU 7 support details for the 5494:

- Network addressable units
- Support characteristics
- SNA path information unit
- SNA commands and responses.

## Network Addressable Units

SNA defines network addressable units (NAUs) for data communications applications. These NAUs are divided into three major categories:

- System services control points (SSCPs)
- Physical units (PUs)
- Logical units (LUs).

### System Services Control Points

The SSCP is a special type of NAU that resides in the AS/400 system. The SSCP provides the following services:

- Assists in starting the network
- Helps establish logical connections between other NAUs
- Assists with recovery functions
- Provides maintenance support
- Provides an interface to the network operator services.

### Physical Units

The 5494 maintains a single session between the SSCP and the PU (SS-PU) as long as the physical link exists between the AS/400 system and the 5494. The ACTIVATE PHYSICAL UNIT (ACTPU) command is not required to activate this session. The 5494 uses the SS-PU session to transfer maintenance data and send alerts to the AS/400 system.

### Logical Units

The 5494 supports LUs of type 4 (printers) and type 7 (workstations). For a list of supported workstations, refer to the *IBM 5494 Remote Control Unit Planning Guide*.

SNA maintains an SS-LU session for each active workstation attached to the 5494. The ACTIVATE LOGICAL UNIT (ACTLU) command establishes this session. The SSCP uses the SS-LU session to send system services (SS) messages to the display. The LU uses the SS-LU session to request system and test functions, and to send LU status information to the SSCP. The BIND command logically connects one LU to another LU in the AS/400 system (typically an application program). This command specifies the communications rules for the LU-LU session and is sent on the LU-LU flow.

## Transmission Control Functions

The TS profile specifies the transmission control (TC) options to be used in a session. The 5494 uses a subset of TS profile 7 that:

- Supports the following session control commands:
  - ACTIVATE LOGICAL UNIT (ACTLU)
  - DEACTIVATE LOGICAL UNIT (DACTLU)
  - BIND
  - UNBIND
- Does not support the following commands:
  - START DATA TRAFFIC (SDT)
  - CLEAR
  - REQUEST RECOVERY (RQR)
  - SET AND TEST SEQUENCE NUMBERS (STSN)
- Allows bidirectional pacing on normal flow
- Does not allow sequence numbers on normal flow
- Specifies maximum request/response unit (RU) sizes for function management data in TS usage field of BIND command
- Does not support cryptography.

The session is *in brackets* after the BIND command (BIND sender is in send state).

## Presentation Services

The FM profile specifies the data flow control (DFC) and the function management data services (FMDS) options to be used in sessions. The 5494 supports the following parts of FM profile 7:

- DFC commands:
  - SIGNAL
  - LU STATUS (LUSTAT)
  - CANCEL
  - REQUEST SHUTDOWN (RSHUTD).
- Multiple RU chains are allowed.
- Normal Flow mode is half-duplex flip-flop (HDX-FF).
- Normal Flow mode is full-duplex for workstations with pass-through data streams.
- Immediate Request mode is used for workstations and printers.
- Delayed Request mode is optional for printers.
- Immediate Response mode is used.
- Chains must flow RQD, RQE, or RQN. However, the 5494 does not send chains RQN.
- RQD chains must include a CD bit.
- End bracket (EB) is not used.
- Chain sender is responsible for error recovery.

- FM headers are not allowed.
- Data compression is not supported.
- An alternate code set is not supported by the 5494.

# SNA LU 4 and LU 7 Path Information Unit

The SNA LU 4 and LU 7 PIU consists of three fields: the transmission header (TH), the request/response header (RH), and the request/response unit (RU). These fields are shown in Figure 10-2.

| | | |
|---|---|---|
| LU 4 and LU 7 Transmission Header (TH) | LU 4 and LU 7 Request/Response Header (RH) | LU 4 and LU 7 Request/Response Unit (RU) |

*Figure 10-2. SNA LU 4 and LU 7 Path Information Unit*

## Transmission Header

Table 10-6 shows the format for the transmission header (TH). Bits 0 through 6 of byte 0 never change for any communications involving the 5494. These values indicate that the format identification (FID) is FID-3 and that segmenting is not permitted. The FID describes physical link characteristics. For a complete description of SNA FID characteristics, refer to *Systems Network Architecture Format and Protocol Reference Manual: Architectural Logic.*

*Table 10-6. Transmission Header Format*

| Byte | Bits | Code | Description |
|---|---|---|---|
| 0 | 0-3 | B'0011' | **Format Identifier.** FID-3 for 5494. |
| | 4-5 | B'11' | Mapping field. Always 11 for 5494 (no segmenting). |
| | 6 | B'0' | Reserved |
| | 7 | B'0' | Normal flow indicator |
| | | B'1' | Expedited flow indicator |
| 1 | | | **Local Session Identifier** (see note) |
| | 0-1 | B'00' | SS-PU session |
| | | B'01' | SS-LU session |
| | | B'11' | LU-LU session |
| | | B'10' | Not valid |
| | 2-7 | B'nnnnnn' | Local station address (also known as unit address) |

**Note:** For the 5494, an SS-PU session has an local session identifier (LSID) of X'00'. An LU-LU session with an attached workstation, which has a unit address of 02, has an LSID of X'C2'.

Bit 7 of byte 0 is set when the command is an expedited-flow command. The receiving station inserts expedited-flow commands ahead of all pending commands in its request/response queue. When this bit is cleared, the request/response is added to the end of the queue.

Byte 1 of the TH is the LSID. Bits 0 and 1 indicate the session type for this frame. Bits 2 through 7 are used to address the individual LUs within the 5494. For SS-PU sessions, bits 2 through 7 are always cleared.

To determine the local station address for an attached workstation, multiply the port number (0, 1, or 2) by 7 and add the unit address for the device (0 through 6). The unit address is set at each workstation either by rocker switches or by software. Refer to the workstation documentation to interpret the switch settings for each device.

## Request/Response Header

Tables 10-7 and Table 10-8 on page 10-14 show the format for the request/response header (RH). The RH is a 3-byte field that defines how the RU is interpreted.

*Table 10-7 (Page 1 of 2). Request Header Format*

| Byte | Bits | Description |
|---|---|---|
| 0 | 0 | Request/response indicator (RRI)<br>0 = Request |
| | 1-2 | Request/response unit category (CAT)<br>00 = Function management data (FMD)<br>01 = Network control (NC) (not supported)<br>10 = Data flow control (DFC)<br>11 = Session control (SC) |
| | 3 | Reserved (always a 0) |
| | 4 | Format indicator (FI) for SC and DFC RUs:<br>0 = Format 0 (not valid)<br>1 = Format 1<br>For FMD RUs, SS-PU and SS-LU session:<br>0 = No network services (NS) header present<br>1 = NS header present<br>For FMD RUs, and LU-LU session:<br>0 = No FM header present<br>1 = FM header present (not supported) |
| | 5 | Sense data included indicator (SDI)<br>0 = No sense data<br>1 = Sense data included |
| | 6-7 | Chain control<br>00 = Middle of chain<br>01 = Last of chain<br>10 = First of chain<br>11 = Only in chain |
| 1 | 0 | Definite response 1 indicator (DR1I) |
| | 1 | Reserved (always a 0) |
| | 2 | Definite response 2 indicator (DR2I) |

*Table 10-7 (Page 2 of 2). Request Header Format*

| Byte | Bits | Description |
|---|---|---|
| | 3 | Exception response indicator (ERI). Used in conjunction with DR1I and DR2I to indicate the form of the requested response.<br>**DR1I DR2I ERI — DEFINITION**<br>0 0 0 — No response (RQN)<br>0 0 1 — Reserved<br>1 0 0 — Definite response (RQD 1/2)<br>0 1 0<br>1 1 0<br>1 0 1 — Exception response (RQE 1/2)<br>0 1 1<br>1 1 1 |
| | 4-5 | Reserved (always 00) |
| | 6 | Queued response indicator<br>0 = Bypass TC queue<br>1 = Use TC queue |
| | 7 | Pacing indicator<br>0 = No pacing<br>1 = Pacing |
| 2 | 0 | Begin bracket indicator (BBI) (always a 0) |
| | 1 | End bracket indicator (EBI) (always a 0) |
| | 2 | Change direction indicator (CDI)<br>0 = Do not change direction<br>1 = Change direction |
| | 3 | Reserved (always 0) |
| | 4 | Code selection indicator (CSI)<br>0 = Code 0<br>1 = Code 1 (not supported) |
| | 5 | Enciphered data indicator (EDI)<br>0 = RU is not enciphered<br>1 = RU is enciphered (not supported) |
| | 6 | Padded data indicator (PDI)<br>0 = RU is not padded<br>1 = RU is padded (not supported) |
| | 7 | Reserved for LU types 4 and 7 (always a 0) |

*Table 10-8 (Page 1 of 2). Response Header Format*

| Byte | Bits | Description |
|---|---|---|
| 0 | 0 | Request/response indicator (RRI)<br>1 = Response |
| | 1-2 | Request/response unit category (CAT)<br>00 = Function management data (FMD)<br>01 = Network control (NC) (not supported)<br>10 = Data flow control (DFC)<br>11 = Session control (SC) |
| | 3 | Reserved |

*Table 10-8 (Page 2 of 2). Response Header Format*

| Byte | Bits | Description |
|---|---|---|
| | 4 | Format indicator (FI), used to indicate an SNA formatted RU:<br>0 = Format 0 (not valid)<br>1 = Format 1<br>For FMD RUs, SS-PU and SS-LU session:<br>0 = No network services (NS) header present<br>1 = NS header present<br>For FMD RUs, and LU-LU session:<br>0 = No FM header present<br>1 = FM header present (not supported) |
| | 5 | Sense data included indicator (SDI)<br>0 = No sense data<br>1 = Sense data is included in the first 4 bytes of the RU |
| | 6-7 | Chain control. Only in a chain (always 11 for a response). |
| 1 | 0 | Definite response 1 indicator (DR1I). The value returned is the same as the value in the request header. |
| | 1 | Reserved (always 0) |
| | 2 | Definite response 2 indicator (DR2I). The value returned is the same as the value in the request header. |
| | 3 | Response type indicator (RTI)<br>0 = Positive response<br>1 = Negative response |
| | 4-5 | Reserved |
| | 6 | Queue response indicator (QRI)<br>0 = Bypass TC queue<br>1 = Use TC queue |
| | 7 | Pacing indicator (PI)<br>0 = No pacing<br>1 = Pacing |
| 2 | 0-7 | Reserved |

## SNA LU 4 and LU 7 Commands and Responses

This section describes the SNA LU 4 and LU 7 commands and responses unique to the 5494. For a complete description of SNA commands and responses, refer to *Systems Network Architecture Technical Overview.*

Figure 10-3 summarizes the SNA commands supported by the 5494. Some commands are found on several of the rightmost nodes of the diagram (for example, CANCEL). This indicates that the request is available to both partners in the current session.

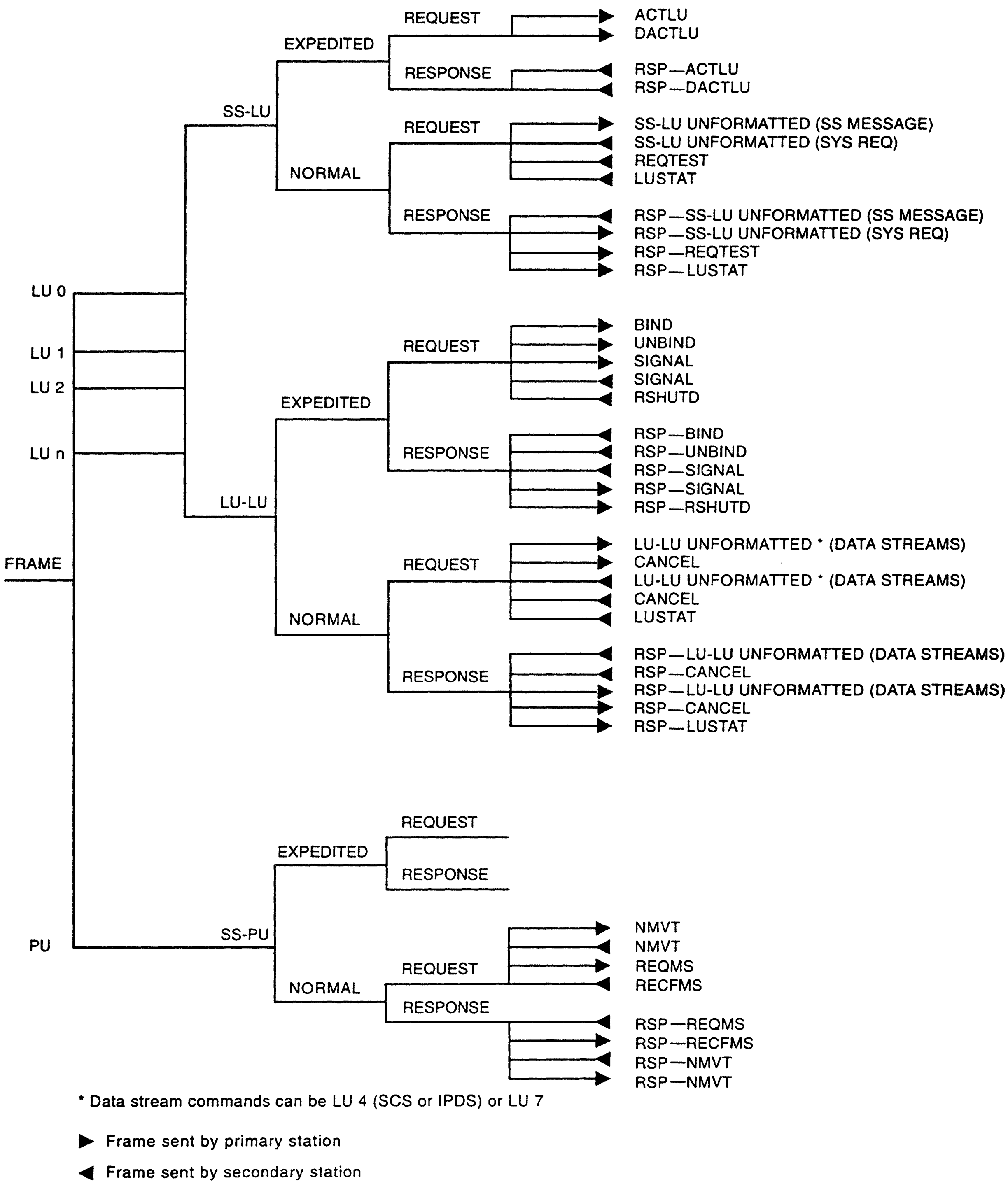



*Figure 10-3. SNA LU 4 and LU 7 Command Summary*

## ACTLU

The AS/400 system uses the ACTIVATE LOGICAL UNIT (ACTLU) command to initialize the SS-LU session for each workstation attached to the 5494. Table 10-9 shows the format of the ACTLU command. Table 10-10 shows the response sent by the 5494. The AS/400 system examines byte 5, bits 0 and 1, to determine whether the LU is a printer or a workstation.

*Table 10-9. The ACTLU Command RU Format*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0 | 0-7 | Code | X'0D' | ACTLU command |
| 1 | 0-7 | Activation type | X'01' or<br>X'02' | Cold activation or<br>ERP activation |
| 2 | 0-3 | FM profile | B'0000' | FM profile 0 |
| | 4-7 | TS profile | B'0001' | TS profile 1 |

*Table 10-10. The ACTLU Response RU Format*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0 | 0-7 | Code | X'0D' | ACTLU command |
| 1 | 0-7 | Activation type | X'01' | Cold activation |
| 2 | 0-3 | FM profile | B'0000' | Same as ACTLU request |
| | 4-7 | TS profile | B'0001' | Same as ACTLU request |
| 3 | 0-7 | Control Vector key | X'00' | Key = '00' |
| 4 | 0-7 | Max RU size on SS-LU normal flow by either half-session | X'84' | 128 bytes maximum |
| 5 | | **LU Capabilities** | | |
| | 0-1 | Host allowed to send SS requests on SS-LU flow | B'00'<br>or<br>B'10' | Printer - SS requests not allowed<br>Display - SS requests allowed |
| | 2 | LU able to process RUs on LU-LU flow (including BIND) | B'0' or<br>B'1' | LU available<br>LU powered down, or unrecoverable hardware error. |
| | 3-7 | Reserved | B'00000' | |
| 6 | | **LU Capabilities** | | |
| | 0-7 | Reserved | X'00' | |
| 7 | 0-7 | Reserved | X'00' | |

## BIND

The BIND command and response specify the protocols that the primary and secondary LUs use when communicating with each other during an LU-LU session. The BIND command establishes an LU-LU session between the AS/400 system and the requested workstation. The AS/400 system sends a BIND request to the 5494 on the LU-LU expedited flow. The 5494 checks the BIND request and returns either a positive or negative response. A negative response indicates that there is a BIND parameter or BIND type that is not valid, or that the LU is already in session.

Table 10-11 on page 10-18 and Table 10-12 on page 10-19 show the format of the BIND command and response for workstations (LU 7) and printers (LU 4).

For more information on the BIND command, refer to *Systems Network Architecture Technical Overview.*

*Table 10-11 (Page 1 of 2). BIND Command and Response RU Format for Workstations LU 7*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0 | 0-7 | Request code | X'31' | BIND command |
| 1 | 0-3 | Format | B'0000' | Format 0 [1] |
| | 4-7 | Type | B'0000' | Cold (negotiable) [1] |
| 2 | 0-7 | FM profile | X'07' | FM profile 7 |
| 3 | 0-7 | TS profile | X'07' | TS profile 7 |
| 4 | | **FM Usage (primary)** | | |
| | 0 | Chaining use | B'1' | Multiple RU chains allowed |
| | 1 | Request mode | B'0' | Immediate Request mode |
| | 2-3 | Chain response | B'11' | Definite or exception response |
| | 4-5 | Reserved | B'00' | |
| | 6 | Compression | B'0' | No compression |
| | 7 | Send end bracket (EB) | B'0' | Will not send EB |
| 5 | | **FM Usage (secondary)** | | |
| | 0 | Chaining use | B'1' | Multiple RU chains allowed |
| | 1 | Request mode | B'0' | Immediate Request mode |
| | 2-3 | Chain response | B'11' | Definite or exception response |
| | 4-5 | Reserved | B'00' | |
| | 6 | Compression | B'0' | No compression |
| | 7 | Send end bracket | B'0' | Will not send EB |
| 6 | | **FM Usage (common)** | | |
| | 0 | Reserved | B'0' | |
| | 1 | FM headers | B'0' | FM headers not allowed |
| | 2 | Bracket reset | B'0' | Reset state is in-bracket |
| | 3 | Bracket termination rule | B'1' | Rule 1 (conditional) |
| | 4 | Code set | B'0' | No alternate code set |
| | 5 | Sequence number | B'0' | Not available |
| | 6 | Bracket initiation stop (BIS) | B'0' | BIS not sent |
| | 7 | Reserved | B'0' | |
| 7 | 0-1 | Normal Flow mode | B'00' | Full-duplex (for pass-through data stream) |
| | | | B'10' | Half-duplex flip-flop (HDX-FF) |
| | 2 | Recovery responsibility | B'0' | Contention loser (primary) |
| | 3 | Brackets contention winner or loser | B'0' | Secondary is winner |
| | 4-6 | Reserved | B'000' | |
| | 7 | HDX-FF reset state | B'1' | BIND sender reset to send state |
| | | **TS Usage (8-13)** | | |
| 8 | 0 | Staging indicator (secondary) | B'x' | Same as BIND request |
| | 1 | Reserved | B'x' | Same as BIND request |
| | 2-7 | Secondary send pacing count | B'xxxxxx' | Same as BIND request |
| 9 | 0-1 | Reserved | B'00' | [1] |
| | 2-7 | Secondary receive pacing count | B'000000' | No pacing count [1] |
| 10 | 0-7 | Max RU size sent by secondary on normal flow [2] | X'xx' | 256, 512, or maximum 1024 bytes in the BIND response depending on the value received in the BIND request and the LU 6.2 RU size. |
| 11 | 0-7 | Max RU size sent by primary on normal flow [2] | X'xx' | Maximum 1024 bytes in BIND response |

*Table 10-11 (Page 2 of 2). BIND Command and Response RU Format for Workstations LU 7*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 12 | 0 | Staging indicator (primary) | B'0' | If BIND request byte 12, bit 0=0, then BIND response byte 12, bits 0-7 are same as BIND request byte 12, bits 0-7. If BIND request byte 12, bit 0=1, then BIND response byte 12, bits 0-7 are same as BIND response byte 9, bits 0-7. |
| | 1 | Reserved | B'x' | |
| | 2-7 | Primary send pacing count | B'xxxxxx' | |
| 13 | 0-1 | Reserved | B'xx' | Same as BIND request |
| | 2-7 | Primary receive pacing count | B'xxxxxx' | Same as BIND request |
| | | **PS Profile (14-25)** | | |
| 14 | 0 | PS usage format | B'0' | Basic format |
| | 1-7 | LU type | B'0000111' | LU 7 (workstation) |
| 15-23 | 0-7 | Reserved | X'00' | |
| 24 | 0 | Reserved | B'0' | |
| | 1-7 | Display screen size | B'0000010' | 1920 (24 x 80) |
| 25 | 0-6 | Reserved | B'0000000' | |
| | 7 | Initial program load (IPL) (download) | B'x' | BIND response If byte 25, bit 7=0, then no download. If byte 25, bit 7=1, then request download. |

1 Negative response generated if parameter that is not valid is specified in this field of the BIND request.

2 Support for these parameters must also be configured at the AS/400 system.

*Table 10-12 (Page 1 of 3). BIND Command and Response RU Format for Printers LU 4*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0 | 0-7 | Request code | X'31' | BIND command |
| 1 | 0-3 | Format | B'0000' | Format 0 [1] |
| | 4-7 | Type | B'0000' | Cold (negotiable) [1] |
| 2 | 0-7 | FM profile | X'07' | FM profile 7 |
| 3 | 0-7 | TS profile | X'07' | TS profile 7 |
| 4 | | **FM Usage (primary)** | | |
| | 0 | Chaining use | B'1' | Multiple RU chains allowed |
| | 1 | Request mode | B'1' | Delayed Request mode |
| | 2-3 | Chain response | B'11' | Definite or exception response |
| | 4-5 | Reserved | B'00' | |
| | 6 | Compression | B'0' | No compression |
| | 7 | Send end bracket | B'0' | Will not send EB |
| 5 | | **FM Usage (secondary)** | | |
| | 0 | Chaining use | B'1' | Multiple RU chains allowed |
| | 1 | Request mode | B'0' | Immediate Request mode |
| | 2-3 | Chain response | B'11' | Definite or exception response |
| | 4-5 | Reserved | B'00' | |
| | 6 | Compression | B'0' | No compression |
| | 7 | Send end bracket | B'0' | Will not send EB |
| 6 | | **FM Usage (common)** | | |
| | 0 | Reserved | B'0' | |
| | 1 | FM headers | B'0' | FM headers not allowed |
| | 2 | Bracket reset | B'0' | Reset state is in-bracket |
| | 3 | Bracket termination rule | B'1' | Rule 1 (conditional) |
| | 4 | Code set | B'0' | No alternate code set |

*Table 10-12 (Page 2 of 3). BIND Command and Response RU Format for Printers LU 4*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| | 5 | Sequence number | B'0' | Not available |
| | 6 | Bracket initiation stop (BIS) | B'0' | BIS not sent |
| | 7 | Reserved | B'0' | |
| 7 | 0-1 | FM Transaction mode | B'10' | Half-duplex flip-flop (HDX-FF) |
| | 2 | Recovery responsibility | B'0' | Contention loser (primary) |
| | 3 | Brackets contention winner or loser | B'0' | Secondary is winner |
| | 4-6 | Reserved | B'000' | |
| | 7 | HDX-FF reset state | B'1' | BIND sender reset to send state |
| | | **TS Usage (8-13)** | | |
| 8 | 0 | Staging indicator (secondary) | B'x' | Same as BIND request |
| | 1 | Reserved | B'x' | Same as BIND request |
| | 2-7 | Secondary send pacing count | B'xxxxxx' | Same as BIND request |
| 9 | 0-1 | Reserved | B'00' | |
| | 2-7 | Secondary receive pacing count [3] | B'000001' to B'000111' | If BIND RU byte 9=1 to 7, then RSP=REQ. If BIND RU byte 9=0 or is greater than 7, then set to 7. [2] |
| 10 | 0-7 | Max RU size sent by secondary on normal flow [3] | X'xx' | 256, 512, or maximum 1024 bytes in the BIND response depending on the value received in the BIND request and the LU 6.2 RU size |
| 11 | 0-7 | Max RU size sent by primary on normal flow [3] | X'xx' | Maximum 1024 bytes in BIND response |
| 12 | 0 | Staging indicator (primary) | B'0' | If BIND request byte 12, bit 0=0, then BIND response byte 12, bits 0-7 are same as BIND request byte 12, bits 0-7. If BIND request byte 12, bit 0=1, then BIND response byte 12, bits 0-7 are same as BIND response byte 9, bits 0-7. |
| | 1 | Reserved | B'x' | |
| | 2-7 | Primary send pacing count | B'xxxxxx' | |
| 13 | 0-1 | Reserved | B'xx' | Same as BIND request |
| | 2-7 | Primary receive pacing count | B'xxxxxx' | Same as BIND request |
| | | **PS Profile (14-25)** | | |
| 14 | 0 | PS usage format | B'0' | Basic format |
| | 1-7 | LU type | B'0000100' | LU 4 (printer) |
| | | **Primary Send Direction of Flow (15-18)** | | |
| 15 | | **Print Data Stream Profile** | | |
| | 0 | Base DSP | B'1' | Supported |
| | 1 | GDS subset | B'1' | Supported |
| | 2 | Remote Job Entry (RJE) SNA Character String (SCS) subset | B'0' | Not supported |
| | 3 | WP final form | B'0' | Not supported |
| | 4 | WP raw form | B'0' | Not supported |
| | 5 | Reserved | | |
| | 6 | Dual pitch printer | B'0' | Not supported |
| | 7 | Proportional ESC | B'0' | Not supported |
| 16 | 0-7 | **Additional Media** | X'00' | No additional media |
| 17 | | **Console Data Stream Profile** | | |
| | 0-3 | Console definition | X'0' | No console support |

*Table 10-12 (Page 3 of 3). BIND Command and Response RU Format for Printers LU 4*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| | 4-7 | Reserved | X'0' | |
| 18 | | **FM and FMH Usage** | | |
| | 0 | SS FM data | B'0' | Not supported |
| | 1-7 | FM header bits | B'0000000' | No FM headers |
| | | **Secondary Send Direction of Flow (19-22)** | | |
| 19 | 0-7 | Print data stream profile | X'00' | No send capability |
| 20 | 0-7 | Additional media | X'00' | No send capability |
| 21 | 0-7 | Console data stream profile | X'00' | No send capability |
| 22 | 0-7 | FM and FMH usage | X'00' | No send capability |
| 23 | | **Code Selection** | | |
| | 0-3 | Repertoire | B'1000' | EBCDIC |
| | 4-5 | Main code | B'00' | EBCDIC |
| | 6-7 | Reserved | B'00' | |
| 24 | | **General Characteristics** | | |
| | 0-1 | Reserved | B'00' | |
| | 2 | Data direction | B'0' | BIND sender may send first |
| | 3 | Reserved | B'0' | |
| | 4 | Attended mode | B'0' | BIND receiver will initiate attended mode |
| | 5 | Alternate mode | B'0' | BIND receiver will not alternate attended and unattended modes |
| | 6-7 | Reserved | B'00' | |
| 25 | | **NCI Characteristics** | | |
| | 0 | Image data | B'0' | Not supported |
| | 1 | Speech data | B'0' | Not supported |
| | 2-6 | Reserved | B'00000' | |
| | 7 | IPL (Download) | B'x' | If byte 25, bit 7=0, then no download. If byte 25, bit 7=1, then request download. |

1 Negative response generated if parameter that is not valid is specified in this field of the BIND request

2 5494 allows a maximum pacing count of 7 for up to three printers. Any additional printers are allowed a maximum pacing count of 3. A count greater than 3 causes an X'03' to be returned in BIND response byte 9.

3 Support for these parameters must also be configured at the AS/400 system.

## CANCEL

The CANCEL command stops a partially transmitted chain of FMD commands. The CANCEL command is sent only when a chain is in progress. The 5494 sends a CANCEL on the normal LU-LU flow when it receives a negative response to a command in the current chain. The request code (RU byte 0) for CANCEL is X'83'

## DACTLU

The DEACTIVATE LOGICAL UNIT (DACTLU) command ends an SS-LU session. DACTLU is sent on the expedited SS-LU flow. The 5494 sends a positive response when the deactivation is complete. The request code (RU byte 0) for DACTLU is X'0E'.

## LUSTAT

The LU STATUS (LUSTAT) reports error conditions during an LU-LU or SS-LU session to the AS/400 system. The request code (RU byte 0) for LUSTAT is X'04'. The 5494 sets the CD bit when it sends LUSTAT on an LU-LU session. Bytes 1 through 4 of the RU for an LUSTAT command contain the status information, which is summarized in Table 10-13.

*Table 10-13. LUSTAT Status Field (RU Bytes 1-4)*

| Status | Session Type | Description |
|---|---|---|
| 00000103 | LU-LU | Display data stream parameter error (format table resequencing error) |
| 00000287 | LU-LU | Display data stream parameter error (self-check field > 33 bytes) |
| 00000288 | LU-LU | Display data stream parameter error (self-check FCW not valid) |
| 00004040 to 0000FFFF | LU-LU | Ideographic request |
| 00010000 | | Sent when: |
| | SS-LU | Station is turned on but only if ACTLU was received while station was turned off |
| | SS-LU | Station becomes available after permanent hardware error (LUSTAT 08310000 condition resolved) |
| | SS-LU or LU-LU | Display contention error is resolved (-RSP 082D0100 condition resolved) |
| | SS-LU | Display becomes available after IPL completion (only if a BIND was rejected) |
| 00020000 | LU-LU | Sent after printer receives request with CD bit set |
| 08310000 | SS-LU | Sent when display is powered off or has unrecoverable hardware error while in session (RSHUTD also sent) |

## NMVT

The 5494 uses the Network Management Vector Transport (NMVT) as follows:

- The 5494 receives an NMVT request from the AS/400 system for product information about the 5494 and attached devices. The Network Services Major Vector (NSMV) Query Product Set ID (QPSID) is used.
- The 5494 sends an NMVT to the AS/400 system with product information about the 5494 and attached workstations. The NSMV Product Set ID (PSID) is used.
- The 5494 sends generic alerts to the AS/400 system.
- The SNA Response Time Monitor (RTM) function enables the 5494 to measure and analyze response times for NWSs, after which the AS/400 user can display the results of the 5494 analysis.

When an error causes the Token-Ring link in a Token-Ring Gateway configuration to go down, the 5494 logs the error by time and date and issues a generic Token-Ring alert. The Token-Ring alerts are described in "Token-Ring Gateway Error Recovery" on page 6-5. You can also find a complete description of the SNA alerts format in "5494 SNA Alert Support" on page 11-1.

The 5494 also forwards alerts issued by PWSs to the AS/400 system on the SSCP-PU flow encapsulated in the LU 6.2 controller session. This is described in "Alert Forwarding" on page 9-3.

The NMVT RU format as sent by the 5494 is summarized in Table 10-14.

*Table 10-14. NMVT RU Format*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0-2 | | Network services header | X'41038D' | NMVT |
| 3-4 | | Reserved | X'0000' | |
| 5-6 | 0-3 | Reserved | B'0000' | |
| | 4-15 | Procedure-related ID | X'xxx' | |
| 7 | 0 | Solicitation indicator | B'0' | Unsolicited |
| | | | B'1' | Solicited |
| | 1-2 | Sequence field | B'00' | Only reply |
| | | | B'01' | Last |
| | | | B'10' | First |
| | | | B'11' | Middle |
| | 3 | SNA address list | B'0' | Not included |
| | | | B'1' | Included |
| | 4-7 | Reserved | B'0' | |
| 8-*n* | | Network Services major vector | | QPSID, PSID, RTM, or generic alert. See *Systems Network Architecture Format and Protocol Reference Manual: Architectural Logic* for details of major vectors. |

## REQTEST

The REQUEST TEST (REQTEST) command is used to request that a test procedure be loaded and run. The format of the REQTEST RU as sent by the 5494 is summarized in Table 10-15. The operator initiates a REQTEST by pressing the Test Request key sequence. The *IBM 5494 Remote Control Unit User's Guide* defines the Test Request key sequence for all supported keyboards.

*Table 10-15. REQTEST RU Format*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0-2 | | **Network Services Header** | | |
| 0 | 0-1 | Involves PU or LU | B'00' | Either PU or LU |
| | 2-7 | Header type | B'000001' | Network Services header |
| 1 | 0 | Domain | B'0' | Same domain |
| | 1 | Reserved | B'0' | |
| | 2-7 | NS category | B'000011' | Maintenance Services |
| 2 | 0-7 | Request code | X'80' | REQTEST command |
| 3 | 0-7 | Network name 1 | X'00' | No name present |
| 4 | 0-7 | Network name 2 | X'00' | No name present |
| 5 | 0-7 | Procedure name | X'00' | No name present |
| 6 | 0-7 | Requester ID | X'00' | No ID present |
| 7 | 0-7 | Password | X'00' | No password present |
| 8 | 0-7 | User Field | X'00' | No user data present |

## RECFMS

The 5494 sends the RECORD FORMATTED MAINTENANCE STATISTICS (RECFMS) command when it receives a REQMS from the AS/400 system or when one of the statistical counters overflows. Byte 7, bit 0, indicates the reason for the RECFMS. Table 10-16 shows the format for the first 13 bytes of the RECFMS command.

*Table 10-16. RECFMS Format (Bytes 1-13)*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0-2 | | **Network Services Header** | | |
| 0 | 0-1 | Involves PU or LU | B'01' | PU only |
| | 2-7 | Header type | B'000001' | Network Services header |
| 1 | 0 | Domain | B'0' | Same domain |
| | 1 | Reserved | B'0' | |
| | 2-7 | NS category | B'000011' | Maintenance Services |
| 2 | | Request code | X'84' | RECFMS command |
| 3-6 | | Communication Network Management (CNM) header | X'xxxxxxxx' | Solicited RECFMS (echoed from bytes 3-6 of REQMS) |
| | | | X'00000000' | Unsolicited |
| 7 | 0 | Solicitation Indicator | B'1' or B'0' | Reply request (REQMS) or Unsolicited |
| | 1 | Not last request Indicator | B'0' | Last request |
| | 2-7 | Type code | B'000001' or B'000100' | Type code of 1 or Type code of 4 |
| | | Node identification | | |
| 8-11 | 0-11 | Block number | X'073' | 5494 block number |
| | 12-31 | ID Number | X'000xx' | xx = Station address |
| 12-13 | 0-15 | Reserved | X'0000' | |

Table 10-17 shows the format of bytes 14 through 17 of the RECFMS command type 2.

*Table 10-17. RECFMS Type 1 Format (Bytes 14-17)*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 14-15 | 0-15 | Test frames received | X'xxxx' | Sum of communications counters 0060 and 0061 |
| 16 | 0-7 | Reserved | X'00' | |
| 17 | 0-7 | Test frames received without error | X'xx' | Communications counter 0061 |

The format of a RECFMS type 4 contains X'FF' in byte 14. The contents of the statistical counters and the error log begin at byte 15 of the RECFMS type 4 response. Table 10-18 provides the format of the counters when sent. The 5494 returns only those counters with nonzero content. The error log entries begin immediately following the last statistical counter sent in the RECFMS. Table 10-19 shows the format of each entry in the log. The 5494 clears the error log after sending an RECFMS regardless of the Reset Indicator bit received in the REQMS command.

*Table 10-18. RECFMS Counter Format*

| Counter | Length | LSID | SRC | Sense Data |
|---|---|---|---|---|
| 60 | X'05' | X'00' | X'0060' | 1 byte counter |
| 61 | X'05' | X'00' | X'0061' | 1 byte counter |
| 62 | X'05' | X'00' | X'0062' | 1 byte counter |
| 63 | X'05' | X'00' | X'0063' | 1 byte counter |
| 64 | X'05' | X'00' | X'0064' | 1 byte counter |
| 65 | X'05' | X'00' | X'0065' | 1 byte counter |
| 66 | X'05' | X'00' | X'0066' | 1 byte counter |
| 67 | X'05' | X'00' | X'0067' | 1 byte counter |
| 68 | X'05' | X'00' | X'0068' | 1 byte counter |
| 69 | X'05' | X'00' | X'0069' | 1 byte counter |
| 6A | X'05' | X'00' | X'006A' | 1 byte counter |
| 6B | Not Used | | | |
| 6C | X'05' | X'00' | X'006C' | 1 byte counter |
| 6D | X'05' | X'00' | X'006D' | 1 byte counter |
| 6E | X'09' | X'00' | X'006E' | X'00' + 4 byte counter |
| 6F | X'09' | X'00' | X'006F' | X'00' + 4 byte counter |

*Table 10-19. Error Log Entry Format*

| Byte | Description |
|---|---|
| 0 | Number of bytes in entry |
| 1 | Logical Session ID |
| 2,3 | SRC |
| 4 | Sense Byte 0 (if present) or third byte for 3-byte SRCs [1] |
| 5 | Sense Byte 1 (if present) |
| 6 | Sense Byte 2 (if present) |
| 7 | Sense Byte 3 (if present) |
| 8 | Sense Byte 4 (if present) |

1 SRCs 0000 through 0FFF are 2-byte SRCs. SRCs 100000 through FFFFFF are 3-byte SRCs.

Workstation and printer SRCs (0100 through 03FF) use all 5 sense bytes to report information to the log. Table 10-20 describes the information contained within the 5 sense bytes.

*Table 10-20. Sense Byte Information*

| Sense Byte | Sense Bits[1] | Information |
|---|---|---|
| 0 | | **Switches** |
| | 0 | Temporary error |
| | 1 | Missed activate write |
| | 2 | Scan error code |
| | 3 | Quiesce |
| | 4 | The expected data stream was too short |
| | 5 | The expected data stream was too long |
| | 6 | Unexpected condition encountered |
| | 7 | Timer 1 is hung in busy mode |
| 1 | | **Switches** |
| | 0 | Reserved |
| | 1 | No response received |
| | 2 | Transmit activity check (TAC) |
| | 3 | Twinaxial port is defective |
| | 4 | Received parity error |
| | 5 | Wrong length information |
| | 6 | Wrong address |
| | 7 | Even/odd parity stop |
| 2 | | **Poll Response 1** |
| | 0 | Unexpected condition encountered |
| | 1 | Transmission parity error |
| | 2 | Reserved (terminals); unit available (printers) |
| | 3 | Unclaimed outstanding status |
| | 4-6 | *Unexpected exceptions* |
| | B'001' | Null/attribute (terminals): activate parity lost (printers) |
| | B'010' | Activate not valid |
| | B'011' | Reserved |
| | B'100' | Command not valid |
| | B'101' | Buffer overrun |
| | B'110' | Register not valid (terminals); reserved (printers) |
| | B'111' | Power-on sequence |
| | 7 | Reserved |
| 3 | | **Poll Response 2** |
| 4 | | **Printer Status or Switches** |
| | 0-7 | Reserved |

[1]If the bit is 1 (on), the condition applies. If the bit is 0 (off), the condition did not take place.

## REQMS

The AS/400 system sends the REQUEST MAINTENANCE STATISTICS (REQMS) command to request the error log and statistical counters from the 5494. The 5494 replies to the REQMS with a RECFMS containing the formatted error log and counters. Table 10-21 provides the format of the REQMS command.

*Table 10-21. REQMS Format*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0-2 | | **Network Services Header** | | |
| 0 | 0-1 | Involves PU or LU | B'01' | PU only |
| | 2-7 | Header type | B'000001' | Network Services header |
| 1 | 0 | Domain | B'0' | Same domain |
| | 1 | Reserved | B'0' | |
| | 2-7 | NS category | B'000011' | Maintenance Services |
| 2 | 0-7 | Request code | X'04' | REQMS command |
| 3-6 | 0-31 | CNM header | X'xxxxxxxx' | Not checked by the 5494 but echoed in RECFMS response |
| 7 | 0 | Reset indicator | B'0' or | Ignore. The 5494 always resets data when RECFMS sent in reply. |
| | | | B'1' | Reset data when RECFMS sent in reply. |
| | 1 | Reserved | B'0' | |
| | 2-7 | Type code | B'000001' or B'000100' | Type code of 1 or Type code of 4 |

## RSHUTD

The 5494 sends the REQUEST SHUTDOWN (RSHUTD) command to the AS/400 system to indicate that it is ready to end the current LU-LU session. The RSHUTD command is always sent on the expedited flow. The 5494 sends RSHUTD when an unrecoverable hardware failure occurs during an active session. The request code (RU byte 0) for RSHUTD is X'C2'.

## SIGNAL

The SIGNAL command passes a signal code from LU to LU. SIGNAL is not affected by the state of the normal flow. SIGNAL is always sent and received on the LU-LU expedited flow. Higher level protocols use SIGNAL to assist with device timeouts and Help key functions. The request code (RU byte 0) for SIGNAL is X'C9'. The 4-byte signal code contained in RU bytes 1-4 is summarized in Table 10-22 on page 10-28.

*Table 10-22. SIGNAL Code Definition*

| Signal Code | Description |
|---|---|
| 00000001 | Turn on the display Message Waiting indicator and sound the audible alarm. |
| 00000002 | Resume data transfer.<br>Sent when a printer intervention required error is resolved.<br>SIGNAL 000302xx reports the error. |
| 00000005 | Turn off the display Message Waiting indicator. |
| 00010000 | Sent when the AS/400 system requests the CD bit back to send a request on the LU-LU normal flow. |
| 00010001 | Sent when the operator presses Attention on the workstation. |
| 0002xxxx | Sent when the operator presses Help on the workstation while in error state. The 2-byte error code (xxxx) is encoded as four binary-coded decimal digits. This error code reflects the current error code displayed in columns 2-5 of the workstation error line. |
| 0003022x [1] | Printer command or parameter not valid. |
| 0003023x | Print check. |
| 0003024x | Forms check. |
| 0003025x | Normal periodic condition (end of file [EOF] reached or unit not ready). |
| 0003026x | Printer data stream error. |
| 0003028x | Printer machine, print or ribbon check. |

1 Refer to your printer documentation for specific information on 000302xx class errors.

## UNBIND

The UNBIND command ends the LU-LU session. The AS/400 system sends this command on the LU-LU expedited flow. The 5494 accepts any valid UNBIND command when the LU is in an LU-LU session. All LU-LU session parameters and SNA states are reset after the UNBIND command, and the 5494 sends the AS/400 system a positive response.

Table 10-23 shows the format of the UNBIND command. The UNBIND response includes only the request code (RU byte 0).

*Table 10-23. UNBIND Command Format*

| Bytes | Bits | Field | Value | Description |
|---|---|---|---|---|
| 0 | 0-7 | Request code | X'32' | UNBIND command |
| 1 | 0-7 | UNBIND type | X'01' | Normal end of session [1] |
| | | | X'06' | Session parameters not valid [1] |

1Any value is accepted here.

## SNA LU 4 and LU 7 Negative Responses

The SNA SRCs are part of a negative response format. The sense data included bit is turned on in the response header (byte 0, bit 5) and is used to indicate that an error has occurred. The information that explains the error is contained in a 4-byte field. When user-defined data cannot be included in the sense data, a sense code is substituted for the user-defined data. The sense data (the negative responses) in the 4-byte field have the following format:

| Category Code (1 byte) | Modifier Code (1 byte) | User-Defined Data User Byte 1 | User Byte 2 |
|---|---|---|---|
| xx | xx | yy | zz |

The category code is a standard SNA code that identifies the error class:

| Value | Category |
|---|---|
| X'08' | Request reject |
| X'10' | Request error |
| X'20' | State error |
| X'40' | RH usage error |
| X'80' | Path error. |

**Note:** All other values are reserved.

The three types of negative responses are:

- SNA session responses (Table 10-24)
- Device and cable error responses (Table 10-25 on page 10-30)
- Data stream responses (Table 10-26 on page 10-31).

*Table 10-24 (Page 1 of 2). SNA Session Responses*

| Category/Modifier | User Byte 1 | User Byte 2 | Description |
|---|---|---|---|
| 0801 | 00 | 00 | AS/400 system issued a BIND command to an unavailable resource |
| | 02 | 00 | Resource not available; when attempting a copy to printer function, the printer was off, bound, or attached to the wrong port |
| 0809 | 00 | 00 | Mode inconsistency; an ACTLU command is issued when the command is already in process |
| 0813 | 00 | 00 | Begin bracket that is not valid was received |
| 0815 | 00 | 00 | A BIND command was received while in session |
| 0821 | 00 | 00 | Parameters that are not valid were sent to the printer on the BIND or ACTLU commands |
| 0829 | 01 | 00 | A request was received that required the change of direction (CD) bit to be set to on |
| 082D | 01 | 00 | A valid command was rejected because the LU was busy |
| 1003 | 00 | 00 | SNA command error; BIND or RSHUTD command that is not valid received; SS message sent to the printer |
| 2002 | 00 | 00 | Chain error detected |

Table 10-24 (Page 2 of 2). SNA Session Responses

| Category/Modifier | User Byte 1 | User Byte 2 | Description |
|---|---|---|---|
| 2004 | 00 | 00 | SNA request received while in send state; 5494 previously received CD bit |
| 8004 | 00 | 00 | The specified LSID is not assigned to an LU |
| 8005 | 00 | 00 | No session open for specified LU |

Table 10-25 (Page 1 of 2). Device and Cable Error Responses

| Category/Modifier | User Byte 1 | User Byte 2 | Description |
|---|---|---|---|
| 081C | 00 | 00 | Twinaxial port malfunction; no response to the POLL |
| | 01 | 00 | Workstation malfunction; no response timeout; workstation turned off during copy-to-printer operation |
| | | 01 | Workstation malfunction; transmit activity check |
| | | 03 | Workstation malfunction; received parity error |
| | | 04 | Workstation malfunction; line parity check |
| | | 05 | Workstation malfunction; the station is not accessible |
| | | 06 | Workstation malfunction; received length check |
| | | 07 | Wrong workstation responded |
| | | 08 | Workstation power is in Transition mode from on to off or off to on |
| | | 09 | Workstation could not be activated |
| | | 20 | Command or device ID received that is not valid |
| | | 21 | Register value that is not valid was encountered |
| | | 22 | Workstation buffer or input queue was overrun |
| | | 23 | A null attribute was found (exception error) |
| | | 24 | An ACTIVATE command found that is not valid |
| | | 25 | Workstation issued an exception response that is not valid |
| | | 26 | Workstation pass-through interface error |
| | | 49 | The workstation issued an invalid POLL or READ response |
| | | 89 | The workstation's outstanding status is erroneous |
| | | 90 | Timeout on the even/odd status of the workstation |
| | | 91 | Workstation busy timeout |
| | 02 | 00 | Printer malfunction; no response timeout; printer turned off during copy-to-printer operation |
| | | 01 | Printer malfunction; transmit activity check |
| | | 03 | Printer malfunction; received parity error |
| | | 04 | Printer malfunction; line parity check |
| | | 05 | Printer malfunction; the station is not accessible |
| | | 06 | Printer malfunction; received length check |
| | | 07 | Wrong printer responded |

*Table 10-25 (Page 2 of 2). Device and Cable Error Responses*

| Category/Modifier | User Byte 1 | User Byte 2 | Description |
|---|---|---|---|
| | | 08 | Printer power is in Transition mode from on to off or off to on |
| | | 09 | Printer could not be activated |
| | | 1X | Printer processing check (device-dependent) |
| | | 20 | Command or device ID that is not valid received |
| | | 21 | Register value that is not valid was encountered |
| | | 22 | Printer buffer or input queue was overrun |
| | | 23 | A null attribute was found (exception error) |
| | | 24 | An ACTIVATE command that is not valid found |
| | | 90 | Timeout on the even/odd status of the printer |
| | | 91 | Printer busy timeout |

*Table 10-26 (Page 1 of 3). Data Stream Responses*

| Category/Modifier | User Byte 1 | User Byte 2 | Description |
|---|---|---|---|
| 0811 | 02 | 00 | The Cancel key of a printer was pressed when it was not in an error state |
| | | 01 | The Cancel key of a printer was pressed when it was in an error state |
| 1003 | 01 | 01 | Command that is not valid encountered in data stream |
| | | 05 | Clear unit alternate command not valid |
| | | 23 | Command to enter text mode not valid for the keyboard or country language code used |
| 1005 | 01 | 03 | Format table resequencing error on display data stream |
| | | 10 | Structured field length is not valid |
| | | 11 | Structured field class or type is not valid |
| | | 12 | Parameter is not valid in structured field |
| | | 13 | Structured field minor structure length is not valid |
| | | 14 | Parameter is not valid in structured field minor structure |
| | | 1B | Data stream command is not valid in WP mode |
| | | 1C | Data stream command is not valid in data processing (DP) mode |
| | | 1D | Command not allowed on display with unlocked keyboard |
| | | 21 | Premature data stream termination |
| | | 22 | Write to display order row/col address is not valid |
| | | 23 | The address in the Repeat to Address is less than the current workstation screen address |
| | | 25 | Start-of-field order length not valid |

*Table 10-26 (Page 2 of 3). Data Stream Responses*

| Category/Modifier | User Byte 1 | User Byte 2 | Description |
|---|---|---|---|
| | | 26 | Start-of-field order address not valid |
| | | 27 | Data in restore not valid |
| | | 28 | Field extends past the end of the display |
| | | 29 | Format table overflow |
| | | 2A | An attempt was made to write past the end of display |
| | | 2B | Start-of-header length not valid |
| | | 2C | Parameter that is not valid is on the ROLL command |
| | | 2D | Extended attribute type not valid |
| | | 2E | RAM load parameter not valid |
| | | 2F | Extended attribute not valid |
| | | 30 | Start-of-field attribute not valid |
| | | 31 | No escape code was found where it was expected |
| | | 32 | WRITE ERROR CODE TO WINDOW command row/col address is not valid |
| | | 33 | WRITE ERROR CODE TO WINDOW command is not valid with the message error line that is in use |
| | | 34 | SAVE PARTIAL SCREEN command was followed by an immediate read or another SAVE type command |
| | | 35 | Continued entry field segment is not valid |
| | | 36 | Word wrap not allowed for this type of entry field |
| | | 38 | An attempt.was made to write a scroll bar beyond the last display column |
| | | 39 | The total row/col, slider position (sliderpos), or display row/col on a scroll bar is not valid |
| | | 3A | At least one selection field choice must be allowed to accept the cursor |
| | | 3B | An attempt was made to write a selection field choice before column 1 or beyond the last display column |
| | | 3C | An attempt was made to define too many selection field choices |
| | | 3D | An attempt was made to define more than one default selected choice in a single choice selection field |
| | | 40 | Write Data command to non-entry field |
| | | 41 | Too much data or too little data in a Write Data command |
| | | 80 | The printer LSID sent in the copy-to-printer data stream from the AS/400 system was not in the SNA session table |
| | | 81 | The LSID sent in the copy-to-printer data stream from the AS/400 system was not a printer LSID |
| | | 87 | Self-check field length (self-check field > 33 bytes) not valid |

*Table 10-26 (Page 3 of 3). Data Stream Responses*

| Category/Modifier | User Byte 1 | User Byte 2 | Description |
|---|---|---|---|
| | | 88 | Self-check field control word not valid |
| | 02 | 28 | SCS command not valid |
| | | 29 | SCS parameter not valid |
| | | 2A | Intelligent Printer Data Stream* (IPDS* parameter error) |
| | | 60 | IPDS printer's multistatus functions are available |

# Chapter 11. Network Management Support

This chapter discusses the 5494 Systems Network Architecture (SNA) Alert functions and the Response Time Monitor (RTM) features.

## 5494 SNA Alert Support

This section describes the 5494 SNA Alert function. These alerts respond to errors detected by the 5494 and are sent on the system services control point physical unit (SSCP-PU) session. The following topics are discussed:

- The SNA Alert function
- The SNA Alert operation
- The SNA Alert Message format
- The Names of the SNA Alerts.

## The SNA Alert Function

The SNA Alert function sends problem determination information collected by the 5494 to the SSCP-PU controller session, which then sends the alert information to the AS/400 system. If the 5494 session is down, no alerts are generated.

The 5494 sends alert messages to the AS/400 system in response to any of the following errors:

- Attached display station errors
- Attached printer errors
- Low-entry networking (LEN) node programmable workstation (PWS) errors
- Logical unit (LU) 6.2 nonprogrammable workstation (NWS) device session errors
- Code change errors
- Token-Ring gateway errors.

## The SNA Alert Operation

You do not have to customize the 5494 for the AS/400 system to receive device or communication error information. The 5494 uses the SNA Alert operation to notify you of any device, program, or communication errors occurring between the AS/400 system and all devices attached to the 5494. The alerts also notify you of any problems you are having with the communication protocols already in use. The SNA Alert operation uses the system reference codes (SRCs) to help you determine which kind of problem is occurring:

*Table 11-1. SRC Code Prefixes and Descriptions*

| SRC Error | Description |
|---|---|
| 01xx | Attached Display Station Errors |
| 02xx | Attached Printer Errors |
| 03xx | Unknown Device Errors |
| 44xxxx | LU 6.2 NWS Device Session Errors |
| 45xxxx | LEN (PWS) |
| 51xxxx | Code Change Errors |
| 54xxxx | Token-Ring Gateway Errors |

### How the SNA Alert Operation Works

The 5494 sends all SRCs to the AS/400 system for viewing. However, if there are communication errors occurring between the 5494 and the AS/400 system, the alerts cannot be sent. To help you determine the nature of a communication error occurring between the 5494 and the AS/400 system, an error log is generated and stored by the 5494.

For SRC error codes 01xx, 02xx, and 03xx (twinaxial devices), the 5494 sends an alert back to a user for permanent SRC errors. See Table 11-1 on page 11-1.

## The SNA Alert Format

For all SNA alerts, the format is similar. The byte format of a generic alert request unit (RU) is defined in *Systems Network Architecture Formats Manual (GA27–3136)*. Each alert is contained within the Network Management Vector Transport (NMVT) RU command. See "NMVT" on page 10-22 for more information about how the 5494 uses the NMVT command. The NMVT RU command contains an Alert Major Vector and a series of subvectors and subfields. See Table 11-2 on page 11-5 for a description of the subvectors and subfields that make up each alert. The following format shows an SNA Alert:

```
-------------------- Start of Alert Format --------------------

NMVT Generic Alert

  Alert Major Vector

    SNA Address List Common Subvector

    Generic Alert Subvector

    Probable Cause Subvector

    Failure Cause Subvector

      Failure Causes subfield
      Recommended Actions subfield
      Detailed Data subfield

    Product Set ID Subvector

      Product Identifier subfield
      Hardware Product Identifier subfield
      Code Engineering Change (EC) Level subfield

    Date/Time Subvector

      Local Date/Time subfield

--------------------- End of Alert Format ---------------------
```

## The Names of the SNA Alerts

There are seven types of SNA Alerts. The SNA Alert types are as follows:

- Attached display station errors
- Attached printer errors
- Unknown device errors
- LU 6.2 NWS device session errors
- LEN PWS session errors
- Code change errors
- Token-Ring Gateway errors.

Within the Token-Ring Gateway alert type, there are nine alerts. The Token-Ring Gateway alerts are as follows:

- Lobe problem during insertion
- Beaconing problem during insertion
- Duplicate station address on ring during insertion
- Remove ring station MAC frame received during insertion
- Undefined error during insertion
- Wire fault on ring
- Adapter off ring under beacon auto-recover process
- REMOVE ADAPTER command received
- Ring beaconing timeout.

### SNA Alert Descriptions

This section describes the seven types of SNA Alerts. There are nine Token-Ring Gateway alerts listed under the Token-Ring Gateway category.

The *IBM 5494 Remote Control Unit User's Guide* describes SRCs that the 5494 issues as the result of an error.

**Attached Display Station Errors.** The 5494 detected a problem while attempting to attach to a display station.

**Attached Printer Errors.** The 5494 detected a problem while attempting to attach to a printer.

**Unknown Device Errors.** The 5494 detected a problem while attempting to communicate with an unknown device. These errors occur before the 5494 can determine whether the device is a display station or a printer.

**LU 6.2 NWS Device Session Errors.** The 5494 detected a problem while attempting to communicate with an LU 6.2 NWS device session.

**LEN PWS Session Errors.** The 5494 detected a problem while attempting to communicate with an LEN PWS session.

**Code Change Errors.** The 5494 detected a problem while attempting to communicate with a code correction file.

**Token-Ring Gateway Errors**. The following list describes the nine Token-Ring Gateway errors.

**Lobe Problem during Insertion**: The Token-Ring adapter detected a problem in its lobe during the wrap-test portion of the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Beaconing Problem during Insertion**: The Token-Ring adapter detected a beaconing condition on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Duplicate Station Address on Ring during Insertion**: The Token-Ring adapter detected a duplicate address on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Remove Ring Station MAC Frame Received during Insertion**: The Token-Ring adapter received a Remove Ring Station MAC frame during the insertion process. The insertion process did not complete. The 5494 operator must reopen the adapter by entering a command at the 5494 operator panel. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**Undefined Error during Insertion**: The Token-Ring adapter detected an undefined error on the Token-Ring network during the insertion process. The insertion process did not complete. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Wire Fault on Ring**: The Token-Ring adapter of the reporting link station detected a wire-fault condition on the Token-Ring network. The 5494 attempts to reopen the adapter at 30-second intervals until the Token-Ring link is reestablished.

**Adapter Off Ring under Beacon Auto-Recover Process**: The Token-Ring adapter of the reporting link station has left the Token-Ring network as part of the beacon automatic recovery process. This means that the reporting station's adapter is a member of the beacon's fault domain and that the adapter removed itself from the network to do a self-test, which was unsuccessful. The 5494 operator must reopen the adapter by entering a command at the 5494 operator panel. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**REMOVE ADAPTER Command Received**: The Token-Ring adapter of the reporting link station has left the Token-Ring network as a result of a REMOVE ADAPTER command from a LAN manager. The 5494 operator must reopen the adapter by entering a command at the 5494 operator panel. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

**Ring Beaconing Timeout**: The hard error detection timer expired while the Token-Ring network was beaconing. The 5494 operator must reopen the adapter by entering a command at the 5494 operator panel. The 5494 operator must reopen the adapter by entering the REQ230 command at the 5494 operator panel.

## Alert Forwarding

The 5494 also forwards PWS-issued alerts to the AS/400 system. For more information about alert forwarding, see Chapter 9, "Programmable Workstation Support."

The detailed formats of the request units (RUs) for SNA Alerts 1 through 15 are shown in Table 11-2. Variables *aaaa* through *zz* in the table are explained on page 11-8 immediately following the table.

*Table 11-2 (Page 1 of 3). Format of SNA Alerts*

| Byte(s) | Value | Description |
|---|---|---|
| | | **NMVT Header** |
| 0-2 | X'41038D' | NS header |
| 3-4 | X'0000' | Retired |
| 5-6 | X'0000' | PRID |
| 7 [1] | B'00000000' | Flags |
| | | **MS Major Vector** |
| 0-1 | X'*aaaa*' | Length |
| 2-3 | X'0000' | Key |
| | | **SNA Address List Common Subvector** [1] |
| 0 | X'0A' | Length |
| 1 | X'04' | Key |
| 2 | X'01' | Address count |
| 3 | X'00' | Address format type |
| 4-8 | X'0000000000' | Reserved |
| 9 | X'@@' | Local address |
| | | **Generic Alert Subvector** |
| 0 | X'0B' | Length |
| 1 | X'92' | Key |
| 2-3 | X'0000' | Flags |
| 4 | X'01' | Alert type |
| 5-6 | X'*bbbb*' | Alert description code |
| 7-10 | X'*cccccccc*' | Alert ID number |
| | | **Probable Cause Subvector** |
| 0 | X'*dd*' | Length |
| 1 | X'93' | Key |
| 2-3 | X'*eeee*' | Probable cause code points |
| 4-5 [3] | X'*ffff*' | Probable cause code points |
| | | ***ggggggg* Cause Subvector** |
| 0 | X'*hh*' | Length |
| 1 | X'96' | Key |
| | | ***ggggggg* Causes Subfield** |
| 0 | X'*ii*' | Length |

Table 11-2 (Page 2 of 3). Format of SNA Alerts

| Byte(s) | Value | Description |
|---|---|---|
| 1 | X'01' | Key |
| 2-3 | X'*jjjj*' | *ggggggg* cause code points |
| 4 | X'*kkkk*' | *ggggggg* cause code points |
| 6-7 [4] | X'*llll*' | *ggggggg* cause code points |
| | | **Recommended Actions Subfield** |
| 0 | X'*mm*' | Length |
| 1 | X'81' | Key |
| 2-3 | X'*nnnn*' | Recommended actions code points |
| 4-5 | X'*oooo*' | Recommended actions code points |
| 6-7 | X'*pppp*' | Recommended actions code points |
| 8-9 [5] | X'*qqqq*' | Recommended actions code points |
| | | **Detailed Data Subfield** |
| 0 | X'*rr*' | Length |
| 1 | X'82' | Key |
| 2 | X'00' | Product ID code |
| 3 | X'*ss*' | Data ID |
| 4 | X'yy' | Data encoding |
| 5 [6] | X'*tt*' | Detailed data |
| | | **Detailed Data Subfield** [7] |
| 0 | X'08' | Length |
| 1 | X'82' | Key |
| 2 | X'00' | Product ID code |
| 3 | X'07' | Data ID |
| 4 | X'00' | Data encoding |
| 5 | X'xx' | SRC byte 2 |
| 6 | X'xx' | SRC byte 1 |
| 7 | X'xx' | SRC byte 0 |
| | | **LAN Link Connection Subsystem Data** [8] |
| 0 | X'*uu*' | Length |
| 1 | X'51' | Key |
| | | *vvvvvvv* **Subfield** [8] |
| 0 | X'*ww*' | Length |
| 1 | X'*xx*' | Key |
| 2-7 | X'*yy*' | MAC address |
| | | **Product Set ID Subvector** |
| 0 | X'23' | Length |
| 1 | X'10' | Key |
| 2 | X'00' | Retired |
| | | **Product Identifier Subvector** |

*Table 11-2 (Page 3 of 3). Format of SNA Alerts*

| Byte(s) | Value | Description |
|---|---|---|
| 0 | X'20' | Length |
| 1 | X'11' | Key |
| 2 | B'00000001' | Product classification |
| | | **Hardware Product Identifier Subfield** |
| 0 | X'13' | Length |
| 1 | X'00' | Key |
| 2 | X'12' | Format type |
| 3-6 | X'F5F4F9F4' | Machine type |
| 7-9 | X'xxxxxx' | Model number |
| 10-11 | X'xxxx' | Plant of manufacture |
| 12-18 | X'xxxxxxxxxxxxxx' | Serial number |
| | | **Code EC Subfield** |
| 19 | X'0A' | Length |
| 20 | X'0B' | Key |
| 21-24 | X'xxxxxxxx' | Code release |
| 25-26 | X'F0F0' | Unused |
| 27-28 | X'xxxx' | Correction level |
| | | **Date/Time Subvector** |
| 0 | X'0A' | Length |
| 1 | X'01' | Key |
| | | **Local Date/Time Subfield** |
| 0 | X'08' | Length |
| 1 | X'10' | Key |
| 2 | X'*zz*' | Year |
| 3 | X'01' - X'0C' | Month |
| 4 | X'01' - X'1F' | Day |
| 5 | X'00' - X'17' | Hours |
| 6 | X'00' - X'3B' | Minutes |
| 7 | X'00' - X'3B' | Seconds |

1 The SNA Address List Common Subvector only exists for Alerts 1 through 5.
2 For Alerts 1 through 5, this value is 00010000.
3 These bytes only exist for Alerts 4 and 11.
4 These bytes do not exist for Alerts 8, 9, 10, 14, and 15.
5 These bytes do not exist for Alerts 4, 6, and 9 through 15.
6 For Alerts 1 through 3 and 15, these are bytes 5-6; for Alert 4, these are bytes 5-12; for Alert 5 these are bytes 5-7; and for Alert 6, these are bytes 5-7 with byte 7 being 51 (bytes 5 and 6 are xx).
7 The Detailed Data Subfield does not exist for Alert 15.
8 The LAN Link Connection Subsystem Data and the *vvvvvvv* subfield does not exist for Alerts 1 through 6.

The following information provides you with the Alert types and their corresponding values for the SNA Alert formats shown in the previous table. The seven SNA Alert types (and the nine Token-Ring Gateway Alerts) are listed first; then the variables listed in Table 11-2 on page 11-5 are defined:

1. Attached display station errors
2. Attached printer errors
3. Unknown device errors
4. LU 6.2 NWS device session errors
5. LEN PWS session errors
6. Code change errors
7. Lobe problem during insertion
8. Beaconing problem during insertion
9. Duplicate station address on ring during insertion
10. Remove ring station MAC frame received during insertion
11. Undefined error during insertion
12. Wire fault on ring
13. Adapter off ring under beacon auto-recover process
14. Remove adapter command received
15. Ring beaconing timeout.

| | |
|---|---|
| | **MS Major Vector** |
| *aaaa*= | **0061** for Alerts 1 through 3 |
| | **0078** for Alert 4 |
| | **0062** for Alert 5 |
| | **0054** for Alert 6 |
| | **006C** for Alerts 7 and 11 |
| | **0063** for Alert 8 |
| | **0066** for Alerts 9, 10, and 14 |
| | **006A** for Alerts 12 and 13 |
| | **005F** for Alert 15 |
| | **Generic Alert Subvector** |
| *bbbb*= | **1002** for Alerts 1, 3, and 5 |
| | **1201** for Alert 2 |
| | **3118** for Alert 4 |
| | **1602** for Alert 6 |
| | **3211** for Alerts 7, 8, 9, 10, and 11 |
| | **3212** for Alert 12 |
| | **3213** for Alert 13 |
| | **3214** for Alert 14 |
| | **3215** for Alert 15 |
| *cccccccc*= | **ED4AAAA3** for Alert 1 |
| | **030C2A29** for Alert 2 |
| | **F2C96F67** for Alert 3 |
| | **A89646AA** for Alert 4 |
| | **4FDFDDDF** for Alert 5 |
| | **6F417AA1** for Alert 6 |
| | **55BF3E1C** for Alert 7 |
| | **CAF3C58A** for Alert 8 |
| | **D615A61E** for Alert 9 |
| | **44D1AD86** for Alert 10 |
| | **016E5F4E** for Alert 11 |
| | **A676B230** for Alert 12 |
| | **EB61E14F** for Alert 13 |

**59F32622** for Alert 14
**2102FCEB** for Alert 15

**Probable Cause Subvector**

*dd=* **04** for Alerts 1 through 3, 5 through 10, and 12 through 15
**06** for Alerts 4 and 11

*eeee=* **6302** for Alert 1
**6210** for Alert 2
**6301** for Alert 3
**1023** for Alert 4
**6313** for Alert 5
**0422** for Alert 6
**3702** for Alerts 7, 11, 12, and 13
**3703** for Alerts 8 and 15
**3704** for Alert 9
**3705** for Alert 10
**7013** for Alert 14

*ffff=* **1022** for Alert 4
**3701** for Alert 11

***ggggggg* Cause Subvector**

*ggggggg=* **Failure** for Alerts 1 through 8, 11, 12, 13, and 15
**Install** for Alert 9
**User** for Alerts 10 and 14

*hh=* **17** for Alerts 1 through 3
**2C** for Alert 4
**18** for Alert 5
**14** for Alert 6
**22** for Alert 7
**1E** for Alert 8
**1C** for Alerts 9, 10, and 14
**20** for Alerts 11, 12, and 13
**15** for Alert 15

***ggggggg* Causes Subfield**

*ii=* **04** for Alerts 1 through 3, 5, 6, 8, 9, 10, 14, and 15
**06** for Alert 4
**08** for Alerts 7, 11, 12, and 13

*jjjj=* **6302** for Alert 1
**6210** for Alert 2
**6301** for Alert 3
**1023** for Alert 4
**6313** for Alert 5
**0422** for Alert 6
**3320** for Alerts 7 and 13
**3703** for Alerts 8 and 15
**3704** for Alert 9
**7101** for Alerts 10 and 14
**3712** for Alert 11
**3711** for Alert 12

| | |
|---|---|
| *kkkk=* | **1022** for Alert 4<br>**3711** for Alerts 7 and 13<br>**3701** for Alert 11<br>**3434** for Alert 12<br>No corresponding byte for Alerts 8, 9, 10, 14, and 15 |
| *llll=* | **3434** for Alert 1 and 13<br>**2600** for Alert 11<br>**3320** for Alert 12<br>No corresponding byte for Alerts 8, 9, 10, 14, and 15 |
| | **Recommended Actions Subfield** |
| *mm=* | **0A** for Alerts 1 through 3, 5, 7, and 8<br>**08** for Alerts 4, 9 through 15<br>**06** for Alert 6 |
| *nnnn=* | **F0A0** for Alerts 1 through 3, 5, and 6<br>**3110** for Alert 4<br>**3301** for Alerts 7 and 8<br>**2010** for Alerts 9 through 15 |
| *oooo=* | **1000** for Alerts 1 through 3, 5, and 6<br>**32D0** for Alert 4<br>**2010** for Alerts 7 and 8<br>**3101** for Alerts 9 through 15 |
| *pppp=* | **3301** for Alerts 1 through 3, and 5<br>**2012** for Alert 4<br>**3101** for Alerts 7 and 8<br>**32C0** for Alerts 9 through 14<br>**32A0** for Alert 15 |
| *qqqq=* | **3000** for Alerts 1 through 3, and 5<br>**32C0** for Alerts 7 and 8<br>No corresponding byte for Alerts 4, 6, and 9 through 15 |
| | **Detailed Data Subfield** |
| *rr=* | **07** for Alerts 1 through 3, and 15<br>**0D** for Alert 4<br>**08** for Alerts 5 and 6<br>**06** for Alerts 7 through 14 |
| *ss=* | **31** for Alerts 1 through 3, 5, and 6<br>**A9** for Alert 4<br>**61** for Alerts 7 through 14<br>**17** for Alert 15 |
| *tt=* | **xx** for Alerts 1 through 3, 5, and 6<br>**(set by user)** for Alert 4<br>**F0** for Alerts 7 through 14<br>**xxxx** for Alert 15 |

| | |
|---|---|
| | **LAN Link Connection Subsystem Data** |
| *uu*= | **0A** for Alerts 7, and 9 through 14<br>**05** for Alerts 8 and 15 |
| | ***vvvvvvv* Subfield** |
| *vvvvvvv*= | **Local Individual MAC Address** subfield for Alerts 7 and 9 through 14<br>**Beaconing Data** subfield for Alerts 8 and 15 |
| *ww*= | **08** for Alerts 7, and 9 through 14<br>**03** for Alerts 8 and 15 |
| *xx*= | **03** for Alerts 7, and 9 through 14<br>**07** for Alerts 8 and 15 |
| *yy*= | **xxxxxxxxxxxx** for Alert 7, and 9 through 14<br>**xx** for Alerts 8 and 15 |
| | **Local Date/Time Subfield** |
| *zz*= | **11** for Alerts 7 through 14<br>**00** for Alert 15 |

## The SNA Response Time Monitor

This section describes the SNA Response Time Monitor (RTM) feature as it applies to the 5494. It contains the following sections that help describe how the RTM feature works for you:

- RTM overview
- Activating the RTM
- Exceptions to the SNA RTM Function with the 5494.

### RTM Overview

The RTM is an SNA feature that enables the AS/400 system to collect performance information about nonprogrammable workstations (NWSs) attached to the 5494. In brief, the response time is the time-lapse between the moment a user presses Enter or a command key and the moment more information can be entered.

The RTM reports provide you with information to analyze:

- General performance problems
- Inadequate hardware performance
- Infrequent hardware usage.

The AS/400 system Performance Monitor sends RTM requests and responses. The Performance Tools Licensed Program (LP) reports the RTM information.

Refer to the following manuals for more detailed information about AS/400 RTM support:

- *Systems Network Architecture Formats*
- *Systems Network Architecture Management Services Reference.*

## Activating the RTM

Once the Start Performance Monitor (STRPFRMON) command (along with the associated remote response time [RRSPTIME] parameter) is specified from the AS/400 system, the RTM feature is activated. The RRSPTIME parameter specifies the remote workstation response time categories. The AS/400 performance monitor keeps track of interactive response times for each remote workstation attached to the 5494, which collects the response time information.

The STRPFRMON command submits the performance monitoring job called the QPFRMON to the job queue identified in the job queue parameter (STRPFRMON(JOBQ)). Once the job is started, it periodically collects performance information and puts it into the system-supplied database files. The data is collected at intervals specified in the interval parameter (STRPFRMON(INTERVAL)). Refer to the *Application System/400 Control Language Reference* for more information about the STRPFRMON command.

Once the RTM feature is activated, it collects performance information about your NWS workstations attached to the 5494. The 5494 collects internal performance information based on parameters from the Request RTM MS Major Vector sent from the AS/400 system. The 5494 responds to the AS/400 system with the RTM MS Major Vector. A response from the 5494 results from the following requests:

- A request from the AS/400 system (solicited)
- When a device session becomes inactive (unsolicited)
- When a counter overflow occurs (unsolicited).

When the 5494 sends responses to the AS/400 system, one vector is sent for each device that is being analyzed by the RTM feature. When the AS/400 system receives RTM responses (MS Major Vector) from the 5494, they are sent by the NMVT RU command. The NMVT RU format as sent by the 5494 is summarized in Table 10-14 on page 10-23.

## Exceptions to the SNA RTM Function with the 5494

The 5494 supports the general SNA RTM feature in much the same way as the SNA RTM feature is supported by other control units. The RTM commands and responses are supported in the same way as those listed in *Systems Network Architecture Formats*, with the following exceptions:

- In the Request RTM MS Major Vector, the SNA Address List Common Subvector value, X'04', requesting performance information for a single device, is not supported. For example, you can set up a request for informational statistics, set recording on, and set recording flags. But you must set these requests for all devices, not just one. However, there are two conditions when the RTM feature sends unsolicited performance information about one device to the AS/400 system, they are as follows:
  - If a device session becomes inactive and the AS/400 system has requested return of data unsolicited on device deactivation, the information for this single device is sent unsolicited to the AS/400 system.
  - If an RTM counter overflows for a device and the AS/400 system has requested return of data unsolicited on the counter overflow, the information for this single device is sent unsolicited to the AS/400 system.
- Only one RTM performance analysis definition value is supported, X'02'. This value is used to measure performance from when the Attention key or the

Action key is pressed until the device is ready to accept input from a user again.

- The correlation value in the RTM Status Reply Subvector is not supported. The 5494 always sets it to zero (0).
- The RTM feature becomes inactive when the following occurs:
  - The 5494 that is attached to the AS/400 system is varied off.
  - The 5494 connection to the AS/400 system fails.

# Chapter 12. Display Data Streams

The 5494 uses format tables in storage to control the presentation of data on 5250 workstation screens. Since the 5494 supports simultaneous operation of up to 56 workstations, space is reserved for 56 separate format tables. The 5494 constructs these tables at format level 0 during initialization. This structure supports the Free Key mode of workstation operation and includes the following characteristics:

- A single input field that includes the entire screen
- Alphanumeric characters only
- Base field attribute
- Cursor at row 1 column 2 (home position)
- Error line at row 1.

The workstation writes keystroke scan codes into its storage buffer and sends these codes to the 5494. The 5494 translates each scan code to its EBCDIC equivalent, and returns this character code for display on the screen.

Certain data transfers between the AS/400 system and a workstation occur immediately after establishing an SS-LU session. Application programs supply the commands required to control overall workstation operation. The AS/400 system transmits individual commands to the 5494 within request/response units (RUs) of the output data stream on the LU-LU session flow. An output data stream begins with a command, but RUs might not. The AS/400 system can organize a number of RUs into a logically linked chain that can also include graphics characters and control information. When an output data stream contains a READ command, the 5494 returns an input data stream that consists of a read header followed by data from either the format table or directly from a workstation regeneration buffer.

**Note:** In this book, all data strings are presented with the most significant byte on the left. Byte and bit numbers are also written from left to right beginning with byte 0 bit 0 as the most significant bit.

## LU 4 and LU 7 SS-LU Session Data Stream

The AS/400 system can initiate data transfer to a designated workstation whenever an SS-LU session is active. These transfers take precedence over LU-LU flows. However, each exchange consists of a single RU having no more than 128 bytes of unformatted data, of which no more than 78 bytes can be presented on the workstation screen. The 5494 will respond negatively to data on the SS-LU flow if the addressed workstation is in the pre-help error, post-help error, system request, or SS message state. If the 5494 accepts such a message, then:

- The workstation enters the SS message state.
- The 5494 saves the contents of the error line for the addressed workstation.
- The 5494 alters the format table by writing attributes of normal intensity, nonblink, and nonreverse image to column 1 and non-display to column 80 of the error line.
- The first 78 display characters in the SS message appear on the error line beginning at column 2.

The SS message remains on the screen until the workstation operator resets the workstation. At that time, the 5494 erases the SS message and returns the original data to the screen.

The workstation operator initiates input to the AS/400 system on the SS-LU flows with a system request or test request key sequence. When the workstation operator enters the correct sequence for a particular workstation the following actions occur:

- The 5494 saves the current contents of the input line and sets the attributes as previously described for incoming SS messages.
- The 5494 writes a row of column separator blanks to the input line.
- Input line remains blank until the workstation operator types the desired input message.
- When the workstation operator presses Enter, the 5494 sends the contents of the input line to the AS/400 system without cursor address or attention identifier (AID) code.

Once the message has been sent, the 5494 returns the keyboard to its previous state and writes the original data on the input line.

## LU 4 and LU 7 LU-LU Session Data Stream Formats

LU-LU session data streams consist of commands transmitted to the 5494 and responses sent back to the AS/400 system. In general, each command includes an escape character (X'04'), a 1-byte command code, and a data field of varying length. When a single transmission contains more than one command, the escape character serves as a delimiter that identifies the first character of the next command code.

The 5494 generates a return data stream in direct response to a command, or waits until the user presses a control key. Each response begins with the current address (row and column) of the cursor, an AID code associated with a particular control key, and the data specifically requested by the AS/400 system. The 5494 supports the following data stream commands; however, not all 5250 workstation controllers support all of the following commands and orders. The "5250 QUERY Command" on page 12-114 can help you determine individual workstation capabilities.

The 5494 supports three different modes of operation that determine overall characteristics of LU-LU data streams:

**Data Processing (DP) Mode.** While operating in DP mode, the 5494 uses format tables to maintain direct control over displays presented on each NWS. The AS/400 system uses data stream commands to write control data into the format table, write data to the workstation, or request a readout of data from the workstation.

In DP mode, the 5494 supports 5250 data stream features enabling the user to define graphical user interface (GUI) capabilities as well as various entry field types for NWSs.

**Word Processing (WP) Mode.** When the 5494 is in WP mode, the format tables serve as storage buffers but do not provide direct control over workstations. This change in internal operation prevents the 5494 from accepting certain combinations of data stream commands.

**Pass-Through Data Stream Processing.** Pass-through data streams are normally reserved for printers. However, because PWSs respond directly to commands from the AS/400 system, the 5494 merely coordinates data transfers for these devices. In this case, the detailed characteristics of LU-LU session data streams depend on the workstation in use and the application program being run.

Table 12-1 lists the name, code, and application for each command accepted by the 5494. Subsequent sections in this chapter provide detailed descriptions of command structures and control formats.

*Table 12-1. Workstation Data Stream Commands*

| Command | Command Code | Modes |
|---|---|---|
| CLEAR UNIT | X'40' | DP Mode and WP Mode |
| CLEAR UNIT ALTERNATE | X'20' | DP Mode and WP Mode |
| CLEAR FORMAT TABLE | X'50' | DP Mode and WP Mode |
| WRITE-TO-DISPLAY | X'11' | DP Mode |
| WRITE ERROR CODE | X'21' | DP Mode and WP Mode |
| WRITE ERROR CODE TO WINDOW [1] | X'22' | DP Mode |
| READ INPUT FIELDS | X'42' | DP Mode |
| READ MDT FIELDS | X'52' | DP Mode |
| READ MDT ALTERNATE [1] | X'82' | DP Mode |
| READ SCREEN | X'62' | DP Mode and WP Mode |
| READ SCREEN WITH EXTENDED ATTRIBUTES [1] | X'64' | DP Mode and WP Mode |
| READ SCREEN TO PRINT [1] | X'66' | DP Mode |
| READ SCREEN TO PRINT WITH EXTENDED ATTRIBUTES [1] | X'68' | DP Mode |
| READ IMMEDIATE | X'72' | DP Mode |
| READ MODIFIED IMMEDIATE ALTERNATE [1] | X'83' | DP Mode |
| SAVE SCREEN | X'02' | DP Mode and WP Mode |
| SAVE PARTIAL SCREEN [1] | X'03' | DP Mode |
| RESTORE SCREEN | X'12' | DP Mode and WP Mode |
| RESTORE PARTIAL SCREEN [1] | X'13' | DP Mode |
| ROLL | X'23' | DP Mode |
| WRITE STRUCTURED FIELD [1] | X'F3' | DP Mode [2] and WP Mode [3] |
| WRITE SINGLE STRUCTURED FIELD | X'F4' | DP Mode |
| COPY-TO-PRINTER [1] | X'16' | WP Mode and DP Mode |

[1] Some non-5494 workstation controllers do not support this command. A negative response is returned if this command is used.

[2] In DP mode, only the DP mode WRITE STRUCTURED FIELD commands are valid.

[3] In WP mode, only the WP mode WRITE STRUCTURED FIELD commands are valid.

## CLEAR UNIT Command

The AS/400 system issues the CLEAR UNIT command to clear both the workstation screen and format table. The command code is X'40'.

| ESC | CLEAR UNIT |
|---|---|
| X'04' | X'40' |

When the 5494 receives a CLEAR UNIT command, it:

- Locks the workstation keyboard
- Turns the keyboard clicker off
- Turns the input inhibited indicator on
- Clears the error state (or system request state)
- Clears the Insert mode (with its associated indicators)
- Clears the Diacritic mode (with its associated indicators), unless type-ahead mode is active
- Clears the Command mode, unless type-ahead mode is active
- Resets any keystroke processing state
- Clears the format table (with its effects on the keyboard shift state)
- Clears the modified data tag (MDT) bit
- Resets read sequencing
- Sets up all PF or Command keys to return data
- Clears the workstation screen by writing nulls to the regeneration buffer and nulling any extended attributes

**Note:** If the workstation is an IBM 3180 Model 2, an IBM 3197 Model D or W, an IBM 3477 (all models), or an IBM 3487 (all models) display station, the 5494 sets the presentation screen size to 24 rows by 80 columns.

- Writes an attribute byte to row 1, column 2 of the display with the following characteristics:
  - Nonblink
  - Nonreverse video
  - Normal intensity.
- Places the cursor (blinking) at row 1, column 1 and sets this address as the insert cursor address
- Clears any AID request not already serviced
- Clears any pending READ INPUT or READ MDT commands.

The default error line is the message line on an IBM 3180 Model 2, an IBM 3197 Models D and W, and IBM 3477 (all models), an IBM 3486 (all models), and an IBM 3487 (all models) display station. Line 24 is the message line on all other workstations.

If the workstation is in SS message state, the 5494 rejects the CLEAR UNIT command and returns a contention error negative response.

## CLEAR UNIT ALTERNATE Command

The AS/400 system issues the CLEAR UNIT ALTERNATE command to clear the display screen and the format table of an IBM 3180 Model 2, an IBM 3197 Models D or W, an IBM 3477 (all models), or an IBM 3487 (all models) display station. However, this command sets the presentation screen size to 27 rows by 132 columns. If the AS/400 system issues this command to any other kind of workstation, the 5494 rejects the command with a negative response of 10030101. The command code is X'20'.

| ESC | CLEAR UNIT ALTERNATE | Parameter |
|---|---|---|
| X'04' | X'20' | X'00' |

The parameter byte must contain X'00'. Any other value causes the 5494 to return a negative response of 10030105.

## CLEAR FORMAT TABLE Command

The AS/400 system issues a CLEAR FORMAT TABLE command to erase the contents of the format table without affecting the data on the workstation screen. The command code is X'50'.

| ESC | CLEAR FORMAT TABLE |
|---|---|
| X'04' | X'50' |

The 5494 processes this command in the same way as the CLEAR UNIT command, with the following exceptions:

- Presentation screen size remains the same.
- Attributes remain the same.
- The cursor remains in its current screen position.
- The AS/400 system does not reset error state or system request state.

A 5250 workstation, such as an IBM 3180 Model 2, an IBM 3197 Model D or W, an IBM 3477 (all models), an IBM 3486 (all models), or an IBM 3487 (all models) display station that does not have a message line selected will reject this command if it is in the pre-help error, post-help error, system request, or SS message states. If an IBM 3180 Model 2, an IBM 3197 Model D or W, an IBM 3477 (all models), an IBM 3486 (all models), or an IBM 3487 (all models) display station has a message line selected, then the AS/400 system generates state errors only for the system request and SS message states.

## WRITE-TO-DISPLAY Command

The AS/400 system issues the WRITE-TO-DISPLAY (WTD) command to modify the contents of the format table and regeneration buffer associated with individual display stations. The command code X'11' marks the beginning of the WTD command, followed by a 2-byte control character and a combination of display parameters and orders.

| | | | |
|---|---|---|---|
| ESC X'04' | WRITE-TO-DISPLAY X'11' | Control Character 2 bytes | Parameter (see Figure 12-1 on page 12-7) |

Figure 12-1 on page 12-7 shows how data streams may be combined during a WTD operation.

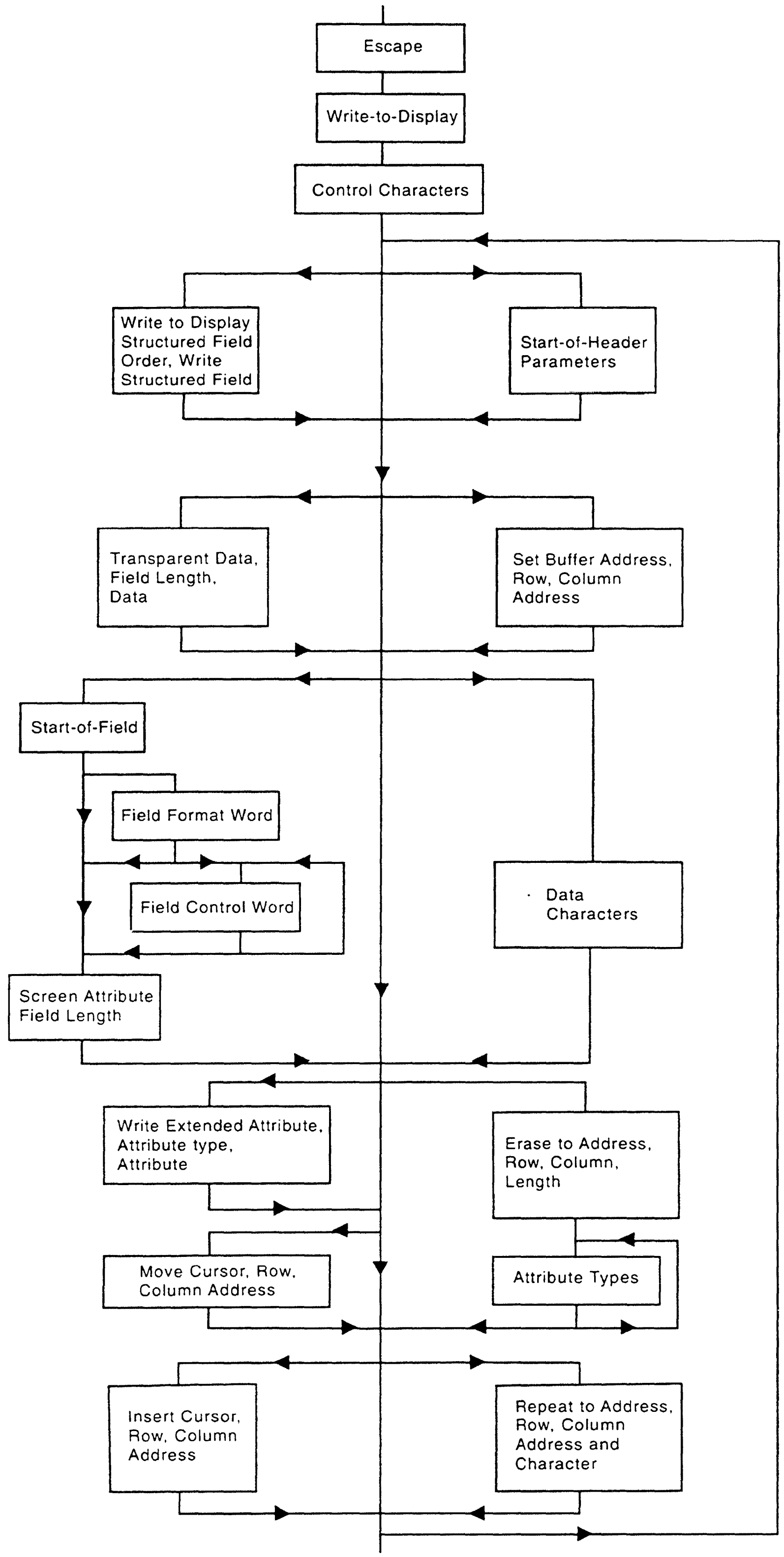



*Figure 12-1. Valid Data Stream Combinations during WRITE-TO-DISPLAY*

The 5494 rejects the WTD command and returns error messages under the following conditions:

- If the workstation supports 5250 data stream in the pre-help error, post-help error, system request, or SS message state
- If the workstation is an IBM 3180 Model 2, an IBM 3197 Model D or W, an IBM 3477 (all models), an IBM 3486 (all models), or an IBM 3487 (all models) display station in the pre-help error, post-help error, system request, or SS message states, and the message line is not selected
- If the workstation is an IBM 3180 Model 2, an IBM 3197 Model D or W, an IBM 3477 (all models), an IBM 3486 (all models), or an IBM 3487 (all models) display station in the system request or SS message state, and the message line is selected.

If the 5494 accepts the command but detects a parameter error during processing, it rejects the incorrect parameter and all data in the remainder of the SNA chain. In addition, the 5494 does not process the second byte of the control character at the beginning of the command. While the 5494 is processing a WTD command:

- If the WTD command changes the format table, the keyboard remains locked until specifically unlocked by a control character or by a subsequent WTD command.
- If the WTD command contains a parameter error, the state of the keyboard depends upon parameters that preceded the error.
- If the WTD command is valid, after the command is processed, the cursor moves to one of three locations:
  - The location set by an insert cursor order (unless control character byte 1, bit 1 is equal to B'1'.)
  - The start of the first non-bypass input field defined in the format table
  - A default starting address of row 1 column 1.

## Control Characters

The 2-byte control character immediately following the WTD command code determines which state the keyboard enters at the start of command processing and which state the workstation enters after command processing is successfully completed. Table 12-2 and Table 12-3 on page 12-9 identify the functions associated with these 2 bytes.

*Table 12-2 (Page 1 of 2). WRITE-TO-DISPLAY Command Control Characters, Byte 0*

| Bits 0–2 | Reset pending AID, lock keyboard | Clear master MDT, reset MDT flags in non-bypass fields | Clear master MDT, reset MDT flags in all fields | Null all non-bypass fields with MDT on | Null all non-bypass fields |
|---|---|---|---|---|---|
| B'000' | | | | | |
| B'001' | X | | | | |
| B'010' | X | X | | | |
| B'011' | X | | X | | |
| B'100' | X | | | X | |

Table 12-2 (Page 2 of 2). *WRITE-TO-DISPLAY Command Control Characters, Byte 0*

| **Bits 0–2** | **Reset pending AID, lock keyboard** | **Clear master MDT, reset MDT flags in non-bypass fields** | **Clear master MDT, reset MDT flags in all fields** | **Null all non-bypass fields with MDT on** | **Null all non-bypass fields** |
|---|---|---|---|---|---|
| B'101' | X | X | | | X |
| B'110' | X | X | | X | |
| B'111' | X | | X | | X |

**Notes:**

1. Bits 3 through 6 are reserved and should be set to B'0000'.
2. If bit 7 is set to on, the data in the WRITE-TO-DISPLAY command is non-stream data and is written to the workstation without data stream optimization.
3. If there are no bypass fields with MDT flags set to on, the master MDT is cleared.

Table 12-3 (Page 1 of 2). *WRITE-TO-DISPLAY Command Control Characters, Byte 1*

| **Bit** | **Code** | **Meaning** |
|---|---|---|
| 0 | | Reserved |
| 1 | B'0'<br>B'1' | Cursor moves to default or insert cursor (IC) order position when keyboard unlocks [1]<br>Cursor does not move when keyboard unlocks |
| 2 | B'0'<br>B'1' | No action<br>Reset blinking cursor [2] |
| 3 | B'0'<br>B'1' | No action<br>Set blinking cursor [2] |
| 4 | B'0'<br>B'1' | No action<br>Unlock the keyboard and reset any pending AID bytes [3] |
| 5 | B'0'<br>B'1' | No action<br>Sound alarm |
| 6 | B'0'<br>B'1' | No action<br>Set Message Waiting indicator off [4] |

Table 12-3 (Page 2 of 2). WRITE-TO-DISPLAY Command Control Characters, Byte 1

| Bit | Code | Meaning |
|---|---|---|
| 7 | B'0' | No action |
| | B'1' | Set Message Waiting indicator on [4] |

**Notes:**

1. An exception is when a WTD is received when the keyboard is unlocked and the WTD does not modify the keyboard state; then the cursor is not moved.
2. If bits 2 and 3 are both on, the cursor blinks. For the IBM 5292 Color Display Station, bits 2 and 3 will be effective only if the workstation operator does not use the blink cursor function.
3. 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 or defaults to the first position of the first non-bypass input field if no IC order has been given. If there is no non-bypass field, it defaults to row 1, column 1.
   e. Clears all unserviced AID requests.

   The 5494 defers this process until after the operator presses the Error Reset key, if in operator error state.
4. If bits 6 and 7 are both on, the Message Waiting indicator is set to on.

# Data Characters

Data characters can be placed in the data stream following the WTD control characters. The data characters are generally greater than or equal to X'20' and less than or equal to X'FE'. X'FF' is not a valid data character.

The null character (X'00'), duplicate character (X'1C'), field mark character (X'1E'), ideographic shift-in (X'OE'), and ideographic shift-out (X'0F') are valid data characters.

# WTD Orders List

The WTD command can include different parameters. The following paragraphs describe the functions listed in Table 12-4.

Table 12-4 (Page 1 of 2). WTD Orders

| Name | Abbreviation | Code (Hex) |
|---|---|---|
| Set buffer address order | SBA | 11 |
| Insert cursor order | IC | 13 |
| Move cursor order [1] | MC | 14 |
| Repeat to address order | RA | 02 |
| Erase to address order [1] | EA | 03 |
| Start of header order | SOH | 01 |
| Transparent data order [1] | TD | 10 |
| Write extended attribute order [1] | WEA | 12 |
| Start of field order | SF | 1D |

*Table 12-4 (Page 2 of 2). WTD Orders*

| Name | Abbreviation | Code (Hex) |
|---|---|---|
| Write to Display Structured Field Order [1] | WDSF | 15 |

**Notes:**

1 Some non-5494 workstation controllers do not support this order.

## Set Buffer Address Order

The set buffer address (SBA) order specifies the address at which data transfer and input field definition will begin. Any location within the boundaries of the workstation presentation screen is valid. The order code is X'11'.

| | | |
|---|---|---|
| SBA X'11' | Row Address 1 byte | Column Address 1 byte |

The row is equal to 1 and the column address is equal to 0, followed by an SF field starting in row 1, column 1. Any other use of 0 in row or column address results in a parameter error.

## Insert Cursor Order

The insert cursor (IC) order specifies the position of the cursor when the AS/400 system unlocks the keyboard or when the workstation operator presses the Home key. The order code is X'13'.

| | | |
|---|---|---|
| IC X'13' | Row Address 1 byte | Column Address 1 byte |

The 5494 saves the row and column addresses in the IC order within the control block assigned to the workstation. If multiple IC orders exist within a single WTD command, only the last one in the command is retained. The last IC or MC order in the command determines cursor position. See "Move Cursor Order." Any address within the boundaries of the display is valid.

## Move Cursor Order

The move cursor (MC) order allows the AS/400 system to move the cursor to a specified position without modifying the home address and without regard to the state of the keyboard. The order code is X'14'.

| | | |
|---|---|---|
| MC X'14' | Row Address 1 byte | Column Address 1 byte |

If multiple IC or MC orders are coded in the WTD data stream, the last IC or MC order determines cursor position. The IC order negates any previously coded MC orders. The MC order negates any previously coded IC orders, with the exception that the last IC order establishes home position. To set the home position and then move the cursor, code the IC order first, followed by the MC order.

The MC order is not affected by WTD control character values, including the move cursor flag. See Table 12-3 on page 12-9.

## Repeat to Address Order

The repeat to address (RA) order results in the repetition of a selected character from the current workstation screen address up to and including the screen row and column addresses given in the order. The order code is X'02'.

| RA X'02' | Row Address 1 byte | Column Address 1 byte | Repeated Character 1 byte |
|---|---|---|---|

The 5494 checks row and column addresses for validity. If the location in the RA is less than the current display address, the 5494 posts a parameter error. Although you can insert any code point into the repeated character field of this order, avoid X'10', X'11', and X'FF'. These values may affect the display of data on displays with extended attribute buffers. The current display address is set to the location specified in the RA, plus one.

## Erase to Address Order

The erase to address (EA) order clears selected extended attribute types and optionally clears the display screen. The order code is X'03'.

| EA X'03' | Row Address 1 byte | Column Address 1 byte | Length 1 byte | List of Attribute Types |
|---|---|---|---|---|

Valid length values are between X'02' and X'05' and include length of the length byte plus length of the list of attribute types.

The valid extended attribute types are:

**X'00'** Display screen
**X'01'** Extended primary attributes
**X'03'** Extended foreground color attributes
**X'05'** Extended ideographic attributes
**X'FF'** Display screen and all extended attribute types supported by this workstation. Use X'FF' to clear all extended attribute types for optimum performance, even if all types are not used.

When the 5494 receives this order, it checks the row and column address for validity. The 5494 then clears the selected attribute types from the current display address up to and including the screen row and column address given in the order. It then sets the current display address to the location specified in the EA plus one.

The following conditions result in a negative response:

- The row and column location in the EA is less than the current display address.
- The length field is not valid.
- A specified attribute type is not valid.
- A specified attribute type is not supported on this workstation.

## Start of Header Order

The start of header (SOH) order specifies header information for the format table. When the 5494 receives this order, it first clears the format table and then inserts the contents of the SOH order. Because the parameters in this order vary in length, the first byte after the control code contains the number of bytes included. The command code is X'01'.

| SOH X'01' | Length 1 byte | Status 1 byte | RSVD X'0' | RESQ Field 1 byte | ERR Row 1 byte | Command Key Switches 3 bytes |
|---|---|---|---|---|---|---|

**BYTE 0** Length of data following SOH order not including the length byte.

**Note:** A value of 0 or a value > 7 is not valid and triggers a parameter error.

**BYTE 1** Flag byte
Bit 0–Right-to-left screen level cursor direction
Bit 1–Enable manual local screen reverse
Bit 2–Automatic local screen reverse
Bit 3–The cursor is allowed to move only to input-capable positions; this cursor movement mode applies to this display screen.
Bits 4–7—Reserved.

**BYTE 2** Reserved.

**BYTE 3** The number of the first field that the control unit sends to the AS/400 system in response to a READ INPUT FIELD, READ MDT FIELD, or a READ MDT ALTERNATE command. Specify 0 if resequencing is not desired.

**BYTE 4** ERR Row.

**Note:** A value of 0 or a line number greater than the number of lines on the display, will result in the selection of a default error line. For 5250 workstations, this default is the last line of the screen. For an IBM 3180 Model 2, an IBM 3197 Models D and W, an IBM 3477, an IBM 3486, and an IBM 3487 display station, it is the message line (line 25 if in 24x80 mode or line 28 if in 27x132 mode). Any other value will result in the specified line being used.

SOH bytes 5, 6, and 7 contain the *data included* switches for the 24 PF keys. If the SOH byte 0 contains a value of 6 or less, all screen input fields are returned with every entry of a PF key. When bytes 5 through 7 are included with an SOH order, a set bit prevents input data and AID codes from being returned with a request from the corresponding PF key.

## Transparent Data (TD) Order

The transparent data (TD) order allows the transmission of data with any value to the workstation screen. The order code is X'10'.

| TD X'10' | LL 2 bytes | Data |
|---|---|---|

The 2-byte field (LL) immediately after the order code indicates the total length of the data field. The 5494 returns a parameter error if:

- Fewer than 2 bytes remain in the data stream when the TD order is found
- The AS/400 system attempts to write data beyond the last available screen address
- The data stream contains fewer bytes than indicated by the LL field.

## Write Extended Attribute Order

The write extended attribute (WEA) order allows an extended attribute to be written to the workstation extended character buffer (ECB) at the current workstation address. The order code is X'12'.

| WEA<br>X'12' | Attribute Type<br>1 byte | Attribute<br>1 byte |
|---|---|---|

The valid extended attribute types are:

X'01' - Extended primary attributes
X'03' - Extended foreground color attributes
X'05' - Extended ideographic attributes

### Valid Extended Primary Attributes

The valid extended primary attributes are X'00' and X'80' to X'9F', as defined in Table 12-5. X'80' is the normal display attribute. X'00' is the null attribute and does not change the current extended attribute in effect.

*Table 12-5. WEA Extended Primary Attributes*

| Bits | Description |
|---|---|
| 0 | Attribute flag<br>1 = Attribute change |
| 1–2 | Reserved |
| 3 | Column separator<br>1 = Column separator |
| 4 | Blink<br>1 = Blink |
| 5 | Underscore<br>1 = Underscore |
| 6 | Intensity<br>1 = High intensity |
| 7 | Reverse image<br>1 = Reverse image |

Extended primary attributes generally take precedence over display screen attributes. If an X'80' extended primary attribute is in effect or if the entire extended attribute buffer is nulled, the display screen attributes affect display screen presentation.

## Valid Extended Foreground Color Attributes

The valid extended foreground color attributes are X'00' and X'80' to X'8F'. The display support of extended foreground color attributes can be determined using the 5250 Query command (5250 Query Response field definition within Device Capabilities, byte 2, bits 6–7). Valid extended foreground color attributes are defined as follows:

**X'00'** Null - continue currently defined attribute

**X'80'** Color of the display background medium; black on most models

**X'81'** same as X'80'

**X'82'** blue

**X'83'** blue; different shade of blue than X'82' on some displays

**X'84'** green

**X'85'** green; different shade of green than X'84' on some displays

**X'86'** turquoise

**X'87'** turquoise; different shade of turquoise than X'86' on some displays

**X'88'** red

**X'89'** red; different shade of red than X'88' on some displays

**X'8A'** pink

**X'8B'** pink; different shade of pink than X'8A' on some displays

**X'8C'** yellow

**X'8D'** yellow; different shade of pink than X'8C' on some displays

**X'8E'** white

**X'8F'** white; different shade of white than X'8E' on some displays

Extended foreground color attributes begin at the position of the extended attribute. Null (X'00') extended attributes continue the currently defined attribute. A X'80' is the normal display attribute. All combinations of attributes between X'80' and X'8F' are valid on all displays with foreground color extended attributing capability.

In general, if extended foreground color attributes are used, the extended foreground color attributes take precedence over display screen attributes. The exception is if a X'80' extended foreground color attribute is in effect, then display screen attributes do affect display screen presentation.

## Valid Extended Ideographic Attributes

The valid extended ideographic attributes are X'00', X'80', and X'81'. The display support of extended ideographic attributes can be determined using the 5250 Query command (5250 Query response field definition within Device Capabilities, byte 3, bits 0-2). Extended ideographic attributes are defined as follows:

```
X'00'   Null - continue currently defined attribute
X'80'   Normal display attribute - end double byte mode (SI)
X'81'   Begin double byte mode (SO)
```

Extended ideographic attributes begin at the position of the extended attribute. Null (X'00') extended attributes continue the currently defined attribute.

In general, if extended ideographic attributes are used, they take precedence over display screen SO or SI characters. However, when the X'80' extended ideographic attribute is in effect, the screen SO or SI characters affect screen presentation.

Extended ideographic attributes should not be written behind middle positions of input fields because the 5494 does not scan the extended ideographic plane to determine whether the cursor is in a single- or double-byte position.

Do not place a X'80' attribute behind the second byte of a double-byte character. The next character is single byte, but the data returned for a Read Screen With Extended Attributes command splits the double-byte character.

Do not mix extended ideographic attributes with screen SO characters. If an SO character is in effect on the screen, use a screen SI character before using an extended ideographic SO attribute. If an extended ideographic SO attribute is in use, use an extended ideographic SI attribute before using a display SO character.

Two restrictions exist when using this command on an NWS:

1. Whenever double-byte data is written between extended ideographic SO and SI attributes, the extended ideographic SO and extended ideographic SI attributes bounding the data must be written to the display using the WRITE EXTENDED ATTRIBUTE command. This is true even if the extended ideographic SO or SI attributes were previously written to the display. If this is not done, the AS/400 will not correctly handle undefined double-byte code points.
2. When using an extended ideographic SO attribute on the display screen, use only one of the following READ commands:
   - READ SCREEN WITH EXTENDED ATTRIBUTES
   - READ SCREEN TO PRINT WITH EXTENDED ATTRIBUTES
   - READ MDT FIELDS
   - READ MDT ALTERNATE
   - READ MDT IMMEDIATE ALTERNATE.

   Other READ commands do not identify double-byte data that is between the extended ideographic SO and extended ideographic SI attributes, causing the AS/400 to process undefined double-byte code points incorrectly.

## Considerations

Extended attributes should be used for screen output fields only. If they are used in input fields, insert and delete processing will not move the extended attribute. The WEA order does not modify the current display address.

The following conditions result in a negative response:

- The specified attribute type is not valid.
- The specified attribute type is not available on this workstation.
- The specified extended attribute is not valid.
- The specified extended attribute is not available on this workstation.

**Note:** When using extended attributes, it may be necessary to null the attributes when the next display screen is written. A CLEAR UNIT command clears the screen and nulls all extended attributes. If, instead of issuing a CLEAR UNIT, the AS/400 system chooses to overwrite existing data (using, for example, an RA order to write nulls to an area of the screen), extended attributes may cause the screen to be displayed incorrectly. The EA order may be used to null display screen data and extended attributes. See "Erase to Address Order" on page 12-12.

## Start of Field Order

The start of field (SF) order controls the characteristics of every input field that appears on workstation screens. The SF order can also define output fields that appear on the workstation screen. However, using an SBA order followed by data characters is preferred for better performance. The order code is X'1D'. SF orders include control words that determine the operating characteristics, display attributes, and length of individual fields.

| SF<br>X'1D' | FFW<br>2 bytes | FCW<br>2 bytes | @<br>1 byte | LL<br>2 bytes |
|---|---|---|---|---|

SF Start of field order.

FFW Optional field format word (FFW). If specified, causes an input field to be defined.

FCW Optional field control word or words (FCW). May not be specified unless FFW is coded.

@ Field attribute.

LL Field length.

The 5494 can accommodate up to 256 input fields for each workstation. The maximum number of fields is not restricted by the number of FCWs defined. The 5494 processes each SF order in the following manner:

- Upon detection of the SF code, the 5494 first sets the SF address. This address is either determined by the contents of a preceding SBA order or calculated from the field length parameter in the last SF order received.
- The 5494 examines the first 2 bits after the code to identify which word is present. If an attribute follows immediately after the code, an output field is being defined, and such fields require no entry in the format table.
- If the 5494 detects an FFW in the SF order, it takes the following actions:
  - Locks the keyboard.
  - Clears Insert mode and the corresponding display on the keyboard.
  - Clears Command mode and any outstanding AID request.
  - Sets the master MDT bit if commanded to do so by the FFW.
  - Examines the format table for an entry that begins at the current starting address plus 1. If such an entry is detected, the 5494 modifies the existing field in accordance with the new FFW and field attributes.
  - If no field previously existed at the current starting address, and this field is after the last field on the display screen, the 5494 enters a new field in the format table in accordance with the FFW and field attributes in the current SF order.

## Field Format Word

The AS/400 system must configure a separate FFW for each input field on a workstation screen. This word contains software flags that define most of the operational characteristics supported by the 5494. Table 12-6 defines each bit or field included in the FFW.

*Table 12-6 (Page 1 of 2). Field Format Word Format*

| | |
|---|---|
| Bit 0–1 | 01 – FFW identification flag |
| Bit 2 | Bypass<br>0 = This is not a bypass field<br>1 = This is a bypass field |
| Bit 3 | Dup or Field Mark Enable<br>0 = Duplication or Field Mark is not allowed in this field<br>1 = Duplication or Field Mark is allowed in this field |
| Bit 4 | Modified Data Tag (MDT)<br>0 = This field has not been modified<br>1 = This field has been modified |
| Bit 5–7 | Field Shift/Edit Specification<br>000 = Alpha shift<br>001 = Alpha only<br>010 = Numeric shift<br>011 = Numeric only<br>100 = Katakana shift<br>101 = Digits only<br>110 = I/O–(feature input field)<br>111 = Signed numeric |
| Bit 8 | Auto Enter<br>0 = No auto enter<br>1 = Auto enter when field is exited |
| Bit 9 | Field Exit Required (FER)<br>0 = Field Exit key is not required<br>1 = Field Exit key is required |
| Bit 10 | Monocase<br>0 = Accept lower case letters<br>1 = Translate operator keyed letters to uppercase |
| Bit 11 | Reserved |
| Bit 12 | Mandatory Enter (ME)<br>0 = Not mandatory enter field<br>1 = Mandatory enter field |

*Table 12-6 (Page 2 of 2). Field Format Word Format*

| | |
|---|---|
| Bit 13–15 | Right Adjust/Mandatory Fill (MF)<br>000 = No adjust specified<br>001 = Reserved<br>010 = Reserved<br>011 = Reserved<br>100 = Reserved<br>101 = Right adjust, zero fill<br>110 = Right adjust, blank fill<br>111 = Mandatory fill |

**Notes:**

1. The 5494 does not check FFW data for validity.
2. The AS/400 system can write anything to any location on screen, regardless of FFW data in the format table.
3. The AS/400 system can set the MDT bit of a particular field by placing an FFW at the proper place in the data stream.
4. Make sure that all bits marked as reserved are set to 0.

***Fields:*** Table 12-7 identifies the field formats that the 5494 supports. Selection of specific field formats is controlled by the FFW. The information in parentheses immediately following the name of each field format identifies the bit position of the corresponding software flag in the FFW. See Table 13-1 on page 13-5 for descriptions of FFW formats.

*Table 12-7 (Page 1 of 2). Available Field Formats*

| Format of Field | Description |
|---|---|
| Alphabetic only (bits 5–7 = 001) | Accepts only characters A—Z (both uppercase and lowercase plus the comma (,), period (.), dash (–), and blank characters). Other characters cause operator errors. Some special characters for World Trade countries are also acceptable. |
| Alphabetic shift (bits 5–7 = 000) | Accepts all characters, and the Shift keys are acknowledged. |
| Auto enter (bit 8) | The contents of all fields, including the modified READ MDT fields, are sent to the AS/400 system. The operator begins by pressing one of the field exit keys or by entering the last character in last required field. |
| Bypass (bit 2) | Entries are not allowed in this field. If the workstation operator tries to enter something into this field, an error results. |
| Dup enable (bit 3) | The 5494 repeats X'1C' from the cursor position to the end of the field when the workstation operator presses the Dup key; this displays on the workscreen as an overstruck asterisk. |
| Field exit required (bit 9) | Requires the workstation 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 (bits 5–7 = 110) | Only a magnetic stripe reader or selector light pen can enter data into an I/O field without causing an error. |
| Katakana shift (bits 5–7 = 100) | This is the same as the alphabetic shift except that the keyboard is Katakana and is placed in Katakana shift. |
| Mandatory enter (MD) (bit 12) | Requires the workstation operator to enter something in the file before the 5494 allows the Enter key to be active. The 5494 recognizes the state of these fields by checking the MDT bit for the field. If the workstation operator tries to bypass the field using a Field +, Field –, or Field Exit key, an error occurs. |

Table 12-7 (Page 2 of 2). Available Field Formats

| Format of Field | Description |
|---|---|
| Digits only (bits 5–7 = 101) | Allows digits 0–9 only from keyboard. Also allows the Dup key if the Dup enabled bit is in the FFW. |
| Mandatory fill (MF)<br>(bits 13–15 = 111) | If the operator enters any character into this type of field, the field must be completely filled before exiting. Any attempt to leave an unfilled field causes an error. The workstation operator can use the Dup key to fill the field. If the field is nulled when the workstation operator exits from the first position using the Field Exit or Erase Input key and the MDT bit is on, the null characters can be sent back to the AS/400 system in response to a READ command. |
| Monocase (bit 10) | 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 are translated to uppercase:<br><br>Austria/Germany ü ä ö<br>Brazil ã ç é õ<br>Denmark å æ ø<br>Finland å ä ö é<br>Norway å æ ø<br>Portugal ã ç õ<br>Spain ñ<br>Spanish-speaking ñ<br>Sweden å ä é ö<br><br>For the remaining World Trade typewriter-like and all data-entry keyboards, the lowercase special characters are keyed and displayed as lowercase. |
| No adjust (bits 13–15=000) | Accepts characters without either position adjustment or insertion of fill characters. |
| Numeric only<br>(bits 5–7 = 011) | Accepts only the 0–9, plus (+), comma (,), period (.), and blank ( ) characters. 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 5494 changes the zone of the low-order digit to X'D', unless it is one of the symbols (+, –, . or blank); in this case, an error results. |
| Numeric shift<br>(bits 5–7 = 010) | Accepts all characters. |
| Right adjust<br>(byte 2, bits 13–15:<br>• 101 = blank fill<br>• 110 = zero fill) | Fills all leftmost unoccupied positions of a field with the specified character; characters are right-adjust and spaces are blank-filled or zero-filled. The operator must specify this as either blank or 0. The fill character appears on the workstation screen. |
| Signed numeric<br>(bits 5–7 = 111) | Allows only characters 0–9. An attempt to enter any other character causes an error. The signed numeric field must be at least 2 bytes long. The last (rightmost) position is reserved for the sign display (– for negative and blank for positive). You cannot type characters into this position. To exit this field, use either the Field +, the Field –, or the Field Exit key. If you use the Field – key to exit this field, the 5494 right-adjusts the field and inserts a negative sign in the rightmost position. If you use Field +, the 5494 right-adjusts the field and inserts a blank in the rightmost position.<br><br>If the last character is negative, the zone of the low-order digit is set to X'D' before the character is sent to the AS/400 system. If the last character is positive, the low-order digit is not changed. The last sign position is not sent to the AS/400 system in response to either the READ MDT or READ INPUT commands. |

## Field Control Word

Field control words (each 2 bytes) are optional and can be included in the SF order. When field control words are used, they should follow the FFW of the SF order. Any FCW encountered during the modification of an existing format table entry is ignored. An FCW of X'FFxx' will not be accepted by the LU.

Table 12-8 lists all valid FCWs and their corresponding functions.

*Table 12-8. Field Control Words*

| FCW Value | Function |
|---|---|
| X'80nn' | Entry field resequencing. The *nn* specifies the next entry field in the sequence (X'00' to X'80'). |
| X'8101' | Magnetic stripe reader entry field |
| X'8102' | Selector light pen or cursor select field |
| X'8103' | Magnetic stripe reader and selector light pen entry field |
| X'8106' | Selector light pen and selectable attention entry field |
| X'8200' | Ideographic-only entry field |
| X'8220' | Ideographic data type entry field |
| X'8240' | Ideographic-either entry field |
| X'8280' or X'82C0' | Ideographic-open entry field |
| X'84nn' | Transparency entry field. The *nn* can be any two digits. |
| X'8501' | Forward edge trigger entry field |
| X'8601'–X'8603' | Continued entry field |
| X'8680' | Word Wrap entry field |
| X'88nn' | Cursor progression entry field. The *nn* is the next entry field in the specified application cursor progression sequence. |
| X'89nn' | Highlighted entry field. The *nn* specifies the field attribute |
| X'8Ann' | Pointer device selection entry field. If a user selects the entry field, the *nn* specifies the AID to be returned. |
| X'B140' | Self-check modulus 11 entry field |
| X'B1A0' | Self-check modulus 10 entry field |

The first FCW of any type is used. Subsequent FCWs of the same type are ignored. The 5494 does not check to determine if the FCWs are formatted correctly or if the requested function is installed. The 5494 can detect and report these errors to the AS/400 system if the FCW is required during subsequent command and keystroke processing.

The following paragraphs explain the types of FCWs.

***Magnetic Stripe Reader (MSR):*** The MSR allows the reading of numeric information encoded on a magnetic stripe card. The card can be encoded with up to 128 numeric and control characters. The following requirements must be met when specifying a field for MSR input:

- An FCW must be defined for the field only if operator ID (OID) secured data is to be entered into this field.

X'8101' identifies an MSR OID secured field. When the MSR OID data is read into the field, the 5494 converts the OID code into a colon that appears in position 1 of the field to indicate secured data.

X'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 sequence 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 AS/400 system.
- MSR data can be entered into an I/O field starting at the cursor position.
- The operator must use the cursor movement keys to move the cursor to the desired position.
- Data entered from the card must satisfy the requirements of the field selected. Any format error can be identified by an appropriate system reference code (SRC).
- There can be only one field on each magnetic stripe card. This field can range from 1 to 125 characters in length for the IBM 5251 and 5292 display stations.
- No data overflow is allowed. Magnetic stripe data must fit within the selected field or the 5494 posts an operator SRC 0034.
- The field starting attribute (nondisplay) must be supplied using the SF order.

***Resequencing:*** Resequencing allows the 5494 to send the input fields to the AS/400 system in any specified order. Resequencing is accomplished by chaining input fields together with FCWs that specify the desired order of transmission. The format of the resequencing FCW is as follows:

| Bits | Description |
|---|---|
| 0–1 | B'10' |
| 2–7 | B'000000' |
| 8–15 | The normal sequence position of the next field to be returned to the AS/400 system. (The first field on the screen is number 1; the field numbers progress sequentially, left to right and top to bottom.) |

Bit 3 of the SOH order contains the number of the field to be sent. If the first field identifier in the SOH is set to 0, resequencing does not occur (that is, all resequencing FCWs are ignored; fields are sent to the AS/400 system in the order defined in the format table). If resequencing does occur, the last field to be sent to the AS/400 system must contain the following FCW:

| Bits | Description |
|---|---|
| 0–1 | B'10' |
| 2–7 | B'000000' |
| 8–15 | B'11111111' |

**Notes:**

1. If the FCWs create a closed loop, the 5494 detects the error and stops the transmission.
2. An FCW for each field is not required. An FCW pointing to the next sequential field is assumed if no resequencing FCW is specified. (The last field in the format table must have a resequencing FCW.)

***Selector Light Pen:*** The selector light pen 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:

- An FCW must be defined for the field.

  X'8102' designates a field that permits selector light pen use.

  X'8103' designates a field that allows the use of both a selector light pen and a magnetic stripe reader.

- Light pen fields on the same line should be separated by at least 4 characters.
- The light pen field should be formatted as:

  @?b*bxx...x@

  The characters in this field are:

  **@** The leading attribute should be high intensity. The trailing attribute should be normal intensity. See Table 12-10 on page 12-32 for a list of field attributes.

  **?** A designator character (?) in the first position of the field indicates field 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 (*) may be inserted into the field format. This character enhances the pen's ability to detect the field. 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.

- The cursor position remains unchanged after a light pen selection is made.

***Ideographic Fields:*** For information on the ideographic fields, see Appendix A, "Ideographic Enhancements."

***Transparency:*** A transparency entry defines a field that can contain data of any value. The 5494 does not format field data during reprocessing.

***Forward Edge Trigger:*** Forward edge trigger has the same function as the auto enter specified in the field format word. With this FCW, however, the 5494 returns a unique forward edge trigger AID code to the AS/400 system when this field is exited.

***Self-Check:*** The self-check function on the 5494 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 FCW must be defined for the field.

  X'B1A0' selects Modulus 10 checking.
  X'B140' selects Modulus 11 checking.

- Field lengths for checking are restricted to 33 positions. For signed numeric fields, only 32 positions can contain digits, and the sign is not checked. If more than 33 characters are given, a LUSTAT parameter error results.

Self-check resolves fields and conditions in the following ways:

- The function 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 X'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 5494 allows the workstation operator to exit the field from the first position by using the Field Exit key.

***Continued Entry Fields:*** Continued entry fields are a set of associated entry fields that are treated by the 5494 as a single entry field during field data entry and editing.

A continued entry field enables a multiple row entry field to be defined inside of a window. Figure 12-2 shows how the continued entry fields format can improve screen appearance and use.

```
Enter Text . . .  ________________________________
                  ________________________________
                  ________________________________
                  ________________________________
```

*Figure 12-2. Continued Entry Fields in a Continuous Text Format*

Continued entry fields are defined by Continued Entry Field FCWs, (X'8601'–X'8603'). Continued entry fields can also define edit mask entry fields.

Bits 0–5 of byte number 2 of the Continued Entry Field FCW are reserved and must be set to zero. For bits 6–7 of byte number 2 of the Continued Entry Field FCW, specify:

**B'00'** Invalid (causes a negative response)
**B'01'** Specifies the first continued field segment
**B'10'** Specifies the last continued field segment
**B'11'** Specifies the middle continued field segment (all continued entry fields have this value specified here).

As with other entry fields, continued entry fields are defined from the top down and from left to right in the data stream, based on the position of the first continued entry field segment. All subsequent continued entry field segments must follow one another consecutively until the last field segment is specified. These segments are also defined from the top down and from left to right. After you complete this task, other continued entry fields (and other entry fields) can be defined.

Continued entry fields are specified in a specific sequence. Consider the following rules when specifying continued entry fields:

- The first field segment in the set must be designated as being first.
- The last field segment in the set must be designated as being last.
- All field segments between the first and last must be designated as being in the middle.
- At least two field segments must be defined (first and last).
- No field segment can span more than one line.

Each continued entry field is presented in the same manner as other entry fields. The 5494 creates all continued entry field segments so that they have the same input field characteristics (FFW and optional FCWs). The FFW of the first segment is used for all subsequent segments. However, all segments must have a valid FFW.

If the first control character (on a WRITE-TO-DISPLAY command or on a PENDING READ command) specifies that modified fields are to be nulled, all segments of a continued entry field will be nulled if any segment has been modified (the MDT is set on).

FCWs may be used in only the first continued entry field definition (with the exception of the continued entry field FCWs associated with each field segment).

The 5494 sends a negative response if field resequencing is defined for the screen display or the first continued entry field segment is defined as:

- Self-check
- Right-adjust
- I/O attention
- Signed numeric
- Mandatory fill
- Selector light pen (SLP)
- Magnetic stripe reader (MSR)

The 5494 also supports ideographic (double byte character set) continued entry fields. The 5494 automatically writes Shift-Out and Shift-In characters on each segment when the field is created (Start Field order). It is recommended that the host write data to an ideographic continued entry field with a WRITE DATA structured field command. (See "WRITE DATA Structured Field" on page 12-92 for more information.)

The 5494 handles each field of the continued entry field set as a single entry field. If any of the following type of data is entered or one of the following keys is pressed, the 5494 processes the continued entry field as follows:

**Character data**

In replace mode, there is no unique character data for processing.

When character data is entered in the last character position of the first or middle segment of the continued entry field set, the cursor moves to the first character position of the next segment in the set. When character data is entered in the last character position of the last segment of the continued entry field set, forward field exit processing is started. See the Field Advance description.

**Insert Mode**

If the display is in insert mode when a character data key is pressed, the 5494 responds as follows:

- If there is no null character specified in the last position of the last segment, an error message is displayed.
- Field data characters following the current cursor position are shifted one position. Each field data character in the last character position of the current and remaining segments (except the last segment) is shifted to the first character position of the following field.
- The field data character that is entered is written at the cursor position.
- The cursor advances to the next cursor position.

**Delete**

If the Delete key is pressed within a continued entry field, the 5494 responds as follows:

- All field data within the continued entry segment (that follows the current cursor position) is shifted toward the cursor position. Each data character in the first character position of the remaining segments is shifted to the last character position of the preceding segment.
- A null character is placed in the last character position of the last segment.

**Field Exit**

If the Field Exit key is pressed within a continued entry field, the 5494 responds as follows:

- All field data that follows the current cursor position is nulled.
- Forward field exit processing is started (see Field Advance description).

**Field Plus**

The 5494 processes this key the same way it processes the Field Exit key.

**Field Minus** This key is not valid. If it is used, an error message is displayed.

**Field Advance** The Field Advance key starts forward field exit processing.

**Field Backspace** The Field Backspace key starts backward field exit processing. When backward field exit processing occurs, the cursor moves to the previous non-bypass field. The previous non-bypass field is determined by exiting the first continued entry field segment (which is independent of the segment containing the cursor).

**Duplicate (Dup) Key** All characters within the continued entry field set following the current cursor location are set to the Dup character.

**Forward Field Exit Processing**

If a continued entry field set is specified as either automatic enter or forward-edge trigger, automatic enter or forward-edge trigger processing is started for the last position of the last field segment.

If cursor progression is specified on the first continued entry field segment, the cursor moves to the cursor progression target field whenever you exit any of the continued entry field segments. Otherwise, the cursor returns to the next non-bypass field when the Field Advance Exit key is pressed (which skips over subsequent field segments of the continued entry field). The next non-bypass field is determined by exiting the first continued entry field segment (which is independent of the segment containing the cursor).

The continued entry field is treated as a single input field. If the AS/400 system sets the MDT flag in the first continued entry field segment, or if the user has modified any continued entry field segment, the MDT flags of all continued entry field segments that make up the continued entry field are set. Therefore, data from the entire continued entry field set is to be sent inbound in response to the READ MDT command. There are no delimiters (SBA orders) separating the data from each of the continued entry field segments. In response to the READ MDT command, trailing null characters are not returned after the last non-null character in the field data set.

For inbound data from an ideographic continued entry field, the 5494 removes extra Shift-Out characters (which start each middle and last segment) and Shift-In characters (which end each first and middle segment). For a READ MDT command from an Ideographic Only or Ideographic Either entry field, the 5494 removes trailing nulls before the last Shift-In. For a READ Input command, the inbound data must be the exact length of the entry field; therefore, the 5494 pads the inbound data with trailing nulls as required. These padded nulls should be removed by the host before writing the field data back to the field using the WRITE DATA STRUCTURED FIELD order.

***Edit Mask Entry Field:*** An edit mask entry field can be created by defining a continued field segment for each input-capable part of the edit mask field. For example, Figure 12-3 on page 12-28 shows two edit mask entry fields:

```
Telephone Number . . .  (800)555-1212
Social Security Number . .  ___-__-____
```

*Figure 12-3. Edit Mask Entry Fields*

In Figure 12-3, the three hyphens (-) and the parentheses ( ) are protected positions. The fields from this figure are defined as follows:

- Each input-capable portion of the edit mask entry field is defined as a continued field segment. In Figure 12-3, there are three continued field segments in each field. In the first field, the continued field segments are separated by a right parenthesis and a hyphen. In the second field, the continued field segments are separated by two hyphens. When creating edit mask entry fields, there must be at least two continued field segments.
- The mask characters are written over the field attributes using an additional set buffer address (SBA) and the actual character in the following command. For the telephone number entry field, a display attribute must be written to the left of the left parenthesis since the field attribute is overwritten by the left parenthesis.

**Notes:**

1. If an edit mask entry field is redefined when the entry field is active on the display screen (and the AS/400 application user redefines the edit mask entry field in order to change the leading field attribute or FFW), the mask characters must be rewritten after each edit mask entry field has been redefined.
2. You can highlight edit mask entry fields, but it is not recommended. In the case of the telephone number edit mask entry field, highlighting is ignored because the attribute position is overwritten by the left mask character parenthesis. In the case of the social security number edit mask entry field, if the user moves the cursor under a mask character, highlighting is not recognized by the system (highlighting would appear to flash on and off as the user moves the cursor left or right on the highlighted edit mask entry field).

***Word Wrap Entry Fields:*** Entry fields may have word wrap specified. Word wrap prevents words from splitting between lines of a field that span lines, or between segments of a continued entry field. Word wrap makes viewing of field data easier because words are not partly on one line or field segment, and partly on the next.

In order to prevent usability problems, the following recommendations should be followed:

- The total entry field length should take into account that word wrap is used. Character positions at the ends of lines or segments may be used for padding when a wrap occurs. If a field is too short, the 5494 may turn off word wrap in order to fit the data within the field.
- The length of each line or segment should be larger than the longest word that would be entered in the field. If a line or segment is too short, insert failed operator errors (0012) could result or the data may be shifted down to the last line or segment by the 5494.

*Word Wrap Entry Fields—Host Interface:* Word wrap is defined by the word wrap FCW (X'8680').

To write data to a word wrap field, the Write Data Structured Field order must be used, or an equivalent algorithm implemented in the host (see page 12-92 for details). The Write Data Structured Field order ensures that words are not split between two segments or lines of word wrap fields. If all the data in the Write Data Structured Field order cannot fit within a word wrap field without splitting words, the word wrap function for that field is not used, and the data is rewritten as if word wrap had not been specified. Note that word wrap could be used again if the user were to change the field data such that the data would fit using word wrap (for example, the user deletes some characters).

If word wrap is specified for an entry field that is contained on a single line, word wrap is allowed. Editing behavior operates as described below, except that words are never spilled.

Word wrap is ignored for ideographic only fields, ideographic pure fields, and ideographic either fields (with double byte). In ideographic open fields, word wrap only applies to the single byte data.

The 5494 will return a negative response if a word wrap field is defined along with any of the following field types or features:

- Signed numeric (FFW)
- Numeric only (FFW)
- Digits only (FFW)
- Right-adjust (FFW)
- Mandatory fill (FFW)
- Magnetic stripe reader (FCW)
- Selector light pen (FCW)
- Selectable attention (FCW)
- Self-check (FCW)
- Dup allowed (FFW)
- For an ideographic open field with word wrap specified that spans lines, each portion of the field on each line must be at least 4 bytes long.

The keyboard functions within the word wrap field are described as follows:

**Replacing Data** In replace mode, a character may cause two words to become one (if a non-blank replaces a blank between two non-blank words), or it may extend a word (by adding to the end of it). In these cases, if the new character causes a word to be split between two lines or segments, the newly formed word is inserted into the next line or segment. The space vacated on the first line or segment is filled with nulls. If data will no longer fit into a word wrap field as a result of words spilling, the field data is rewritten to the field as if word wrap were not specified. Note that word wrap could be used again if the user were to change the field data such that the data would fit using word wrap (for example, the user deletes some characters).

**Inserting Data** In insert mode, a character may also cause words to no longer fit on lines or segments. In this case, any non-fitting word is spilled to the following line. During this process, imbedded nulls may be removed. If the data will not fit back into the field, the data is written as without word wrap in effect. Note that word wrap could be used again if the user were to change the field data such that the data would fit using word wrap. If the data still will not fit back into the field, operator error 0012 is posted.

**Deleting Data** Imbedded nulls may be removed as a result of the Delete key.

**Reverse Key** The Reverse key is not allowed in word wrap fields. Operator error 0091 is posted.

**ASD Processing** For Arabic and Farsi, Automatic Shape Determination precludes the word wrap function. Word wrapping will not occur when the cursor direction is right-to-left for these languages.

*Word Wrap Fields—Inbound Field Data:* The 5494 removes all nulls from the inbound data. If the entry field is a right-to-left entry field, data is returned starting at the right-most position.

**Note:** Write Data command processing into a right-to-left entry field is consistent with inbound data from a right-to-left Word Wrap field; the AS/400 system does not need to reverse the entry field data.

**Inbound Data from a Read MDT Command:** Trailing nulls at the end of the field are not returned in the inbound data.

**Inbound Data from a Read Input Command:** Entry field data returned from a READ INPUT command must be exactly the length of the entry field. Therefore, the 5494 pads the inbound data for the entry field with trailing nulls, if necessary. These padded nulls should be removed by the host before resending the entry field data to the 5494 using a Write Data structured field.

***Cursor Progression Entry Field:*** Cursor Progression fields are defined by the Cursor Progression FCW (X'88nn'), where X'nn' specifies the cursor progression field. It is the number of the entry field to which the cursor will be moved when a forward field exit occurs. Remember that all entry fields on the display are presented from top to bottom and left to right for each new row, which starts at field number 1 (including bypass entry fields).

Continued entry fields and selection entry fields count as a single field. Scroll bar fields are not counted.

If you have defined a display to use read resequencing (defined in the SOH order), the 5494 ignores cursor progression FCWs. Read resequencing and cursor progression cannot be used together on the same display screen. The 5494 ignores the cursor progression field number X'00' and any field number of an undefined field.

If a backward field exit occurs within a non-bypass entry field, and the display screen contains cursor progression fields, the 5494 will scan for a cursor progression FCW that is targeting the entry field or selection field that is being exited. If a cursor progression FCW is found, the cursor is moved to the entry field associated with it.

***Highlighted Entry Field:*** Highlighted entry fields are defined by a X'8900'-X'89FF' FCW.

When the cursor is in a highlighted field, the leading field attribute is changed to the specified attribute. The field can be any type of entry field. Continued entry fields can be defined as highlighted fields (the highlighted FCW is sent only on the first segment); and the 5494 will replace each leading segment field attribute with the specified attribute when the cursor enters any of the segments.

Table 12-9 defines the bytes of the highlighted entry field FCW (X'8900'-X'89FF').

*Table 12-9. Definitions for the Highlighted Entry Field FCW. ( X'8900'-X'89FF')*

| Byte | Field | Value | Description |
|---|---|---|---|
| Byte 1 | | X'89' | |
| Byte 2 | Bits 0–1 | B'00' | Applies to both monochrome and color displays. |
| | | B'01' | Applies to monochrome displays only. The 5494 ignores the FCW on a color display. If a different hex attribute on monochrome or color displays is desired, two highlighting FCWs can be sent. |
| | | B'10' | Applies to color displays only. The 5494 ignores the FCW on a monochrome display. |
| | | B'11' | Reserved. FCW is ignored. |
| Byte 2 | Bit 2 | B'0' | The text cursor is visible within the field. |
| | | B'1' | The text cursor is invisible when it enters the field. The field must be an I/O field (with no MSR, LP, or I/O attention FCW). |
| Byte 2 | Bits 3–7 | | Defines the lower five bits of the attribute to be used when the cursor enters the field, (X'00'-X'1F'). The 5494 will specify the OR operand with X'20' to produce the proper attributes. |

**Notes:**

1. A highlighted entry field FCW is ignored for a bypass field and a row 1, column 1 field (actually defined at row 1, column 0).
2. If a field has an invisible text cursor, and the field is not an I/O field, the highlighting entry field FCW is ignored.
3. If an I/O field has an invisible text cursor, the field must not have an LP, MSR, or I/O attention FCW, otherwise the highlighting FCW is ignored.
4. I/O fields normally enable the user to use specific keys to modify entry field data (for example, Field Exit and Erase EOF keys). However, if an I/O field has no LP, MSR, or I/O attention FCW, but it does have a highlighting entry field FCW, the entry field data is not able to be modified.
5. A highlighted entry field can have an invisible text cursor. If this is the case, the first field position is returned in the inbound data.
6. Whenever the cursor enters a highlighted entry field, the leading field attribute is changed to the specified attribute. When the cursor exits the field, the original field attribute is restored.

***Mouse Selection Entry Field:*** Mouse selection fields are defined by a X'8A*nn*' FCW where *nn* is the AID to be returned in the inbound data when a user selects this non-bypass field. The AID value should be a currently defined AID or be between the values X'70'—X'7F'. See Table 13-1 on page 13-5.

The mouse selection entry field enables the user to use a pointing device when selecting values for a field. When a user selects a position on a mouse selection field, the text cursor is moved to the location of the mouse cursor, the keyboard is locked, and the specified AID is returned.

The AID specified in the mouse selection entry field FCW is returned to the AS/400 system. Field data can be included in the inbound data, depending on the type of AID. AID values such as Enter and Roll Up return inbound data.

## Field Attributes

The field attributes control the image produced on the workstation screen. Each attribute occupies one character position in the workstation regeneration buffer and is displayed as a blank. The effect produced by an attribute begins at its location in the regeneration buffer and continues until the next attribute appears.

The attributes for non-color and color displays are shown in Table 12-10.

*Table 12-10 (Page 1 of 2). Field Attributes in the SF*

| **The attributes for a non-color display are specified as follows:** | |
|---|---|
| Bit 0–2 | 0 0 1 = Attribute identification flag |
| Bit 3 | 0 = Column separator off |
| | 1 = Column separator on |
| Bit 4 | 0 = Do not blink field |
| | 1 = Blink field |
| Bit 5 | 0 = Do not underscore field |
| | 1 = Underscore field |
| Bit 6 | 0 = Low intensity |
| | 1 = High intensity |
| Bit 7 | 0 = Normal image |
| | 1 = Reverse image |
| **Note:** Multiple functions can be selected. If bits 5, 6, and 7 all = 1, displaying of field will be inhibited. | |
| **The attributes for a color display are specified as follows:** | |
| X'20' | Green |
| X'21' | Green/Reverse image |
| X'22' | White |
| X'23' | White/Reverse image |
| X'24' | Green/Underscore |
| X'25' | Green/Underscore/Reverse image |
| X'26' | White/Underscore |
| X'27' | Nondisplay |
| X'28' | Red |
| X'29' | Red/Reverse image |
| X'2A' | Red/Blink |
| X'2B' | Red/Reverse image/Blink |

Table 12-10 (Page 2 of 2). Field Attributes in the SF

| | |
|---|---|
| X'2C' | Red/Underscore |
| X'2D' | Red/Underscore/Reverse image |
| X'2E' | Red/Underscore/Blink |
| X'2F' | Nondisplay |
| X'30' | Turquoise/Column separators |
| X'31' | Turquoise/Column separators/Reverse image |
| X'32' | Yellow/Column separators |
| X'33' | Yellow/Column separators/Reverse image |
| X'34' | Turquoise/Underscore |
| X'35' | Turquoise/Underscore/Reverse image |
| X'36' | Yellow/Underscore |
| X'37' | Nondisplay |
| X'38' | Pink |
| X'39' | Pink/Reverse image |
| X'3A' | Blue |
| X'3B' | Blue/Reverse image |
| X'3C' | Pink/Underscore |
| X'3D' | Pink/Underscore/Reverse image |
| X'3E' | Blue/Underscore |
| X'3F' | Nondisplay |

### Field Length

The length of each field is controlled by a 2-byte field immediately following the attribute character. The field length specifies the number of keying positions for the input field, not including the starting and ending attribute. Limitations on this field are:

- Alphabetic fields must be at least 1 character long.
- Signed numeric fields can be at least 2 characters long.

## Write to Display Structured Field Order

The Write to Display Structured Field (WDSF) order enables structured fields to be used in a WRITE-TO-DISPLAY command. The maximum length of a structured field which follows a WDSF is 8191 bytes. The order code is X'15'. A single structured field must come after the WDSF order, which is shown as follows:

| | | | | | |
|---|---|---|---|---|---|
| ESC X'04' | WTD COMMAND X'11' | ORDERS AND DATA | WDSF X'15' | STRUCTURED FIELD | ORDERS AND DATA |

Because there is a significant amount of information describing the WDSF order, Table 12-11 on page 12-34 is provided to help you understand some of the major functions and commands that are included in the WDSF order, and where you can locate them in this chapter. The WDSF order functions and commands are not listed in the order that they appear in this chapter, they are listed by byte type. The far right column of the table directs you to the location where the information about the function or command can be found.

*Table 12-11. Write to Display Structured Field Order Structured Fields*

| Structured Field | Type | Location |
|---|---|---|
| DEFINE SELECTION FIELD | X'50' | Page 12-45 |
| CREATE WINDOW | X'51' | Page 12-34 |
| UNRESTRICTED WINDOW CURSOR MOVEMENT | X'52' | Page 12-41 |
| DEFINE SCROLL BAR FIELD | X'53' | Page 12-87 |
| WRITE DATA | X'54' | Page 12-92 |
| PROGRAMMABLE MOUSE BUTTONS | X'55' | Page 12-94 |
| REMOVE GUI SELECTION FIELD | X'58' | Page 12-86 |
| REMOVE GUI WINDOW | X'59' | Page 12-41 |
| REMOVE GUI SCROLL BAR FIELD | X'5B' | Page 12-91 |
| REMOVE ALL GUI CONSTRUCTS | X'5F' | Page 12-42 |

## CREATE WINDOW Structured Field

Use the CREATE WINDOW structured field to create a window on the display screen. With this command, the 5494 can draw a window border and clear a window area.

On a PWS, a window can be a GUI construct, and the CREATE WINDOW structured field has the following effect:

- The window GUI construct covers screen data. You may not simply write data over a window border, for example, with an SBA order followed by data to remove a GUI construct.

  Use one of the following commands to remove a GUI window created by the CREATE WINDOW structured field:

  - RESTORE command
  - RESTORE PARTIAL SCREEN command
  - CLEAR UNIT command
  - CLEAR UNIT ALTERNATE command
  - REMOVE GUI WINDOW structured field
  - REMOVE ALL GUI CONSTRUCTS structured field.

- The PWS determines whether to write data to the base display screen or into a GUI window (there can be multiple GUI windows on the display screen). The PWS does not support an SBA order that writes data characters to both the base display screen and the window. You can write to one or the other, but not both.

- If you want to create another window that partially overlaps a window that you just created, use the CREATE WINDOW structured field again rather than specifying an SBA order followed by data characters.

Your window position is relative to the top row, left corner attribute. See Figure 12-4 and Figure 12-5 on page 12-39. The window position is also determined by the current display address (typically set with an SBA order).

A pull-down window is positioned as if the top row, left corner attribute was actually written.

Writes to the window are still addressed according to actual location on the display screen. The current display address is not modified as a result of a CREATE WINDOW structured field.

If you want to print a screen image on hardcopy, the AS/400 application user may choose to use the READ SCREEN TO PRINT command. See "READ SCREEN TO PRINT Command" on page 12-103.

The CREATE WINDOW structured field must follow the WRITE TO DISPLAY structured field order.

*Table 12-12. Format for Create Window Structured Field Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | > 8 | Length of structured field in bytes (including length bytes) |
| 3 | Class | X'D9' | 5250 class of structured field |
| 4 | Type | X'51' | Create window structured field type |
| 5 | Flag Byte 1 | Bit 0 | Cursor restricted to window if set to on |
| | | Bit 1 | Window is a pull-down menu bar if set to on |
| | | Bits 2–7 | Reserved (must be set to off) |
| 6 | Flag Byte 2 | Bits 0–7 | Reserved (must be set to off) |
| 7 | Reserved | X'00' | Reserved |
| 8 | Window Depth | 1–25 | Number of screen rows inside the window |
| 9 | Window Width | 1–126 | Number of screen columns inside the window |
| 10–n | Minor Structures | | Optional minor structures |

### *CREATE WINDOW Major Structure Parameters*

**Restrict Cursor:** If this parameter is set, cursor movement is restricted to within the window. Cursor movement processing within the window is similar to cursor movement processing on a display screen. Unpredictable cursor movement occurs if fields that accept the cursor or the cursor home address are defined outside of the window and restricted cursor movement is set to on.

Cursor movement is not restricted if any of the following commands are sent:

- RESTORE command
- RESTORE PARTIAL SCREEN command
- CLEAR UNIT command
- CLEAR UNIT ALTERNATE command
- REMOVE GUI WINDOW structured field (removing last window that was written)
- REMOVE ALL GUI CONSTRUCTS structured field

- UNRESTRICTED WINDOW CURSOR MOVEMENT structured field
- CREATE WINDOW structured field (another one).

**Pull-Down Window:** If this parameter is set, this window is a pull-down menu. Pull-down menus have the following qualities to consider:

- Some PWSs will not create a normal window border when other highlighting values are used, for example, background color.
- Only the corner characters on the top row are written. The remaining window border is not affected by this parameter. See Figure 12-5 on page 12-39.
- When this parameter is specified, the selection field that defines the pull-down menu should indicate that the selection field is a pull-down menu.

**Window Depth:** If this parameter is used, it indicates the number of rows within the window. The minimum window depth value is 1. The maximum window depth value is the number of rows remaining on the window minus 1 (for the bottom border row).

**Window Width:** If this parameter is used, it indicates the number of columns within the window. The minimum window width value is 1. The maximum window width value is the number of columns remaining on the window on the right minus 3 (for the right border).

***Border Presentation Minor Structure:*** This minor structure is optional. If this minor structure is not specified, the default border presentation is used, based on the capabilities for a given display. See "Default Border Attribute and Characters" on page 12-39 for a description of default characters and attributes.

If the border presentation minor structure is used, it must be the first minor structure following the CREATE WINDOW structured field major structure.

Table 12-13 describes the format for the border presentation minor structure.

*Table 12-13 (Page 1 of 2). Format for Border Presentation Minor Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Minor Length | 4–13 | Minor structure length (including length byte) |
| 2 | Type | X'01' | Border presentation minor structure type |
| 3 | Flags | Bit 0 | Use Border presentation characters on a GUI-like NWS if set to on |
| | | Bits 1–7 | Reserved (must be set to off) |
| 4 | Monochrome Border Attribute | X'00' or X'20'–X'3F' | Display attribute to be used for window border presentation on a monochrome display. |
| 5 | Color Border Attribute | X'00' or X'20'–X'3F' | Display attribute to be used for window border presentation on a color display. |
| 6 | Upper Left Border Character | X'00' or X'01'–X'FF' | Character to be used for upper left corner. |
| 7 | Top Border Character | X'00' or X'01'–X'FF' | Character to be used for top border. |

Table 12-13 (Page 2 of 2). Format for Border Presentation Minor Structure

| Byte | Name | Value | Description |
|---|---|---|---|
| 8 | Upper Right Border Character | X'00' or X'01'-X'FF' | Character to be used for upper right corner. |
| 9 | Left Border Character | X'00' or X'01'-X'FF' | Character to be used for left border. |
| 10 | Right Border Character | X'00' or X'01'-X'FF' | Character to be used for right border. |
| 11 | Lower Left Border Character | X'00' or X'01'-X'FF' | Character to be used for lower left corner. |
| 12 | Bottom Border Character | X'00' or X'01'-X'FF' | Character to be used for bottom border. |
| 13 | Lower Right Border Character | X'00' or X'01'-X'FF' | Character to be used for lower right corner. |

If a PWS has GUI capabilities, the PWS can ignore the border presentation characters that were specified and use GUI borders and attributes instead.

A value of X'00' in any of bytes 4–13 indicates that the default attribute or border character is used.

A display attribute that is not valid is ignored by the 5494, and the default display attribute is used.

***Window Title Minor Structure:*** This minor structure is optional, but it should be used if you want a title in the top window border. On a PWS, this minor structure must be used to integrate the text title into the window border. This minor structure is ignored for pull-down windows.

Table 12-14 describes the format for the window title minor structure.

Table 12-14 (Page 1 of 2). Format for Window Title Minor Structure

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Minor Length | >6 | Minor structure length (including length byte) |
| 2 | Type | X'10' | Window title minor structure type |
| 3 | Flags | Bits 0–7 | Reserved (must be set to off) |
| 4 | Monochrome Title Attribute | X'00' or X'20'-X'3F' | Display attribute to precede the title on a monochrome display. |
| 5 | Color Title Attribute | X'00' or X'20'-X'3F' | Display attribute to precede the title on a color display. |
| 6 | Reserved | X'00' | Reserved |

Table 12-14 (Page 2 of 2). *Format for Window Title Minor Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 7–n | Title Text | | The window title text is written in the top border of the window (for more information see page 12-38). If the title text is too long to fit in the window border, the title text is truncated. The title text is centered in the window border and the 5494 does not format the title text in any way. You can add padding (extra blanks beside the title text) to specify left or right justification for the title. Title text for a pull-down window is ignored. |

If the specified title attribute parameter (for a color or monochrome display) corresponds to a valid display attribute, the 5494 places the specified attribute immediately in front of the title text and places the window border attribute immediately after the title text. If the display attribute is X'00' or not valid, no attribute is written and the title text will have the same attribute affect as the window border.

***How the 5494 Processes the CREATE WINDOW Structured Field:*** When the CREATE WINDOW structured field is received by the 5494, the 5494 performs the following tasks:

- Creates the window borders
- Clears the window area (including the display screen and active extended attribute planes).

The AS/400 application is responsible for ensuring that all entry fields and data defined in the window do not extend beyond the window borders. However, the exceptions are:

- A leading attribute (input or output data beginning with a display attribute) can overwrite the second left border attribute.
- An ending field attribute can overlap the first right border attribute. The 5494 suppresses an ending field attribute (SF order) if the ending attribute overlaps exactly the first attribute on the right border.
- The 5494 suppresses the trailing attributes of a scroll bar field if the attributes overlap exactly.
- The 5494 suppresses trailing attributes of a selection field if the attributes overlap exactly. The 5494 only keeps track of the right window border for the last CREATE WINDOW structured field that was specified.

Figure 12-4 shows the default format of a 5494 generated window.

```
@..........title..........@
@:@                     @:@
@:@                     @:@
@:@                     @:@
@:@                     @:@
@:@                     @:@
@:@                     @:@
@:......................:@
```

*Figure 12-4. Default Format of a 5494 Generated Window*

**Notes:**

1. @ = Display attribute
2. : and . = Default border characters

Figure 12-5 on page 12-39 shows the default format of a 5494 generated pull-down window.

```
 .                        .
@:@                      @:@
@:@                      @:@
@:@                      @:@
@:@                      @:@
@:@                      @:@
@:@                      @:@
@:........................:@
```

*Figure 12-5. Default Format of a 5494 Generated Pull-Down Window*

**Notes:**

1. @ = Display attribute
2. : and . = Default border characters
3. Only the corner characters are created on the top window row (when a menu bar is created, a separator line is drawn below the menu bar. This separator line corresponds to the top window row). Positioning of the window is based on the current display address, as if the leftmost attribute was written on the top row.

***Default Border Attribute and Characters*** The following default window border attribute is:

| | |
|---|---|
| Normal display (X'20') | For monochrome displays |
| Blue (X'3A') | For color displays. |

You can use the border presentation minor structure to change border attribute settings.

The default border characters for 5250 displays are as follows:

| | |
|---|---|
| Period (.) | Upper left corner |
| Period (.) | Top border character |
| Period (.) | Upper right corner |
| Colon (:) | Left border character |
| Colon (:) | Right border character |
| Colon (:) | Lower left corner |
| Period (.) | Bottom border character |
| Colon (:) | Bottom right corner |

The NWS 3486 and 3487 can create more advanced border characters, for example, drawing a box around the window. The border is made up of GUI-like characters. The GUI-like characters are the default characters on a 3486 and 3487 NWS.

**Left Border Attributes:** The first display attribute in the left border of the window is the left border attribute, which is used to create the highlighting and border color.

The 5494 sets the second display attribute in the left window border to normal intensity (X'20') to terminate highlighting and the window color. This causes the window contents to be green on color displays. The second display attribute can be changed after the CREATE WINDOW structured field has been issued, but it should be an attribute to terminate highlighting and the border color.

**Right Border Attributes:** The first display attribute in the right border of the window is the right border attribute, which is used to create highlighting and the border color. The right border attribute is set to the same value as the left border attribute.

The 5494 uses the second display attribute in the right window border to retain color and highlighting effects in the underlying window area. The 5494 scans the underlying window contents for display attributes to determine what the display attribute value should be.

If extended attributes (other than ideographic) are used on the screen, the 5494 clears the extended attribute plane behind the window and creates normal extended attributes on the left side of the plane behind the window. The 5494 does not scan for extended attributes to determine a right border extended attribute. Extended attributes are used behind the display screen and do not take a screen position.

The 5494 assumes that there are no ideographic extended attributes between display screen Shift-out or Shift-in pairs. Similarly, the 5494 assumes that there are no display screen Shift-out or Shift-in characters between ideographic extended Shift-out or Shift-in attribute pairs. If there are any ideographic extended attributes on the display screen, the 5494 generates ideographic extended Shift-in attributes as required in the left border and ideographic extended Shift-out attributes as required in the right border.

If there are ideographic characters in the underlying window area, the 5494 generates Shift-in control characters as required for the left border and Shift-out control characters as required for the right border. The 5494 will add blanks (as needed) to maintain proper byte alignment.

You can create multiple levels of windows. The AS/400 application restores the display screen as windows are removed.

The format of inbound window field data is the same as inbound data from the base window.

## UNRESTRICTED WINDOW CURSOR MOVEMENT Structured Field

You can use this structured field to obtain unrestricted cursor movement. The cursor movement may be restricted in the CREATE WINDOW structured field. The structured field of the UNRESTRICTED WINDOW CURSOR MOVEMENT structured field must follow a WDSF order.

Table 12-15 describes the format for the unrestricted window cursor movement major structure.

*Table 12-15. Format for Unrestricted Window Cursor Movement Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | 6 | Length of structured field in bytes (including length bytes) |
| 3 | Class | X'D9' | 5250 class structured field |
| 4 | Type | X'52' | Unrestricted window cursor movement structured field type |
| 5 | Flag byte 1 | Bits 0–7 | Reserved (must be set to off) |
| 6 | Reserved | X'00' | Reserved |

## REMOVE GUI WINDOW Structured Field

It is recommended that you use this structured field with caution. The REMOVE GUI WINDOW structured field can be used to terminate a GUI window construct.

For a PWS, a window created by the CREATE WINDOW structured field can be a GUI construct. The 5494 performs limited processing for this structured field.

When using the REMOVE GUI WINDOW structured field, the current display address must be the same as the address used when the window was created by a CREATE WINDOW structured field. The 5494 attempts to find a match (current display address and a GUI window). When a match is found, the GUI construct is removed, but the display screen is not cleared.

If the current display address matches the address of the top window (the most recent window created on the display), the 5494 performs the following screen actions:

- Cursor movement is unrestricted (if cursor movement was restricted when the window was created).
- The 5494 no longer keeps track of the right window border, and no longer suppresses trailing field attributes, selection field ending choice text attributes, or ending scroll bar attributes.

It is recommended that a PWS send data to both the GUI window construct and to the display screen. When this is done and the REMOVE GUI WINDOW command is issued, the NWS display screen and the PWS display screen will be similar (screen data can then be overwritten).

If a GUI window construct has a GUI selection field or GUI scroll bar field in the window, GUI constructs are also deleted when a GUI window is removed. Therefore, it is important to issue a CLEAR FORMAT command or SOH order after the REMOVE GUI WINDOW structured field in the same display data stream.

The structured field of the REMOVE GUI WINDOW structured field must follow a WDSF order.

Table 12-16 describes the format for the remove GUI window major structure.

*Table 12-16. Format for Remove GUI Window Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | 7 | Length of structured field in bytes (including length bytes) |
| 3 | Class | X'D9' | 5250 class structured field |
| 4 | Type | X'59' | Remove GUI Window structured field type |
| 5 | Flag Byte 1 | Bit 0 | Reserved (must be set to off) |
| | | Bit 1 | Window was a menu bar pull down if set to on |
| | | Bits 2–7 | Reserved (must be set to off) |
| 6 | Flag Byte 2 | Bits 0–7 | Reserved (must be set to off) |
| 7 | Reserved | X'00' | Reserved |

The pull-down window parameter must be specified in the same manner that it was when the window was created by the CREATE WINDOW structured field; otherwise, the REMOVE GUI WINDOW structured field is ignored.

## REMOVE ALL GUI CONSTRUCTS Structured Field

It is recommended that you use this structured field with caution. The REMOVE GUI CONSTRUCTS structured field can be used to terminate all GUI constructs on the display screen.

For a PWS, GUI constructs can be windows, selection fields, and scroll bars. The 5494 performs limited processing for this command.

When this structured field is issued, the 5494 and PWS:

- Process all of the functions of a REMOVE GUI WINDOW structured field against all of the GUI windows on the display screen (see page 12-41).
- Process all of the functions of a REMOVE GUI SELECTION FIELD structured field against all of the GUI selection fields on the display screen (see page 12-86).
- Process all of the functions of a REMOVE GUI SCROLL BAR FIELD structured field against all of the GUI selection fields on the display screen (see page 12-91).

If there is a GUI selection field or a GUI scroll bar field on the display screen, these GUI constructs are deleted by this command. Therefore, it is important to issue a CLEAR FORMAT command or SOH order after the REMOVE ALL GUI CONSTRUCTS structured field in the same display data stream.

The structured field of the REMOVE ALL GUI CONSTRUCTS structured field must follow the WDSF order.

Table 12-17 on page 12-43 describes the format for the remove all GUI constructs major structure.

*Table 12-17. Format for Remove All GUI Constructs Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | 7 | Length of structured field in bytes (including length bytes) |
| 3 | Class | X'D9' | 5250 class structured field |
| 4 | Type | X'5F' | Remove all GUI constructs structured field type |
| 5 | Flag Byte 1 | Bit 0 | A 5494 maps GUI-like characters if set to on |
| | | Bits 1–7 | Reserved (must be set to off) |
| 6 | Flag Byte 2 | Bits 0–7 | Reserved (must be set to off) |
| 7 | Reserved | X'00' | Reserved |

The 3486, 3487, and 3488 NWSs support GUI-like characters that can be created using the WDSF order or the RESTORE command. If you are creating GUI-like characters for a new NWS and the map GUI-like characters parameter is set to on, the 5494 maps the GUI-like characters to their character equivalents. This process is similar to the READ SCREEN TO PRINT command. See "READ SCREEN TO PRINT Command" on page 12-103.

## DEFINE SELECTION FIELD Structured Field

A selection field is a list from which users select one or more choices. Figure 12-6 on page 12-68 shows a display panel with several enhanced selection fields, such as:

- Menu bar
- Push buttons
- Single choice selection field
- Multiple choice selection list that can be scrolled.

Figure 12-6 on page 12-68 also describes the 5250 display data stream required to build the example screen.

For a PWS, a selection field can be a GUI construct. Consider the following guidelines when working with GUI constructs and selection fields:

- A GUI construct overlays screen data. Simply creating a selection field does not remove a GUI construct, for example, if you issued an SBA order followed by data characters. The CREATE WINDOW structured field creates a GUI window which can overlay part or all of the GUI selection field. The following commands remove a GUI selection field:
  - CLEAR UNIT command
  - CLEAR UNIT ALTERNATE command
  - RESTORE command
  - RESTORE PARTIAL SCREEN command
  - REMOVE GUI SELECTION FIELD structured field
  - REMOVE ALL GUI CONSTRUCTS structured field.
- A GUI construct requires equal or less space on the display screen than the character equivalent of the selection field.
- When the selection cursor is on a selection field choice, the cursor row and column values in an inbound data stream must be exactly the same as an NWS.

The selection field address is the current display address (set with the SBA order) when the 5494 receives the DEFINE SELECTION FIELD (DSF) structured field. This address defines the position of the leading attribute for the upper left choice. If indicators such as check boxes or push buttons are used, the 5494 creates two or three columns of data to the left of the current display address. The current display address is not modified as a result of the DEFINE SELECTION FIELD structured field.

The following rules must be followed when defining a selection field, or a negative response is returned:

- All fields including selection fields must be defined in descending left-to-right order on the screen. Subsequent entry or selection fields can be defined after the DSF structured field is issued.
- The selection field presentation area must not overlap the presentation area of any other selection field or entry field. When placing selection fields or entry fields next to another selection field, consider the following:
  - When placing a selection field to the left, the ending attribute of the left field must not overlap the first selection field attribute of the selection field to the right.
  - When placing a selection field to the right, the leading attribute of the right field can be next to either the ending choice text attribute or the ending scroll bar attribute but must not overlap either of them.
- You cannot have a selection field and field resequencing on the same display screen. See “Resequencing” on page 12-22.

Major structure byte 8 governs the type of selection fields that are used for presentation on a display. Major structure bytes 9 through 11 govern the type of workstation for which the selection fields are created and many of the selection field characteristics. For the DEFINE SELECTION FIELD structured field, you can use the following techniques for defining and presenting selection fields:

- For a PWS, the type of selection field (byte 8) and the GUI device characteristics (byte 9) determine how the selection field is presented on the display.
- For 3486, 3487, and 3488 NWSs, the type of selection field and the GUI device characteristics (byte 9) determine how the selection field is presented on the display.
- For 3477 NWSs that have the capability to create mnemonic underscoring, the type of selection field and mnemonic underscore characteristics (byte 10) determine how the selection field is presented on the display.
- For all models prior to the 3477 NWSs that do not have the capability to create mnemonic underscoring, the type of selection field byte 11 determines how the selection field is presented on the display.

**Note:** If you want a consistent cursor position in the inbound data, there is an advantage to keeping the screen layout the same for the different types of workstations, for example, by the consistent use of selection indicators.

***DEFINE SELECTION FIELD Major Structure:*** This major structure is used to define the entire selection field. A set of minor structures define individual choices and other information. At least one Choice Text minor structure must be included. The DSF structured field must follow a WDSF order.

Table 12-18 describes the format for the define selection field major structure.

*Table 12-18 (Page 1 of 5). Format for Define Selection Field Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | | Length of structured field in bytes (including length bytes). It must include a major structure and at least one choice text minor structure. |
| 3 | Class | X'D9' | Class of structured field |
| 4 | Type | X'50' | Type of structured field |
| 5 | Flag Byte 1 | Bits 0–1 | Mouse characteristics:<br>B'00' Use this selection field in all cases.<br>B'01' Use this selection field only if the display does not have a mouse.<br>B'10' Use this selection field only if the display has a mouse.<br>B'11' Reserved. |
| | | Bits 2–3 | Reserved (must be set off) |
| | | Bits 4–5 | Auto-enter:<br>B'00' Selection field is not auto-enter<br>B'01' Selection field is auto-enter on all display types<br>B'10' Reserved<br>B'11' Selection field is auto-enter on a GUI display, but not auto-enter on other displays. |
| | | Bit 6 | Auto-select if set to on |
| | | Bit 7 | Field MDT |
| 6 | Flag Byte 2 | Bit 0 | If set to on, a scroll bar should is created beside the selection field choices, and TotalRows and SliderPos that can be scrolled are included in the major structure. |
| | | Bit 1 | If set to on, one blank is added after the numeric separator character. |
| | | Bit 2 | If set to on, an asterisk (*) replaces the first character of an unavailable choice on a monochrome display. |
| | | Bit 3 | If set to on, cursor is limited to input-capable positions only. |
| | | Bit 4 | If set to on, the Field Advance/Field Backspace function is like the Character Advance/Character Backspace keys within this selection field. |
| | | Bit 5 | If set to on, the cursor movement keys are not allowed to exit this selection field. |
| | | Bits 6–7 | Reserved (must be set to off) |

Table 12-18 (Page 2 of 5). Format for Define Selection Field Major Structure

| Byte | Name | Value | Description |
|---|---|---|---|
| 7 | Flag Byte 3 | Bit 0 | If set to on, any selected choices are changed to available whenever the keyboard is unlocked. |
| | | Bits 1–7 | Reserved (must be set to off) |
| 8 | Type of Selection Field | | Defines the type of selection field:<br>X'01' Menu bar<br>X'11' Single choice selection field<br>X'12' Multiple choice selection field<br>X'21' Single choice selection list<br>X'22' Multiple choice selection list<br>X'31' Single choice selection field and a pull-down list<br>X'32' Multiple choice selection field and a pull-down list<br>X'41' Push buttons<br>X'51' Push buttons in a pull-down menu<br>Other Values Reserved. |
| 9 | GUI Device Characteristics: This byte is used if the target device is a GUI PWS or a GUI-like NWS. If neither of these workstations are the targets, this byte is ignored. | Bits 0–3 | Indicators:<br>B'0000' An indicator to the left of each choice (check box or radio button) is created. [1]<br>B'0010' A push button box is created around choice text and the choice text is padded with a blank on both sides. [2]<br>B'0011' A push button indicator specifies each choice instead of a push button box on a GUI-like NWS. (A GUI PWS treats this setting like B'0010'.) [2]<br>B'0100' A push button box is created around choice text and choice text is padded with a blank on both sides, and a leading choice text attribute is written on top of the previous choice text ending attribute. [2]<br>B'0101' A push button indicator specifies each choice instead of a push button box on a GUI-like NWS, and a leading choice text attribute is specified on top of the previous ending choice text attribute. (A GUI PWS treats this setting like B'0100'.) [2]<br>B'0110' A push button box is created around choice text (with no padding). [2]<br>B'1111' There are no indicators for this value. It is valid for all types of selection fields.<br>Other Values Reserved. |
| | | Bit 4 | Reserved |
| | | Bits 5–7 | Selection techniques:<br>B'001' Defines a mnemonic (or numeric) selection for some or all of the choices. The mnemonic is underscored.<br>B'010' Defines a mnemonic (or numeric) selection for some or all of the choices. The mnemonic is not underscored.<br>B'111' No mnemonic (or numeric) selection is specified.<br>Other Values Reserved. |

*Table 12-18 (Page 3 of 5). Format for Define Selection Field Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 10 | NWS with Mnemonic Underscore Characteristics: This byte is used if the target device is a non-GUI NWS or a non-GUI PWS, both of which are capable of underscoring mnemonics. This byte is ignored if these are not the target devices. | Bits 0–3 | Indicators:<br>B'0000' An indicator to the left of each choice (for example, a slash (/)) is created. [1]<br>B'0011' A push button indicator specifies each choice. [2]<br>B'0101' A push button indicator specifies each choice, and a leading choice text attribute is specified on top of a previous ending choice text attribute. [2]<br>B'1000' A numeric field to the left of the first choice is created. (Single- or double-digit numeric fields are determined by bits 5–7.) [3]<br>B'1111' No indicators are specified for this value. This is valid for all types of selection fields.<br>Other Values Reserved. |
| | | Bit 4 | Reserved |
| | | Bits 5–7 | Selection techniques:<br>B'001' Defines a mnemonic (or numeric) selection for some or all of the choices. The mnemonic is underscored. A negative response is sent if bits 0 through 3 specifies a numeric field to the left of a choice.<br>B'010' Defines a mnemonic (or numeric) selection for some or all of the choices. The mnemonic is not underscored. A negative response is sent if bits 0 through 3 specifies a numeric field to the left of a choice.<br>B'100' Defines a single-digit numeric selection. A negative response is sent if bits 0 through 3 did not specify a numeric field to the left of a choice.<br>B'101' Defines a double-digit numeric selection. A negative response is sent if bits 0 through 3 did not specify a numeric field to the left of a choice.<br>B'111' No mnemonic or numeric selection is defined.<br>Other Values Reserved. |

*Table 12-18 (Page 4 of 5). Format for Define Selection Field Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 11 | NWS without Mnemonic Underscore Characteristics: This byte is used if the target device is a non-GUI NWS, which is not capable of underscoring mnemonics. This byte is ignored if this is not the target device. | Bits 0–3 | Indicators:<br>B'0000' An indicator to the left of each choice (for example, a slash (/)) is created. [1]<br>B'0011' A push button indicator specifies each choice. [2]<br>B'0101' A push button indicator specifies each choice, and a leading choice text attribute is specified on top of a previous ending choice text attribute. [2]<br>B'1000' A numeric field to the left of the first choice is created. (Single- or double-digit numeric fields are determined by bits 5–7.) [3]<br>B'1111' No indicators are specified for this value. This is valid for all types of selection fields.<br>Other Values Reserved. |
| | | Bit 4 | Reserved |
| | | Bits 5–7 | Selection techniques:<br>B'010' Defines a mnemonic (or numeric) selection for some or all of the choices. The mnemonic is not underscored. A negative response is sent if bits 0 through 3 specifies a numeric field to the left of a choice.<br>B'100' Defines a single-digit numeric selection. A negative response is sent if bits 0 through 3 did not specify a numeric field to the left of a choice.<br>B'101' Defines a double-digit numeric selection. A negative response is sent if bits 0 through 3 did not specify a numeric field to the left of a choice.<br>B'111' No mnemonic or numeric selection is defined.<br>Other Values Reserved. |
| 12 | Reserved | X'00' | Reserved (must be zero) |
| 13 | Reserved | X'00' | Reserved (must be zero) |
| 14 | TextSize | 1–*nn* | Size of selection field choice text. |
| 15 | Rows | 1–*nn* | Number of rows of choices to be displayed. |
| 16 | Columns or Menu Bar Choices | 1–*nn* | Number of columns of choices to be displayed or the maximum number of menu bar choices. |
| 17 | Padding Between Choices | 0–*nn* | Number of columns of nulls to place between choices. |
| 18 | Numeric Separator Character | | If a NWS uses numeric selection, the numeric separator character is defined here. If zero is specified, the default numeric separator character, period (.), is used. |
| 19 | Country Specific Selection Character | | Country specific selection character to be used along with the character slash (/). |
| 20 | Mouse Pull-Down Cancel AID | | If you are using a pull-down selection field, you can specify an AID to be sent to the user if a selection is made outside of the pull-down selection field. |

*Table 12-18 (Page 5 of 5). Format for Define Selection Field Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 21–24 or 21–n | TotalRows or Minor Structures that can be Scrolled | > 2 | Only include this parameter if you want to create a scroll bar beside a selection field. The value specified here is the total number of rows in a selection field available to an AS/400 user. |
| 25–28 | SliderPos that can be Scrolled | | Only include this parameter if you want to create a scroll bar beside a selection field. The value specified here is the total number of rows that can be scrolled in a selection field above the first row defined to the 5494. |
| 20–n or 28–n | Minor Structures | | Selection field minor structures. See "Define Selection Field Minor Structure" on page 12-55. |

**Notes:**

1 A negative response is sent if one of the following types of selection fields are specified: Menu bar, push buttons, or push buttons in a pull-down menu.

2 A negative response is sent if the selection field type is not a push button or push button in a pull-down menu.

3 A negative response is sent if one of the following types of selection fields are specified: Menu bar, push buttons, push buttons in a pull-down menu, multiple choice field, or multiple choice list.

*DEFINE SELECTION FIELD Major Structure Flags:* The DSF major structure flags are defined as follows:

*Mouse:* This parameter enables you to send two DEFINE SELECTION FIELD commands in a single display data stream. One of the commands is processed (based on the existence of a mouse), and the other command is ignored.

*Auto-Enter:* It is recommended that you define menu bars and pushbuttons as auto-enter. In an auto-enter selection field, the user can return field data to the AS/400 application when a selection is made in the field. If auto-enter is not defined, the user must press a key that creates an AID. If a double-digit numeric selection field is being used, auto-enter is not allowed (auto-enter is ignored). If this parameter is B'00', auto-enter is not defined for the field. If the parameter is B'01', auto-enter is defined for the field. If the parameter is B'11', auto-enter is defined only for a GUI display (This could be useful for a single choice selection field in a pull down).

*Auto-Select:* When you use this parameter for a selection field (and the cursor is in the selection field), pressing the Enter key causes the choice to be selected before the inbound data is sent as a result of pressing the Enter key.

**Note:** This parameter is considered set to on for a single- or double-digit numeric selection field.

*Field MDT:* The modified data tag (MDT) is similar to entry fields in that it can be activated by an AS/400 application. The 5494 activates this parameter whenever a user selects a field choice. This parameter can be reset by any one of the following commands or functions:

- CLEAR UNIT command
- CLEAR UNIT ALTERNATE command
- CLEAR FORMAT TABLE command
- Start of header order
- Write to display control characters.

*Write Scroll Bar:* When this parameter is used, a scroll bar is created to the right of a specified selection field. Also, the TotalRows and SliderPos parameters are included in the major structure.

**Note:** Do not use this parameter if you want the user to scroll a selection field without a scroll bar.

*Pad After Numeric Separator:* This parameter can be set to on if a single- or double-digit numeric selection is used for a non-GUI NWS.

When this parameter is set to on, the 5494 will add one blank between the numeric separator character and the first choice text character.

*Replace Character on Unavailable Choice:* This parameter is used when you are working with a device that is not capable of indicating to the user that a choice is unavailable. A monochrome NWS is an example of such a device. This parameter causes the first choice text character to be replaced with an asterisk (*) for any unavailable choices. You can customize the asterisk (*) character by using the choice indicator minor structure.

**Note:** For color displays, there are three color attribute values for the three different choice states on a selection field:

- A color indicating that the choice is available
- A color indicating that the choice has been selected
- A color indicating that the choice is unavailable.

For monochrome displays, there are two attribute values:

- Normal color indicating that the choice is available or unavailable
- The intensity attribute indicates that the choice is selected.

*Cursor Movement to Input-Capable Positions Only:* If this flag is set to on, the four cursor movement keys are allowed to move only to input-capable positions on the display screen. This cursor movement mode applies to the entire display screen.

*Field Advance and Field Backspace Keys Function Like Character Advance and Character Backspace Keys:* If set to on, the Field Advance key functions like the Character Advance key within this selection field, and the Field Backspace key functions like the Character Backspace key within this selection field. If the cursor enters a selection field with this parameter set on using the Field Backspace key, the selection cursor is positioned on the last choice that can accept the cursor within the selection field.

*Cursor Movement Keys are not Allowed to Exit this Selection Field:* If set to on, the four cursor movement keys are not allowed to exit this selection field.

*Change Selected Choices to Available Choices on Unlock:* If set to on, any selected (default) choices are changed to available (not a default choice) whenever the keyboard is unlocked as a result of a Write-to-Display command. This function may be useful for pushbutton selection fields.

*Types of Selection Fields:* Selection fields that are single choice allow the user to select one choice. Selection fields that are multiple choice allow the user to select any number of choices. The following types of selection fields are defined:

*Menu Bar:* This single-choice selection field creates either a single row choice or multiple rows of choices that do not have selection indicators. Mnemonic selection is allowed. Menu bars are normally specified with the auto-enter and auto-select parameters. A menu bar typically extends across the entire row of the display screen or the window; no data should be written beside a menu bar (on the same row). A menu bar will typically have a separator line below the menu bar. However, if no separator line is desired (to save one row on the display screen), see the Draw Menu Minor structure. For more information on NWS Menu Bar Presentation see page 12-70.

*Single Choice Selection Field:* The AS/400 application user determines whether or not to create indicators. The indicators are radio buttons to the left of each choice on a GUI PWS and GUI-like NWS. For a non GUI-like NWS, there are two types of indicators. The indicators are either character indicators to the left of each choice or a single- or double-digit numeric selection indicator to the left of the first choice. Mnemonic selection is allowed. For more information, see "NWS Single Choice Selection Field Presentation" on page 12-71.

*Multiple Choice Selection Field:* The AS/400 application user determines whether or not to create indicators. The indicators are check boxes to the left of each choice on a GUI PWS and GUI-like NWS. Mnemonic selection is allowed. For a non GUI-like NWS, the indicators are character indicators to the left of each choice. For more information, see "NWS Multiple Choice Selection Field Presentation" on page 12-74.

*Single Choice Selection List:* The AS/400 application user determines whether or not to create indicators. Unlike the Single Choice Selection Field, you can define a vertical scroll bar in the selection list. The indicators are radio buttons to the left of each choice on a GUI PWS and GUI-like NWS. Mnemonic selection is allowed. For a non GUI-like NWS, there are two types of indicators. The indicators are either character indicators to the left of each choice or a single- or double-digit numeric selection indicator to the left of the first choice. For more information, see "NWS Single Choice Selection List Presentation" on page 12-75.

*Multiple Choice Selection List:* The AS/400 application user determines whether or not to create indicators. Unlike the Multiple Choice Selection Field, you can define a vertical scroll bar in a selection list. The indicators are check boxes to the left of each choice on a GUI PWS and GUI-like NWS. For a non GUI-like NWS, the indicators are character indicators to the left of each choice. Mnemonic selection is allowed. For more information, see "NWS Multiple Choice Selection List Presentation" on page 12-76.

*Single Choice Selection Field (List) in a Pull-Down Menu:* The AS/400 application user determines whether or not to create a single choice pull-down menu using a selection field or selection list. A GUI PWS uses a different highlighting style for specifying a menu bar or a pull-down menu. Mnemonic selection and single- and double-digit numeric selection are allowed. For more information, see "NWS Selection Field (List) in a Pull-Down Menu Presentation" on page 12-76.

*Multiple Choice Selection Field (List) in a Pull-Down Menu:* The AS/400 application user determines whether or not to create a multiple choice pull-down menu in a selection field or selection list. A GUI PWS uses a different highlighting style for specifying a menu bar or a pull-down menu. Mnemonic selection is allowed. For more information, see "NWS Selection Field (List) in a Pull-Down Menu Presentation" on page 12-76.

*Push Buttons:* This field is a single choice selection field. A GUI PWS and NWSs 3486 and 3487 can create push buttons. NWSs 3486 and 3487 create a box around each choice. All other NWSs create push button-like characters around each choice. When using the push button field, the auto-enter and auto-select parameters are normally specified. Different choices can be presented depending on the existence of a pointing device. Mnemonic selection is allowed. For more information, see "NWS Push Button Presentation" on page 12-77.

*Push Buttons in a Pull-Down Menu:* You can use this field just like the push button field. A GUI PWS uses a different highlighting style from an NWS display for specifying a menu bar or a pull-down menu.

*GUI Device Characteristics:* If you are using a GUI PWS or a GUI-like NWS, the GUI device characteristics define the indicators and selection techniques used for creating windows.

*Indicators:* Use this selection to specify the type of indicators that you want to use.

NWSs 3486 and 3487 create a box around push button text.

**Note:** You can cause some performance degradation by creating push button boxes around push button text when the WRITE TO DISPLAY command is processing. This is also true if you issue either the SAVE or RESTORE command.

*Selection Techniques:* Use this selection to specify the type of selection field that you want to use. Mnemonic selection is allowed. Numeric characters are valid mnemonics. (The AS/400 application places numeric characters in the choice text.)

NWSs 3486 and 3487 can underscore mnemonic characters.

**Note:** You can cause some performance degradation by creating underscores for mnemonic characters when the WRITE TO DISPLAY command is processing. This is also true if you issue either the SAVE or RESTORE command.

*Underscoring Mnemonics with a NWS:* If you are using an NWS that is not capable of creating GUI characters (but is capable of underscoring mnemonics), this selection enables you to define indicators and selection techniques.

*Indicators:* Use this selection to specify the type of indicator that you want. You can customize indicator characters by using the choice indicator minor structure.

*Selection Techniques:* Use this selection to specify the type of selection field that you want to use. Mnemonic selection is allowed. Numeric characters are valid mnemonics. (The AS/400 application places numeric characters in the choice text.)

NWS 3477 can underscore mnemonic characters.

**Note:** You can cause some performance degradation by creating underscores for mnemonic characters when the WRITE TO DISPLAY command is processing. This is also true if you issue either a SAVE command or a RESTORE command.

*Inability to Underscore Mnemonics with an NWS:* If you are using an NWS that is not capable of creating GUI characters (and is also not capable of underscoring mnemonics), this selection enables you to define indicators and selection techniques.

*Indicators:* Use this selection to specify the type of indicators that you want to use. You can customize indicator characters by using the choice indicator minor structure.

*Selection Techniques:* Use this selection to specify the type of selection field that you want to use. Mnemonic selection is allowed. Numeric characters are valid mnemonics. (The AS/400 application places numeric characters in the choice text.)

*Field Presentation Parameters:* The field presentation parameters are defined as follows:

*TextSize:* The textsize parameter defines the amount of space that you want to use for choice text. The space is specified between the leading choice text attribute and the ending choice text attribute. The textsize must be equal to or greater than the longest choice text phrase in the selection field. If you use single- or double-digit numeric selection, push buttons with indicator characters, or blanks padding each side, each of these characters is counted as part of the text size in the choice text minor structure. The AS/400 application user ensures that the text size is at least two or three characters greater than the longest choice text phrase. If your choice text ends up being longer than the specified textsize value, the choice text is truncated. The 5494 pads the choice text on the right with blanks if the choice text is shorter than the specified textsize value. However, the 5494 does not pad the choice text for a menu bar or any type of selection field that has only a single row of text. If a selection field or an associated scroll bar extends beyond the right edge of the display screen, you will receive a negative response.

*Rows:* The rows parameter defines the number of rows that you want displayed within a field presentation area. If a value of 1 is specified, the 5494 does not pad any choices that are less than the textsize value. (AS/400 application users can pad choices with nulls or blanks). If your selection field has an associated scroll bar, this value must be greater than 2 or a negative response is returned. If your selection field is a menu bar, this parameter is ignored.

*Columns or Menu Bar Choices:* For a non-menu bar selection field, this parameter defines the number of columns of choices to be displayed within the field presentation area. The 5494 specifies the required space in the field format table (FFT). This enables you to go back to the FFT and redefine the values if you want to change them later.

For a menu bar selection field, this parameter defines the maximum number of choices available to the AS/400 application user. The 5494 specifies the required space and the required number of choices in the FFT. When specifying a menu bar, the parameter that specifies when a new row is started must be specified in the choice text minor structure.

*Padding Between Choices:* This parameter specifies whether nulls are to be placed between selection field choices. If 0 is specified, no nulls are added. If the column or menu bar choices parameter value is 1, this parameter is ignored. Also, if push button leading choice text attributes are to overwrite previous ending choice text attributes, this parameter is ignored.

**Note:** When the user moves the cursor to the left or right within a selection field, the cursor skips over padded nulls.

*Numeric Separator:* The numeric separator character is used if single- or double-digit numeric selections are used for an NWS. The separator character is placed to the right of the single- or double-digit numeric character. If 0 is specified, the default numeric separator character, period (.), is used.

*Country Selection:* This parameter defines a selection character that can be used to select choices. A country specific character is used in addition to the slash (/) character. A value of X'00' indicates no country specific selection character. The last specified define selection field major structure determines the country specific selection character.

*Pull-Down Menu Cancel AID:* Specify an AID in this parameter if a selection field is inside of a pull-down menu. This enables the user to cancel the pull-down menu while using a pointer device (instead of the user having to use the keyboard to cancel the pull-down menu). You can use the same AID that is used when a user cancels a pull-down menu from the keyboard. If the user of the display is using a pointer device and an AID is specified, a special mode is set when the user selects something on the screen that has no specific meaning. The text cursor is moved to the location of the pointer device cursor, the keyboard is locked, and the specified AID is returned to the AS/400 system. Depending on the specified AID, inbound data can be included. The special mode is reset when any of the following commands or functions are received by the NWS:

- CLEAR UNIT command
- CLEAR UNIT ALTERNATE command
- CLEAR FORMAT TABLE command
- RESTORE command
- RESTORE PARTIAL SCREEN command
- SOH order.

Specify X'00' for this parameter if you do not want to send a pull-down menu cancel AID to the user. If a selection field is not defined as a selection field in a pull-down menu, this parameter is ignored.

*TotalRows:* Use this parameter if you want to create a scroll bar beside a selection field. This parameter defines the total number of rows in a selection field and is used to determine the slider size of the scroll bar. If you use this parameter, you must specify single choice selection list or multiple choice selection list for the type of selection field, otherwise a negative response is returned.

*SliderPos:* Use this parameter if you want to create a scroll bar beside a selection field. This parameter determines the position of the top of the slider in the scroll bar. This parameter defines the total number of rows in the selection field above what is defined to the 5494. This parameter and the totalrows parameter enables the 5494 to determine:

- The size of the slider
- The size of the space above the slider in the scroll bar
- The size of the space below the slider in the scroll bar.

If the sliderpos parameter value and the rows parameter value is greater than the totalrows parameter value, a negative response is returned.

*Selection Field Presentation Area:* For all selection field types (except a menu bar), the selection field presentation area is a rectangular area on the display screen. The size and layout of the selection field presentation area is determined by the following parameters and characteristics:

- For a menu bar or any single row selection field, choice text is not padded up to the textsize value. Note that each choice text is bound by a leading and ending choice text attribute that uses one column on the display screen.
- The columns parameter is not valid for menu bars.
- The rows parameter is not valid for menu bars.
- If indicators are placed to the left of each choice, this adds two columns to each choice.
- If single-digit numeric selection is used, this adds two columns to each choice.
- If double-digit numeric selection is used, this adds three columns to the first column of choices and two columns for subsequent columns of choices.
- Padding between choices adds columns between each column of choices.
- If a scroll bar is created, add two columns to each row.

The 5494 sends a negative response if:

- The selection field extends beyond the last column of the display screen
- The selection field extends beyond the last row of the display screen
- The selection field indicators are created before the first column.

The 5494 truncates the choice text specified by the AS/400 system if the choice text (between the leading and ending choice text attributes) is greater than the textsize value. The following specified values determine the choice text layout:

- For a single-digit numeric selection, the specified single-digit number, the numeric separator character, and an optional blank are added in front of the choice text specified by the AS/400 application user.
- For a double-digit numeric selection, the specified two-digit number, the numeric separator character, and an optional blank are added in front of the choice text specified by the AS/400 application user.
- For push buttons, an indicator character or optional blank is added in front of and after the choice text specified by the AS/400 application user.

See “Presenting Selection Field Choices” on page 12-67 for some examples of selection field layouts.

***Choice Text Minor Structure:*** When defining a selection field, you must use a choice text minor structure to define each selection field choice.

At least one choice that can be selected with a cursor must be defined. The total number of choices defined must be equal to or less than the product of the total number of the rows and columns parameter values (or menu bar choices for a menu bar).

If the total number of choices is less than the product of the total number of rows and columns (or menu choices), and the selection field is redefined, the 5494 deletes the remaining choices.

*Table 12-19 (Page 1 of 2). Format for Choice Text Minor Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Minor length | >4 | Length of minor structure in bytes (including length byte). |
| 2 | Type | X'10' | Choice text minor structure type. |
| 3 | Flag Byte 1 | Bits 0–1 | Choice state:<br>B'00' Available and not a default selection<br>B'01' Available and is a default selection (selected state)<br>B'10' Not available<br>B'11' Reserved. |
| | | Bit 2 | If set to on, specifies a menu bar choice that starts a new row. |
| | | Bit 3 | Reserved (set to zero). |
| | | Bit 4 | If set to on, specifies that a mnemonic offset is included in the minor structure. |
| | | Bit 5 | If set to on, specifies an AID if *selected* is included in this minor structure. |
| | | Bits 6–7 | Numeric selection characters:<br>B'00' Numeric selection characters are not included in this minor structure.<br>B'01' A single-digit numeric selection character is included in this minor structure.<br>B'10' Double-digit numeric selection characters are included in this minor structure.<br>B'11' Reserved. |
| 4 | Flag Byte 2 | Bit 0 | If set to on, the choice cannot accept a cursor. |
| | | Bit 1 | If set to on, the application user desires a roll-down AID if the Cursor Up key is pressed on this choice. |
| | | Bit 2 | If set to on, the application user desires a roll-up AID if the Cursor Down key is pressed on this choice. |
| | | Bit 3 | If set to on, the application user desires a roll-left AID if the Cursor Left key is pressed on this choice. |
| | | Bit 4 | If set to on, the application user desires a roll-right AID if the Cursor Right key is pressed on this choice. |
| | | Bits 5–7 | Reserved (set to zero). |

Table 12-19 (Page 2 of 2). Format for Choice Text Minor Structure

| Byte | Name | Value | Description |
|---|---|---|---|
| 5 | Flag Byte 3 | | At least one of the following three flags must be set to on, otherwise the choice text minor structure is ignored. |
| | | Bit 0 | If set to on, use this minor structure for GUI devices (including GUI-like NWSs). |
| | | Bit 1 | If set to on, use this minor structure for non-GUI NWSs that are capable of creating mnemonic underscores. |
| | | Bit 2 | If set to on, use this minor structure for NWS display devices that are not capable of creating underscores. |
| | | Bits 3–7 | Reserved (must be set to off). |
| 6 | Mnemonic Offset (if included) | | Offsets mnemonic within choice text. This parameter is included in the choice text minor structure only when the mnemonic offset (flag byte, bit 4) is set to on. |
| 6 or 7 | AID (if included) | | The AID to be used if the choice is selected. This parameter is only included in the choice text minor structure if the AID if selected (flag byte, bit 5) is set to on. |
| 6, 7, 8, 6–7, 7–8, or 8–9 | Numeric Characters (if included) | | If single-digit numeric selection is defined, one numeric character is included. If double-digit numeric selection is defined, two characters are included. This parameter is only included in the choice text minor structure if the numeric selection characters two-bit field (flag byte 1, bit 6–7) is non-zero. |
| 6–n, 7–n, 8–n, 9–n, or 10–n | Choice Text | | Selection field choice text. |

*Choice Text Minor Structure Flags:* The choice text minor structure parameters are described as follows:

*Choice State:* If this parameter is set to B'00', the choice is available and is not a default selection. If this parameter is set to B'01', the choice is available and the choice is selected (default selection). If this parameter is set to B'10', the choice is unavailable.

For the default selection, the 5494 indicates to the user that this choice is selected by providing a specific highlighted feature. The definition of the default selection does not affect the field MDT. See "Presenting Selection Field Choices" on page 12-67 for more information on how choice availability affects selection.

*Menu Bar Starting a New Row:* The menu bar choice that starts a new row flag (when set to on) indicates to the 5494 that the choice should be placed on the next row. The column numbers of the leading choice text attributes of the specified choice and the first choice are equal. If you are specifying a single row choice in a menu bar, do not set this parameter to on.

*Mnemonic Offset:* If set to on, this parameter notifies the 5494 that a mnemonic offset parameter is included in the data stream (in byte 6) for the specified choice.

*AID If Selected:* If set to on, this parameter notifies the 5494 that an AID is included in the data stream (in byte 6 or 7, depending on whether a mnemonic offset is specified) for the specified choice.

*Numeric Selection Characters:* If set to on, this parameter notifies the 5494 that either single- or double-digit selection characters are included in the data stream (in bytes 6, 7, or 8, depending on whether a mnemonic offset and an AID instruction are specified) for the specified choice. If this parameter is set to B'01', a single-digit numeric character is included. If this parameter is set to B'10', two double-digit numeric characters are included. If single- or double-digit selection is used, and the choice accepts a cursor, this parameter must be non-zero.

*Instruction for Cursor to Skip Choice:* If set to on, this parameter prevents the user from selecting the specified choice with the cursor.

*Top Choice:* If set to on, this parameter notifies the 5494 that the AS/400 application user must receive a roll-down AID when the Cursor Up key is pressed on the specified choice. This parameter can be used for any choice. Generally, the specified choice is the first choice available to the 5494 within the selection field, and additional choices are available above this choice. The selection field is not required to have a scroll bar. The 5494 uses this information to support cursor-sensitive scrolling. For more information, see "Scrolling the Choice List" on page 12-85.

**Note:** Numeric and mnemonic selection selects only choices that are currently defined to the 5494. This is also true of the deselect function associated with the display user selecting a choice in a single choice selection list.

*Last Choice:* If set to on, this parameter notifies the 5494 that the AS/400 application user must receive a roll-up AID when the Cursor Down key is pressed on the specified choice. You can use this parameter for any choice. The 5494 uses this information to support cursor-sensitive scrolling. For more information, see "Scrolling the Choice List" on page 12-85.

*Left Choice:* If set to on, this parameter notifies the 5494 that the AS/400 application user must receive a roll-left AID when the Cursor Left key is pressed on the specified choice. This parameter can be used to support pull-down menu browse. Generally, the specified choice is the first choice available to the 5494 within the selection field, and additional choices are available to the left of the specified choice. The 5494 uses this information to support cursor-sensitive scrolling. For more information, see "Scrolling the Choice List" on page 12-85.

*Right Choice:* If set to on, this parameter notifies the 5494 that the AS/400 application user must receive a roll-right AID when the Cursor Right key is pressed on the specified choice. This parameter can be used to support pull-down menu browse. Generally, the specified choice is the last choice available within the selection field, and additional choices are available to the right of the specified choice. The 5494 uses this information to support cursor-sensitive scrolling. For more information, see "Scrolling the Choice List" on page 12-85.

*Use Minor Structure Flags:* Three parameter flags are available. These parameters are used to direct a Choice Text minor structure to one or more types of workstations. If no flags are set to on, the Choice Text minor structure is ignored. The parameter selection allows different characteristics or text for different workstation types. For example, if mnemonic underscoring is available, the choice text can be presented as E<u>x</u>it. However, not all NWSs can underscore mnemonics. A different choice text minor structure for NWSs that cannot underscore mnemonics may be specified as:

- 5. Exit
- eXit
- Exit(x).

You must set all three parameter flags to on if the choice text minor structure applies to all workstation types.

*Choice Text Minor Structure Optional Parameters:* The following are descriptions of the choice text minor structure optional parameters:

*Mnemonic Offset:* If set to on, this optional parameter defines the position of a mnemonic or numeric character within the choice text. The mnemonic offset parameter contains the offset within the choice text (starting with 0 for first character) of the mnemonic or numeric character associated with the specified choice. The major structure defines whether the numeric or mnemonic character is underscored (NWS 3477, 3486, and 3487 are capable of creating mnemonic underscoring). The mnemonic or numeric character does not need to be underscored to be recognized by the keyboard. If the major structure defines a selection field as having mnemonic selection, not all choices need to have a numeric or mnemonic character (set the mnemonic offset parameter to off). This parameter is ignored if a major structure defines a selection field as not having mnemonic selection.

*AID If Selected:* If set to on, this optional parameter defines an AID to be returned in the inbound data stream instead of the enter AID (which is used for auto-enter) when the specified choice is selected. This parameter is ignored if any of the following are true:

- The specified AID is not a currently defined AID (See Table 13-1 on page 13-5).
- The selection field is defined as auto-enter.
- The selection field is not defined as auto-select.
- The choice is unavailable for selection.

Depending on the specified AID, inbound data can be included.

*Numeric Characters:* If set to on, this optional 1- or 2-character parameter contains 1- or 2-numeric digits to be used in a single- or double-digit numeric selection field. This parameter is ignored if the major structure does not define this selection as single- or double-digit.

The 5494 sends a negative response if the major structure defines a single-digit numeric selection field, this choice accepts a cursor, and a single-digit numeric character is not included in the data stream. The 5494 sends a negative response if a character is not a valid numeric character (X'F0'-X'F9').

The 5494 sends a negative response if the major structure defines a double-digit numeric selection field, this choice accepts a cursor, and a double-digit numeric character is not included in the data stream. The 5494 sends a negative response if the first character is not a blank or a valid numeric character, or the second character is not a valid numeric character.

*Choice Text:* This optional parameter includes a string of character data that describes the field choice. Text data must not include display attributes. If you are using mnemonic selection, the mnemonic is contained within the choice text where an offset is specified. Choice text can contain spaces and nulls, which are used without alteration by the 5494.

You can specify an empty choice (where no choice text is included). This causes the 5494 to create a null choice in the next choice position (except for a menu bar or any selection field with a single row). In the case of menu bars or single row selection fields, an empty choice is ignored. Empty choices can be used to separate related groups of choices. The user is not able to position the selection cursor on an empty choice. If an empty choice selection field has indicators specified to the left of the choice text, the null indicator is used.

If the length of the choice text exceeds the textsize value, the choice text is truncated.

***Draw Menu Bar Separator Minor Structure:*** The optional draw menu bar separator minor structure causes a separator line to be drawn on the row after the last choice in the selection field. It is recommended that you use this minor structure to create the separator line instead of using a different data stream method (for example, SBA followed by the separator characters).

**Note:** If no separator line is desired and you want to save a screen row, do the following steps when presenting a pull-down window in order to have proper presentation on NWS and PWS:

1. A Save or Save Partial may be done by the application
2. Then, the data stream that creates the pull-down should include:
   - CLEAR FORMAT command or SOH order
   - CREATE WINDOW structured field for the window (typically to row 1)
   - DEFINE SELECTION FIELD structured field to define the menu bar
   - Define the data inside the pull-down (typically a selection field to row 2)

The 5494 creates a separator line that consists of the following components:

- An optional leading attribute (to the start column), which is specified in the minor structure. The default leading attribute is normal display (X'20') on monochrome displays and blue (X'3A') on color displays.
- Either the default separator character (a solid separator line character if available), the dash (–), or the character specified in the minor structure.
- If a leading attribute was written, a trailing normal display attribute is written to the end column of the row by the 5494.

Depending on the PWS, other methods can be used to separate the menu bar from the window (for example, background color).

If you are using two or more rows in a menu bar, the minor structure must be sent after all choice text minor structures are issued (the separator line is drawn on the row after the last choice).

You can customize both monochrome and color displays using the same minor structure; therefore, AS/400 applications do not need to check display types at run time.

If you update a selection field, it is necessary to resend the menu bar separator minor structure only if part of the separator had been overwritten (for example, a pull-down menu generally overwrites two of the separator characters).

*Table 12-20. Format for Menu Bar Separator Minor Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Minor Length | 5–8 | Length of minor structure in bytes (including length byte). |
| 2 | Type | X'09' | Defines selection field menu bar separator minor structure type. |
| 3 | Flags | Bit 0 | Use specified separator character on GUI-like NWSs if set to on. |
| | | Bit 1 | Suppress writing of leading and ending attributes if set to on. |
| | | Bits 2–7 | Reserved (must be set to off). |
| 4 | Start Column | 1–131 | Column to start writing the separator line. The leading attribute is written to this column, if included. If there is no leading attribute, the first separator character is written to this column. |
| 5 | End Column | 2–132 | Column to end writing the separator line. The ending attribute is written to this column, if included. If there is no ending attribute, the last separator character is written to this column. |
| 6 | Monochrome Separator Emphasis | X'00' or X'20'–X'3F' | Value of attribute placed in first position of the separator line on a monochrome display. If X'00' is specified, the default attribute is used. |
| 7 | Color Separator Emphasis | X'00' or X'20'–X'3F' | Value of attribute placed in first position of the separator line on a color display. If X'00' is specified, the default attribute is used. |
| 8 | Separator Character | X'00' or X'01'–X'FF' | Value of the separator character to be used across the entire row. If X'00' is specified, the default separator character is used. |

When you set the use specified separator character parameter to on, the specified separator character is used for GUI-like NWSs. This parameter is ignored if sent to a PWS that has GUI capabilities.

***Choice Presentation Display Attributes Minor Structure:*** This optional minor structure enables an AS/400 application to specify the display attribute values to be used when presenting selection field choices. The minor structure enables customization of both monochrome and color displays using the same minor structure; therefore, AS/400 applications do not need to check display types at run time.

The 5494 uses the default display attribute settings for all choices in the specified selection field if alternative attribute settings are not specified in the minor structure. When the minor structure is issued, it must come before the choice text minor structures. If you update a choice (for example, rewriting a list that is scrolled) you must resend the choice presentation display attributes minor structure.

Table 12-21 on page 12-62 describes the format for the menu bar separator minor structure.

*Table 12-21 (Page 1 of 2). Format for Choice Presentation Display Attributes Minor Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Minor Length | 4–19 | Length of minor structure in bytes (including length byte). |
| 2 | Type | X'01' | Define selection field display attributes minor structure type. |
| 3 | Flags | | At least one of the following three flags must be set to on, otherwise this minor structure is ignored. |
| | | Bit 0 | Uses the minor structure for GUI devices (including GUI-like NWSs) if set to on. |
| | | Bit 1 | Uses the minor structure for NWSs that are capable of creating underscores if set to on. |
| | | Bit 2 | Uses the minor structure for NWSs that are not capable of creating mnemonic underscores if set to on. |
| | | Bits 3–7 | Reserved (must be set off). |
| 4 | Monochrome Selection Cursor Available Emphasis | X'00' or X'20'–X'3F' | Value used for the selection cursor display attribute for an available choice on a monochrome display. |
| 5 | Color Selection Cursor Available Emphasis | X'00' or X'20'–X'3F' | Color version of byte 4. |
| 6 | Monochrome Selection Cursor Selected Emphasis | X'00' or X'20'–X'3F' | Value used for the selection cursor display attribute for a selected choice on a monochrome display. |
| 7 | Color Selection Cursor Selected Emphasis | X'00' or X'20'–X'3F' | Color version of byte 6. |
| 8 | Monochrome Selection Cursor Unavailable Emphasis | X'00' or X'20'–X'3F' | Value used for the selection cursor display attribute for an unavailable choice on a monochrome display. |
| 9 | Color Selection Cursor Unavailable Emphasis | X'00' or X'20'–X'3F' | Color version of byte 8. |
| 10 | Monochrome Available Emphasis | X'00' or X'20'–X'3F' | Value used for the leading choice text attribute for an available choice on a monochrome display. |
| 11 | Color Available Emphasis | X'00' or X'20'–X'3F' | Color version of byte 10. |
| 12 | Monochrome Selected Emphasis | X'00' or X'20'–X'3F' | Value used for the leading choice text attribute for a selected choice on a monochrome display. |
| 13 | Color Selected Emphasis | X'00' or X'20'–X'3F' | Color version of byte 12. |
| 14 | Monochrome Unavailable Emphasis | X'00' or X'20'–X'3F' | Value used for the leading choice text attribute for an unavailable choice on a monochrome display. |
| 15 | Color Unavailable Emphasis | X'00' or X'20'–X'3F' | Color version of byte 14. |

*Table 12-21 (Page 2 of 2). Format for Choice Presentation Display Attributes Minor Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 16 | Monochrome Indicator Emphasis | X'00' or X'20'-X'3F' | Value used for the indicator display attribute to be used on a monochrome display (except for an unavailable choice in a selection field with indicators to the left of choice text—the value is specified in byte 18). This value is ignored if this selection field does not have indicators to the left of the choice text or if the selection field is not a single- or double-digit numeric selection field. For a single- or double-digit numeric selection field, this attribute applies only to the first choice. |
| 17 | Color Indicator Emphasis | X'00' or X'20'-X'3F' | Color version of byte 16. |
| 18 | Monochrome Unavailable Indicator Emphasis | X'00' or X'20'-X'3F' | Value used for the indicator display attribute for an unavailable choice on a monochrome display. This value is ignored if the specified selection field does not have indicators to the left of the choice text. |
| 19 | Color Unavailable Indicator Emphasis | X'00' or X'20'-X'3F' | Color version of byte 18. |

The three parameter flags, specified in byte 3 of Table 12-21 on page 12-62, determine which type or types of display devices use this minor structure. All three flags can be set to on to customize all device types.

Specifying an attribute value of X'00' indicates that the default highlighting value is used for the entry. If highlighting values are not a valid display attribute, the value is ignored and default highlighting is used. A GUI PWS ignores the values in the minor structure and uses its normal highlighting attributes.

It is recommended that you only use one method to highlight selected choices. The 5494 uses one of the following methods for highlighting selected choices:

- Places a selection indicator to the left of each choice.
- Uses a single- or double-digit indicator field for single- or double-digit numeric selection fields.
- Uses the leading choice text attribute, if no indicators are used.

***Choice Indicators Minor Structure:*** This optional minor structure enables an AS/400 application to specify the indicator values to be used for presenting selection fields.

The 5494 uses the default indicators for this selection field if alternative indicators are not specified in the minor structure. When this minor structure is issued, it must come before choice text minor structures. If you update a choice (for example, rewriting a list that is scrolled), you must resend the choice indicators minor structure. The minor structure is ignored if no indicators are used in the selection field.

Table 12-22 on page 12-64 describes the format for the choice indicator minor structure.

Table 12-22. Format for Choice Indicator Minor Structure

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Minor length | 4–6 | Length of minor structure in bytes (including length byte). |
| 2 | Type | X'02' | Defines the choice indicators minor structure type. |
| 3 | Flags | Bit 0 | Use the specified indicators on GUI-like NWSs if set to on. |
| | | Bits 1–7 | Reserved (must be set to off). |
| 4 | Empty Indicator or Left Push Button | X'00' or X'01'–X'FF' | Value used for the unselected/available indicator character if the specified selection field has indicators to the left of the choice text or left push button character. If no push button indicator is desired, a blank (X'40') can be specified. |
| 5 | Selected Indicator or Right Push Button | X'00' or X'01'–X'FF' | Value used for the selected indicator character if this selection field has indicators to the left of the choice text or right push button character. If no push button indicator is desired, a blank (X'40') can be specified. |
| 6 | Character That Replaces the First Choice Text Character for Unavailable Choices On a Monochrome Display | X'00' or X'01'–X'FF' | Value used for the character that replaces the first choice text character for an unavailable choice on a display not capable of identifying a choice as unavailable (most commonly, a monochrome display). If the major structure flag indicates that replace is off, this value is ignored and no replacing is done. |

The specified indicator flag is applicable only for bytes 4 and 5 in Table 12-22. If you set the specified indicator flag to on, the specified indicators on GUI-like NWSs are capable of creating check boxes, radio buttons, or push buttons. A GUI PWS ignores this flag and uses its own selection indicators.

If you specify an indicator value of X'00', the default indicator is used. The 5494 does not check any of the specified values.

***Scroll Bar Indicators Minor Structure:*** This optional minor structure enables an AS/400 application to specify the character values and highlighting to be used when creating a scroll bar for a specified selection field.

You can also use the minor structure to customize vertical and horizontal scroll bar fields. For more information see "DEFINE SCROLL BAR FIELD Structured Field" on page 12-87.

The 5494 uses the default characters for the scroll bar if no alternative characters for the scroll bar are specified in the minor structure. When the minor structure is issued, it must come before choice text minor structures. If you update a scroll bar, you must resend the scroll bar indicators minor structure. The minor structure is ignored if no scroll bar is used for the selection field.

Table 12-23 describes the format for the scroll bar indicators minor structure.

*Table 12-23. Format for Scroll Bar Indicators Minor Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Minor Length | 4–11 | Length of minor structure in bytes (including length byte). |
| 2 | Type | X'03' | Defines the scroll bar indicators minor structure type. |
| 3 | Flags | Bit 0 | Use the specified indicators on GUI-like NWSs, if set to on. |
| | | Bits 1–7 | Reserved (must be set off). |
| 4 | Monochrome Top of Scroll Bar Highlighting | X'00' or X'20'–X'3F' | Value used for the display attribute to be used to highlight the top and bottom characters of the scroll bar on a monochrome display. For a horizontal scroll bar field, this attribute is used for the entire scroll bar. |
| 5 | Color Top of Scroll Bar Highlighting | X'00' or X'20'–X'3F' | Color version of byte 4. |
| 6 | Monochrome Shaft Scroll Bar Highlighting | X'00' or X'20'–X'3F' | Value used for the display attribute to be used to highlight the shaft portion of the scroll bar (between top and bottom indicators) on a monochrome display. This attribute is ignored for a horizontal scroll bar field. |
| 7 | Color Shaft Scroll Bar Highlighting | X'00' or X'20'–X'3F' | Color version of byte 6. |
| 8 | Top Scroll Bar Character | X'00' or X'01'–X'FF' | Value used for the top of scroll bar indicator (or left scroll bar indicator for a horizontal scroll bar field). |
| 9 | Bottom Scroll Bar Character | X'00' or X'01'–X'FF' | Value used for the bottom of scroll bar indicator (or right scroll bar indicator for a horizontal scroll bar field). |
| 10 | Empty Scroll Bar Character | X'00' or X'01'–X'FF' | Value used for the empty scroll bar position within the scroll bar shaft. |
| 11 | Slider Scroll Bar Character | X'00' or X'01'–X'FF' | Value used for the slider scroll bar position within the scroll bar shaft. |

When you set the specified indicator flag to on, the specified indicators and display attributes are used on a GUI-like NWS. A GUI PWS ignores this flag and uses its own GUI scroll bars.

If you specify a value of X'00', the default character or highlighting is used. The 5494 does not check any specified character values.

***How the 5494 Processes the Define Selection Field:*** The 5494 processes the define selection field as follows:

*Outbound Data Stream Processing:* As with the SF order, the:

- Insert mode is reset.
- Keyboard is locked.
- Outstanding AID requests are cleared.
- Master MDT bit is set if the selection field MDT is set to on.
- Keyboard modes are reset when the define selection field structured field is received and processed by the 5494.

*Selection Field Choice Definition Limitations:* Selection field data is stored in the field format table (FFT) storage area. Enough storage is reserved for the maximum number of selection field choices. The maximum number of selection field choices is either the product of the rows value and the columns value or the maximum number of menu bar choices within a menu bar. Two FFT entries are made for each selection field choice. If a selection field has an associated scroll bar, three additional FFT entries are required. You can specify a maximum of 256 FFT entries. If you attempt to define more than 256 FFT entries, the 5494 sends a negative response.

*Selection Field Redefinition:* The AS/400 application user can redefine a selection field by sending another define selection field major structure to the same display address that was used when the field was initially defined. You must redefine a selection field when one or more choices have changed. If the following values do not remain the same, the 5494 may send a negative response.

- Rows value
- Columns value
- Textsize value
- Type of indicators
- Selection techniques
- Padding between choices
- Type of selection field
- Presence of a scroll bar.

When you redefine a selection field, you can specify more choices or fewer choices. However, the maximum number of choices must remain the same (the maximum is equal to the number of rows multiplied by the number of columns, or the number of menu bar choices within a menu bar). The 5494 deletes any choices remaining from the previous definition by erasing a rectangular area using the longest selection field row.

*Inbound Selection Field Data:* The inbound data from a selection field is determined by the existence of a scroll bar and if the selection field is single choice.

For any single choice selection field (menu bar, push button, or a single choice selection field or list), two bytes are returned, which is the selected choice number. If the selected choice number is X'0000', no choice is selected, otherwise the selected choice number is the number of the choice that is selected plus X'1F' (where the first choice returns X'0020'). All choices are included for numbering purposes, including null choices. The choice number is unrelated to the single- or double-digit numbers on the display screen.

For any type of multiple choice selection field (multiple choice selection field or list), each choice returns one byte of the selection field data (the product of rows and columns or menu bar choices). This is independent of how many choices are actually written to the display screen. The data byte that is returned for each choice is X'F1' for a selected choice. The data byte that is returned for each choice is X'00' for an unselected choice. The data byte is X'00' for possible choices that are not actually on the display screen.

The selection field has an associated scroll bar, 4 bytes follow selection field data (known as a scroll increment). The 4 bytes will be zero unless the requested key is a roll-up or roll-down request and the user has selected the scroll bar with a pointer device. The increment is always a positive number. If the increment is one, the user is requesting to scroll one row. The increment could be quite large if the user drags and drops the scroll bar slider using a pointer device. The increment could be larger than the number of rows that the AS/400 application user had specified for the (up or down) direction when the selection field was defined.

If a selection cursor is active when an AID is sent to the AS/400, the cursor column in the inbound data is set to the first column of the selection cursor (first position to the right of the leading choice text attribute).

For READ INPUT FIELDS command processing, all inbound data from selection fields is returned as specified in the inbound selection field description. Selection and entry field data is positioned in the inbound data stream, ordered by starting field address with no field data delimiters. The AS/400 application determines how much field data is returned and parses the data appropriately.

For READ MODIFIED FIELDS command processing and all READ MODIFIED type commands, inbound data processing is the same for the READ INPUT FIELDS command except that data is returned only if the selection field MDT is set to on. The SBA that is returned before the field data is the selection field address (one position past the original address that was used to position the selection field).

For READ IMMEDIATE command processing, all inbound data that is returned is in exactly the same format as for the READ INPUT FIELDS command.

*Presenting Selection Field Choices:* The 5494 creates selection choices in the order that they are issued, one column at a time, in rows from top to bottom. For example, the choices in the multiple choice selection list shown in Figure 12-6 on page 12-68 are ordered in the data stream as:

- Cable TV
- Groceries
- Car
- House
- Charities
- Insurance
- Clothes
- Interest
- Gifts
- Recreation.

This is consistent with field ordering for the 5250 data stream.

The 5494 aligns the choice indicators and text. For an example of a selection field presentation, see Figure 12-6 on page 12-68.

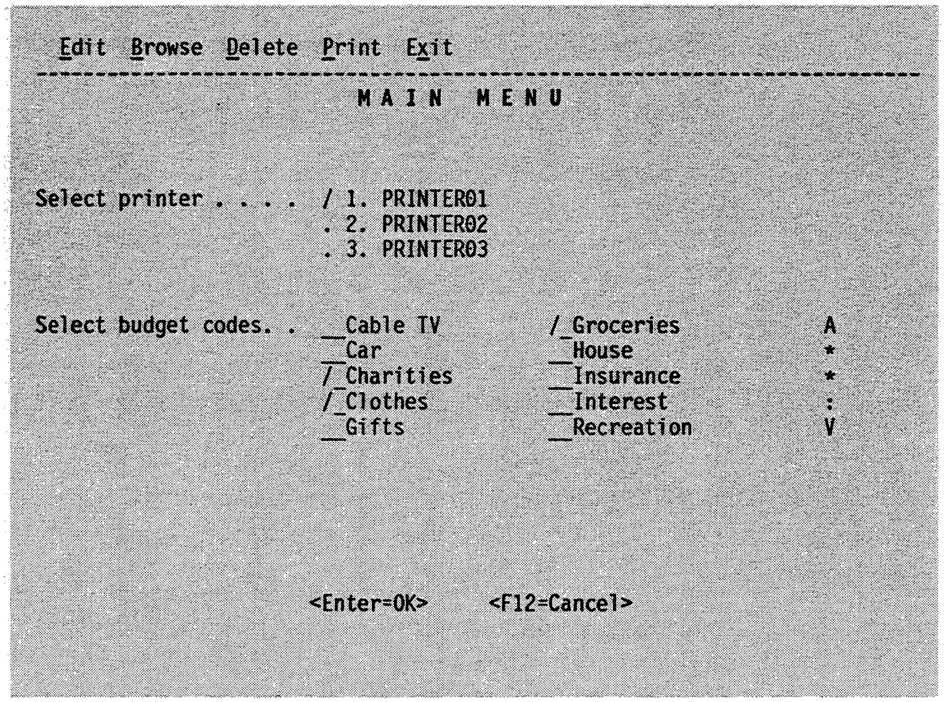



*Figure 12-6. Selection Field Presentation*

Consider the following explanations for Figure 12-6:

- The figure represents a NWS that is capable of mnemonic underscoring, but not GUI-like presentation.
  - Some NWSs are not capable of creating mnemonic underscores. However, mnemonic selection is still allowed. The AS/400 application is responsible for identifying the mnemonic characters.
  - NWSs 3486 and 3487 support:
    - GUI-like check boxes, radio buttons, and scroll bars
    - A solid menu bar separator line
    - Push button text with a box around it.
  - A GUI PWS supports the following features:
    - GUI scroll bars
    - GUI push buttons
    - GUI empty and checked boxes
    - GUI empty and filled-in radio buttons.
- The selection cursor (not shown) is active on one of the choices.
- The scroll bar is reverse image.
- All indicators (indicators are optional) and attributes within selection fields can be customized.

You can create Figure 12-6 on page 12-68 with a 5250 display data stream containing the following constructs:

- Escape, CLEAR UNIT command
- Escape, WRITE TO DISPLAY command, and two control characters (typically specify keyboard unlock)
- SBA order for row 1 and column 1
- WDSF order
- Define selection field major structure
  - The major structure defines the selection field type as a menu bar.
  - Five choice text minor structures that specify the five choices and define the offset for the mnemonic character.
  - A menu bar separator minor structure that specifies where the menu bar separator is drawn below the menu bar.
- SBA order for row 3 and column 26
- Attribute, title text, attribute
- SBA order for row 7 and column 1
- Attribute, select printer text, attribute
- SBA order to row 7 and column 28
- WDSF order
- Define selection field major structure
  - The major structure defines the selection field type as a single choice selection field.
  - Three choice text minor structures that specify the three choices (choice 1 is the default choice) and defines the offset for the mnemonic character (in this case, numbers 1 through 3).
- SBA order for row 12 and column 1
- Attribute, select budget codes text, attribute
- SBA order for row 12 and column 28
- WDSF order
- Define selection field major structure
  - The major structure defines the type of selection field as a multiple choice selection list with a scroll bar.
  - 14 choice text minor structures that specify the 14 choices (and default choices).
- SBA order for row 24 and column 26
- WDSF order

- Define selection field major structure
  - The major structure defines the selection field type as push buttons (and specifies padding between choices).
  - Two choice text minor structures that specify the two choices.
- Escape, READ MDT FIELDS command, and control characters.

*GUI PWS Selection Field Presentation:* A GUI PWS presents selection fields as GUI constructs. When a GUI construct is used, it requires space on the display screen equal to or less than the character equivalent of the selection field.

*NWS Menu Bar Presentation:* Examples of presenting a menu bar are shown in Figure 12-7 and Figure 12-8.

```
Example 1

@  Edit@ @Browse@ @Delete@ @Print@ @Exit@ @
@  Complete@ @Help@
@------------------------------------------------------------------@
```

*Figure 12-7. Menu Bar with Optional Underscored Mnemonics and Separator Line*

**Notes:**

1. The at sign (@) indicates an attribute.
2. The example is supported on a GUI-like NWS that is capable of underscoring mnemonics.
3. The AS/400 system instructs the 5494 to begin a new row on the choice named Complete.
4. The data stream instructs the 5494 to pad between choices with nulls (one null is shown). The Cursor Left and Cursor Right keys move the selection cursor from choice to choice without stopping at the nulls.
5. The default separator line is a solid line on GUI-like NWS devices and dashes on NWS devices capable of underscoring mnemonics.
6. Two leading blanks are shown in the first choice. This enables the pull-down menu text to line up with the choice named Edit.

```
Example 2

@1. Edit @@ 2. Browse @@ 3. Delete @@ 4. Print @@ 5. Exit @
```

*Figure 12-8. Menu Bar with Numeric Selection With AS/400 System Padding*

**Notes:**

1. The example is supported by all NWS devices.
2. The user can select from numeric choices. Numbers are valid mnemonic characters. The AS/400 application includes the numbers in the choice text.
3. The data stream indicates that the mnemonics are not underscored.
4. The example shows how the AS/400 application pads choice text with nulls or blanks.

*NWS Single Choice Selection Field Presentation:* Figure 12-9 on page 12-71 and Figure 12-10 on page 12-71 show how the NWS presents single choice selection fields.

**Example 1**

```
@r@Choice 1       @   @r@Choice 2 text  @
@R@Choice 3       @   @ @               @
@r@Choice 5 - text@   @r@Choice 6       @
@r@Choice 7       @   @ @               @
```

*Figure 12-9. Single Choice Selection Field With Indicators*

**Notes:**

1. The at sign (@) indicates an attribute.
2. The uppercase R character indicates a filled-in radio button and the lowercase r character indicates an empty radio button.
3. On an NWS without GUI-like indicators, the slash (/) character is the default single choice indicator (choice is selected) and the period (.) character is the default single choice available indicator (choice is still available).
4. Using a single- or double-digit selection field for non-GUI NWSs may be desired.
5. Where desired, the AS/400 application can add null choices as separators. The cursor skips over null choices. Null choices do not have an indicator.
6. Choice 5 in the figure is shown as unavailable. The default indicator and choice text attributes on a color NWS are blue. The default highlighting for both attributes on a monochrome NWS is normal (like available choices). The AS/400 application can instruct the 5494 to change the choice text to *Choice 5 - text* to indicate unavailability on a monochrome NWS.
7. You can instruct the 5494 to pad between choices with nulls (3 nulls between choices is shown) in the data stream. The Cursor Left and Cursor Right keys move the selection cursor from choice to choice without stopping at the nulls.
8. When a user selects a choice, the radio button is filled-in. The indicator attribute and the choice text attribute are not modified as a result of the user selecting the choice. Any other selected choice is deselected (changed to an empty radio button).

**Example 2**

```
@.@1. Choice1@  @.@2. Choice 2 has very long choice text@  @.@3. Choice 3 text@
```

*Figure 12-10. One Row Single Choice Selection Field With Indicators*

**Notes:**

1. The example is supported by NWS types. It is not recommended for use with GUI-like NWSs; use the default radio buttons instead.
2. For a single row selection field, the 5494 does not pad choices up to the textsize value. The AS/400 application can pad the choice text as desired.
3. The user sees numeric selection; however, mnemonic selection is really used. All three NWSs support mnemonic selection. Numbers are valid mnemonic

characters. The AS/400 application includes the numbers in the choice text. The data stream indicates that mnemonics are not underscored.

4. Null choices for a single row selection field are ignored.

*Single- and Double-Digit Numeric Selection Indicator Field:* For single-digit numeric selection fields, the indicator field has the following states:

**Null State:** The indicator field displays a space. (See the underscored position in Figure 12-11 on page 12-73.) The indicator field is null whenever:

- The cursor is outside of the selection field and no choice is selected.
- The cursor was on a selected choice and the Space Bar or Delete key was pressed to deselect the choice. Any cursor movement within the selection field causes the indicator field to change to the filled-in state.

**Filled-In State:** The indicator field displays *n*, where *n* is a numeric character (0 through 9). The indicator field is filled-in when:

- The cursor is outside of the selection field and the choice with *n* as the first choice text character is selected.
- The cursor is on the choice with *n* as the first choice text character and the indicator field is not in the null state.

For double-digit numeric selection fields, the indicator field has the following states:

**Null State:** The indicator field displays two spaces. See the underscored positions in Figure 12-12 on page 12-73. The indicator field is null when:

- The cursor is outside of the selection field and no choice is selected.
- The user was on a selected choice and the user pressed the Space Bar or Delete key to deselect the choice. Any cursor movement within the selection field causes the indicator field to change to the filled-in state.

**½ Filled-In State:** The indicator field displays *n* with a space following it (*n* ), where *n* is a numeric character (0 through 9). The indicator is ½ filled when the indicator field is in the null or filled-in state and the user has pressed the numeric character (*n*) that matches the second digit of a choice beginning with a blank (or the numeric character matches the first digit of a choice). Any cursor movement within the selection field causes the indicator field to change to the filled-in state.

**Filled-In State:** The indicator field displays *nm* or *n* with a space before it ( *n*), where *n* and *m* are numeric characters (0 through 9). The indicator is filled-in when:

- The cursor is outside of the selection field and the choice with *nm* or *n* with a space before it ( *n*) as the first two choice text characters is selected.
- The selection cursor is on the choice with *nm* or *n* with a space before it ( *n*) as the first two choice text characters and the indicator field is not in the null or ½ filled-in state.

Figure 12-11 on page 12-73 shows how you can present a single-digit numeric selection field on a display device.

```
@_@1. Choice 1       @
@ @2. Choice 2 txttxt@
@ @8. Choice 3       @
@ @                  @
@ @9. Choice 5       @
```

*Figure 12-11. Single-Digit Numeric Selection Field*

**Notes:**

1. The example is not supported by GUI-like NWSs.
2. The indicator field is underscored.
3. The numeric digit, period (.) character, and optional space are not part of the choice text, but are included relative to the textsize value.
4. If single-digit numeric selection is a specified option, the maximum choice text size (depending on optional space) is 2 or 3 characters less than the textsize value.
5. The example requires the same screen space as an equivalent GUI selection field with radio buttons. The inbound cursor address is also the same.
6. The single-digit indicator field is null. This is true if the cursor was outside of the field and no choice was selected.

Figure 12-12 shows how you can present a multiple column double-digit numeric selection field on a display device.

```
@_3@ 1. Choice 1   @@ @ 2. Choice 2   @
@   @ 3. Choice 3  @@ @ 4. Choice 4   @
@   @              @@ @               @
@   @20. Choice 7  @@ @21. Choice 8   @
```

*Figure 12-12. Multiple Column Double-Digit Numeric Selection Field*

**Notes:**

1. The example is not supported by GUI-like NWSs.
2. The 2-character indicator field is underscored.
3. The indicator field has a 3 indicating that either the cursor is outside the selection field and choice 3 is selected or a selection cursor is positioned on choice 3.
4. The example requires that 1 column is added to the left side as compared to a single choice selection field with radio buttons (only one indicator position is used on subsequent columns). The inbound cursor address is the same as a 2-column selection field with radio buttons.

Figure 12-13 on page 12-74 shows how you can present a single choice selection field without indicators on a display device.

```
@Choice 1       @@Choice 2 text  @
@Choice 3       @@Choice 4       @
@Choice 5 text  @@Choice 6       @
@               @@               @
@Choice 9       @@Choice 10 text @
```

*Figure 12-13. Single Choice Selection Field Without Indicators*

**Notes:**

1. The example is supported by all NWSs.
2. When a user selects a choice, the choice text attribute is changed to show the users selection. In the figure, Choice 2 is selected.

*NWS Multiple Choice Selection Field Presentation:* Multiple choice selection fields are similar to the single choice selection fields shown earlier. The exception is that multiple choice selection fields have different indicators. Multiple choices can be selected, and there is no single- or double-digit multiple choice selection field. Multiple choice selection field examples are shown in Figure 12-14 and in Figure 12-15.

**Example 1**

```
@c@Choice 1     @ @C@Choice 2     @
@ @             @ @c@Choice 4 text@
@C@Choice 5     @ @c@Text choice 6@
```

*Figure 12-14. Multiple Choice Selection Field With Indicators*

**Notes:**

1. The uppercase C character indicates that a check box is checked and the lowercase c character indicates that the check box is empty. For an NWS that cannot create GUI-like indicators, an underscored slash (/) character is the default multiple choice selection indicator. An underscored blank (_) is the default choice indicator attribute.
2. Mnemonic selection is shown (not all choices are required to have a mnemonic).
3. When a user selects a choice, the check box is checked. The indicator attribute and the choice text attribute are not modified as a result of the user selecting the choice.

**Example 2**

```
@Choice 1       @  @Choice 2 text  @
@Choice 3       @  @Choice 4       @
@Choice 5 txt   @  @Choice 6       @
@               @  @               @
@Choice 9       @  @               @
```

*Figure 12-15. Multiple Choice Selection Field Without Indicators*

**Notes:**

1. The example is supported on all NWSs.
2. The example shows padding of two nulls between choices.
3. When a user selects a choice, the choice text attribute is changed to show the selection made by the user.

*NWS Single Choice Selection List Presentation:* Single choice selection lists are similar to single choice selection fields. The exception is that a vertical scroll bar can be presented beside the selection field. Single choice selection list presentation examples are shown in Figure 12-16 and Figure 12-17.

```
Example 1

@r@Choice 1        @   @r@Choice 2 text  @@#@
@R@Choice 3        @   @ @               @@#@
@r@Choice 5 - text@    @r@Choice 6       @@#@
@r@Choice 7        @   @ @               @@#@
```

*Figure 12-16. GUI-like Single Choice Selection List With a Scroll Bar*

**Notes:**

1. The example is supported only by GUI-like NWSs.
2. The pound sign (#) indicates part of a GUI scroll bar. A single choice selection list does not require a scroll bar.
3. The example shows radio button indicators. The advantage of presenting indicators is that the screen layout is the same between GUI NWSs and non-GUI NWSs using single-digit numeric selection.
4. A selection field that can be scrolled should have at least five rows for optimal presentation. However, three rows are required.
5. The AS/400 application can add null choices as separators.
6. In the data stream, you can instruct the 5494 to pad between choices with nulls.
7. When a user selects a choice, the radio button is filled-in. Any previously selected choice is deselected.

```
Example 2

@__@ 1. Choice 1        @@A@
@  @ 2. Choice 2 txttxt@@*@
@  @ 3. Choice 3        @@*@
@  @                    @@:@
@  @10. Choice 5        @@:@
@  @11. Choice 6        @@:@
@  @13. Choice 7        @@V@
```

*Figure 12-17. Double-Digit Numeric Selection List With a Scroll Bar*

**Notes:**

1. The example is not supported by GUI-like NWSs.
2. The example shows default character equivalents of a scroll bar. The scroll bar is optional.
3. The 2-character indicator field is underscored.
4. The example requires that one column is added to the left side as compared to a single choice selection field with radio buttons.

*NWS Multiple Choice Selection List Presentation:* Multiple choice selection lists are very similar to multiple choice selection fields. The exception is that a vertical scroll bar can be presented beside the selection field. A multiple choice selection list presentation example is shown in Figure 12-18.

```
@_@Choice 1       @@A@
@/@Choice 2       @@:@
@/@Choice 3       @@:@
@_@Text - choice 4@@*@
@ @               @@*@
@/@Text - choice 6@@V@
```

*Figure 12-18. Non-GUI Multiple Choice Selection List With Indicators*

**Notes:**

1. The example is supported by all NWSs, but is not recommended for GUI-like NWSs (check boxes and GUI scroll bars should be used instead).
2. The scroll bar is optional.
3. Indicators are optional.
4. Mnemonic selection can be used.

*NWS Selection Field (List) in a Pull-Down Menu Presentation:* Any type of single or multiple selection field (or list) can be placed in a pull-down menu. A pull-down menu can contain more than one selection field. Figure 12-19 shows two selection fields in a pull-down menu.

```
@ Edit@@Browse@@Delete@@Exit@
@.------------------------.--------------------------------------------------@
@:@Choice 1 @@Choice 2 @ @:@
@:@Choice 3 @@Choice 4 @ @:@
@:@Choice 5 @@Choice 6 @ @:@
@:@Choice 7 @@         @ @:@
@:@                      @:@
@:@_@Choice 1          @A@:@
@:@/@Choice 2          @:@:@
@:@/@Choice 3          @:@:@
@:@_@Text - choice 4   @*@:@
@:@/@Text - choice 5   @V@:@
@:.......................:@
```

*Figure 12-19. Pull-Down With a Selection Field and Selection List*

**Notes:**

1. The example shows a 2-column single choice selection field without indicators and a multiple choice selection list with indicators.

   This type of presentation is not recommended, but it is an example of the different types of single and multiple selection fields (or lists) in a pull-down menu. The AS/400 application positions the pull-down menu and the selection fields inside a window.

2. The default separator line and default pull-down menu borders are solid lines on GUI-like NWSs.

3. The menu bar and pull-down menu window are shown starting at column 1.

4. The example shows how the indicator attribute (or the leading choice text attribute) can overwrite the second left border attribute. Writing the ending choice text attribute or ending scroll bar attribute is suppressed if it exactly overlaps the first right border attribute.

5. If a pull-down browse menu is desired, the leftmost and rightmost choices can be defined as leftmost and rightmost in the choice text minor structure.

*NWS Push Button Presentation:* Figure 12-20, Figure 12-21 on page 12-78, and Figure 12-22 on page 12-78 show examples of push button selection field presentations.

**Example 1**

```
@ Enter=OK @@ F12=Cancel @
```

**Example 2**

```
@<Enter=OK>@@<F12=Cancel>@
```

*Figure 12-20. Two Push Button Selection Fields With 4-Character Spacing*

**Notes:**

1. The example has 4 positions between the push button text. You can add more space between the choices by instructing the 5494 to pad between choices. Also, the AS/400 application can pad choices.

2. Example 1 shows a GUI push button indicating that a box is created around the choice text (which includes the padded blanks surrounding the choice text). The box is created between rows and columns of characters.

3. Example 2 shows a non-GUI push button indicating that characters are used for the push button. The default push button characters are the less than sign (<) and the greater than sign (>).

   Notice that the two different types of selection fields require the same amount of screen space.

4. The padded blanks or added push button characters are included when truncating a choice to the specified textsize value. Therefore, the textsize value must be at least 2 positions greater then the length of the longest text choice.

5. For any selection field with a single row, the 5494 does not pad choices to the textsize value.
6. The examples show mnemonic selection, which are supported by GUI-like NWSs and NWSs that are capable of mnemonic underscoring.

**Example 1**

```
@ Enter=OK @ F12=Cancel @
```

**Example 2**

```
@<Enter=OK>@<F12=Cancel>@
```

*Figure 12-21. Two Push Button Selection Fields With 3-Character Spacing*

**Notes:**

1. The example has 3 positions between push button text. The leading choice text attribute overwrites the previous ending choice text attribute.
2. Example 1 shows a GUI box that is created around the choice text (which includes the padded blanks surrounding the choice text).
3. Example 2 shows a non-GUI push button that uses characters.

   Notice that the two different types of selection fields require the same amount of screen space.

**Example 1**

```
@Enter=OK@@F12=Cancel@
```

**Example 2**

```
@Enter=OK@@F12=Cancel@
```

*Figure 12-22. Two Push Button Selection Fields With 2-Character Spacing*

**Notes:**

1. The example has 2 positions between push button text.
2. Example 1 shows a GUI box that is created around the choice text.
3. Example 2 shows a non-GUI with no push button indicator characters.

   Notice that the two different types of selection fields require the same amount of screen space.

*Choice Attributes:* All selection field entries have a leading choice text attribute and an ending choice text attribute. The leading choice text attribute is used to indicate the choice state, if no indicators are used (available, selected, or unavailable). It is modified when the selection cursor is on the choice.

Optionally, selection field entries can have an indicator attribute and an indicator that comes before the leading choice text attribute and choice text.

If the selection field has a scroll bar, the ending choice text attribute of the rightmost column of choices is overwritten by the leading scroll bar attribute. An ending scroll bar attribute is written after the scroll bar character. Figure 12-23 on page 12-79 shows how choice attributes are specified.

```
   @choice  text@         choice with no indicators
   @<push button>@        push button choice
 @i@choice  text@         choice with indicator
 @ @4. choice tx@         single digit choice
@  @12. choice t@         double digit choice
   @choice  text@#@       choice with a scroll bar
 @i@choice  text@#@       choice with indicator and scroll bar
 @ @4. choice tx@#@       single digit choice and scroll bar
@  @12. choice t@#@       double digit choice and scroll bar
|| ||          || |
|| ||          || --- ending scroll bar attribute
|| ||          |----- ending choice text attribute or leading scroll bar attribute
|| |ttttttttttt----- choice text
|| ------------------ leading choice text attribute or selection cursor attribute
|-------------------- indicator attribute (to the left of each choice or single-digit)
--------------------- indicator attribute for a double digit select field choice


@      - display attribute
i      - indicator to the left of choice
#      - scroll bar character
```

*Figure 12-23. Choice Attributes*

*Indicator Attributes for Selection Fields:* If the selection field has indicators to the left of each choice, or the selection field is a single- or double-digit numeric selection, the leftmost display attribute is the indicator attribute; otherwise, this selection field does not have an indicator attribute.

The default indicator attributes for a selection field with indicators to the left of each choice text are:

**Normal (X'20')** For a GUI-like monochrome NWS with available or selected choices.

**Green (X'20')** For a GUI-like color NWS with available or selected choices.

**Normal (X'20')** For a GUI-like monochrome NWS with an unavailable choice.

**Green (X'20')** For a GUI-like color NWS with an unavailable choice.

**Underscore (X'24')**
For a non-GUI monochrome NWS with available or selected multiple choice selection field or list.

**Green Underscore (X'24')**
For a non-GUI color NWS with available or selected choice multiple choice selection field or list.

**Normal (X'20')** For a non-GUI monochrome NWS with an unavailable choice.

**Green (X'20')** For a non-GUI color NWS with an unavailable choice.

**Normal (X'20')** For a non-GUI monochrome NWS with an unavailable or selected choice within a single choice selection field or list.

**Green (X'20')** For a non-GUI color NWS with an unavailable or selected choice within a single choice selection field or list.

The default indicator attributes for a single- or double-digit selection field are:

| | |
|---|---|
| **Underscore (X'24')** | For the first choice (monochrome display). |
| **Green Underscore (X'24')** | For the first choice (color display). |
| **Normal (X'20')** | For subsequent choices (monochrome display). |
| **Green (X'20')** | For subsequent choices (color display). |

*Cursor Attributes for Selection Fields:* The display attribute that comes before the choice text is the leading choice text attribute. If the selection cursor is on this choice, the leading choice text attribute is overwritten by the selection cursor attribute.

The selection cursor is a type of cursor that is used for making choice selections. The selection cursor is active within selection fields. The text cursor is not displayed within a selection field.

It is recommended that you use only one of the following methods for highlighting selected choices. The 5494 default fields conform to the following methods for selected choices:

- Selection indicators are placed to the left of each choice.
- Single- or double-digit indicator fields are used for single- or double-digit numeric selections.
- The leading choice text attribute is used, if no indicators are used.

The default selection cursor attribute is described as follows:

| | |
|---|---|
| **Reverse Image (X'21')** | For an available choice on a monochrome display. |
| **Green Reverse (X'21')** | For an available choice on a color display. |
| **Reverse Image (X'21')** | For an unavailable choice on a monochrome display. |
| **Blue Reverse (X'3B')** | For an unavailable choice on a color display. |
| **Reverse Image (X'21')** | For a selected choice, if there is an indicator attribute on a monochrome display. |
| **Green Reverse (X'21')** | For a selected choice, if there is an indicator attribute on a color display. |
| **Intense Reverse (X'23')** | For a selected choice, if indicator attributes are not used on a monochrome display. |
| **White Reverse (X'23')** | For a selected choice, if indicator attributes are not used on a monochrome display. |

The selection cursor attribute values can be changed with the choice presentation attributes minor structure.

*Leading Choice Text Attribute for Selection Fields:* If the selection cursor is not on a choice, the default leading choice text attributes are partially determined by the use of the indicators to the left of the choices.

The default leading choice text attributes can be changed on a field-to-field basis by using the choice presentation display attributes minor structure. The default leading choice text attributes are:

**Normal (X'20')** For a choice that is available on a monochrome display.

**Green (X'20')** For a choice that is available on a color display.

**Normal (X'20')** For a choice is that unavailable on a monochrome display.

**Blue (X'3A')** For a choice that is unavailable on a color display.

**Normal (X'20')** For a selected choice, if indicator attributes are used on a monochrome display.

**Green (X'20')** For a selected choice, if indicator attributes are used on a color display.

**Intensify (X'22')** For a selected choice, if indicator attributes are not used on a monochrome display.

**White (X'22')** For a selected choice, if indicator attributes are not used on a color display.

*Ending Choice Text Attribute for Selection Fields:* A choice text termination attribute is written after the choice text. This attribute is normal display with a value of X'20'. If the ending choice text attribute exactly overwrites the first right border attribute of the top window border, the ending choice text attribute is not written.

*Leading Scroll Bar Attribute for Selection Fields:* The attribute immediately to the left of the scroll bar, if a scroll bar is present, is the leading scroll bar attribute. The leading scroll bar attribute overwrites the ending choice text attribute of the rightmost column of choices. The default leading scroll bar attributes can be changed on a field-to-field basis by using the scroll bar indicators minor structure.

The default leading scroll bar attributes are for GUI-like NWSs and non-GUI NWSs, and are described as follows:

**Intensify (X'22')** On a monochrome GUI-like display.
**White (X'22')** On a color GUI-like display.
**Reverse (X'21')** On a monochrome non-GUI-like display.
**Reverse White (X'23')** On a color non-GUI-like display.

*Ending Scroll Bar Attribute for Selection Fields:* An ending scroll bar attribute is written after the scroll bar. This attribute is normal display (X'20'). If the ending scroll bar attribute exactly overwrites the first right border attribute of the top window border, the ending scroll bar attribute is not written.

*Choice Selection Indicators for Selection Fields:* If indicators are presented to the left of each non-null choice, the 5494 uses the choice selection indicators to indicate which choices have been selected.

The following indicators are used within single-choice selection fields:

**Period (.)** For an unselected choice.
**Empty Radio Button** For an unselected choice.
**Slash (/)** For a selected choice.
**Filled-In Radio Button** For a selected choice.

The indicators can be changed on a field-by-field basis by using the choice indicator minor structure. The following indicators are used within multiple-choice selection fields:

**Space** For an unselected choice.

**Empty Check Box** For an unselected choice.

**Slash (/)** For a selected choice (the country-specific selection character is used instead of the slash (/) character, if applicable).

**Filled-In Check Box** For a selected choice.

*Default Push Button Characters for Selection Fields:* The default push buttons can be changed on a field-by-field basis by using the choice indicator minor structure. The default push button characters on displays that are not capable of creating boxes (or when boxes are not used for displays capable of creating them) are the:

**Less Than Sign (<)** For left choice text.
**Greater Than Sign (>)** For right choice text.

When an NWS display device creates a box around push button text, the push button characters are ignored and replaced with nulls. The choice text is bound by one null on each side to keep push buttons the same size.

*Choice Text for Selection Fields:* The 5494 writes the choice text that is specified in the choice text minor structures.

The 5494 appends a blank area after the choice text, which consists of trailing spaces, to clear the remaining choice text area (if necessary).

*Scroll Bar Characters for Selection Fields:* The default scroll bar characters for a display without GUI-like scroll bar characters are:

**A** For a top scroll bar character.
**V** For a bottom scroll bar character.
**Colon (:)** For empty scroll bar positions.
**Asterisk (*)** For slider scroll bar positions.

The following scroll bar indicator settings can be changed on a field-by-field basis by using the scroll bar indicators minor structure. The default scroll bar characters for a model with GUI-like scroll bar characters are:

**Up Arrow** For a top scroll bar character.
**Down Arrow** For a bottom scroll bar character.
**Filled-In Block** For slider scroll bar positions.
**Blank With Vertical Borders**
For empty scroll bar positions.

The 5494 uses totalrows values that can be scrolled, sliderpos values, and row parameter values from the define selection field major structure to determine where a slider is to be placed within the scroll bar shaft and how large the slider is going to be.

It is recommended that selection fields with a scroll bar have 5 or more rows. For an NWS, when a scroll bar with 3 or 4 rows is presented, the top and bottom scroll bar characters are not displayed; only the shaft is visible.

*Using Selection Fields:* When the cursor enters a selection field, a selection cursor is created and the text cursor is made invisible. If the selection field is a single- or double-digit selection field, the indicator field is filled with the numeric character or characters.

*Choice Selection:* There are several ways to make a choice selection within a selection field, depending on the type of selection field and the AS/400 application user defined characteristics of the field.

There are three states for each choice, they are:

- Available
- Selected
- Unavailable.

If a user attempts to select an unavailable choice, an operator error is returned to the user.

The 5494 changes the appearance of a choice whenever a choice is selected, changing it from available status to selected status. When a choice is deselected, the 5494 changes it from selected status to available status.

When one of the following types of choices is selected in a single choice selection field, a previously selected choice is automatically deselected. Descriptions of the three basic types of choices are:

**Choice With No Indicator Attributes**: Selecting a choice results in the leading choice text attribute being changed to the selected value. Deselecting a choice results in the leading choice text attribute being changed to the available value.

**Choice With Indicators to the Left of Each Choice**: Selecting a choice results in the indicator being changed to the selected value. Deselecting a choice results in the indicator being changed to the available value.

**Choice With Single- Or Double-Digit Numeric Selection**: Selecting a choice results in the single- or double-digit indicator field being filled-in. Deselecting a choice results in the single- or double-digit indicator field being nulled.

*Cursor Selection:* The selection of a choice by moving the selection cursor onto it and pressing the Enter key. Cursor selection is enabled when the selection cursor is activated within an auto-select selection field.

*Mnemonic Selection:* The selection of a choice by entering a mnemonic character associated with that choice. Numeric characters are valid as mnemonics. When numeric characters are used as mnemonics, the user sees what looks like numeric selection. A choice is selected by entering the number associated with that choice (this is not the same as single- and double-digit numeric selection).

When the user presses a mnemonic (numeric) character within a selection field, the 5494 searches for a choice with a mnemonic (numeric) value that matches the character entered. When a match is found, the selection cursor is moved to the choice and the associated choice is selected.

While using mnemonic selection, the 5494 does not distinguish between uppercase and lowercase characters.

*Single- and Double-Digit Numeric Selection:* Single- and double-digit numeric selection is supported only by NWS non-GUIs.

When the user presses a numeric character (0 through 9) while in a single- digit numeric selection field, the 5494 processes it as follows:

- If a numeric character matches the digit of a choice that can be selected with a cursor, the selection is moved to the choice. The choice is selected and the selection indicator is filled-in (*n* where *n* is the numeric character). If there is no match, an operator error is returned to the user.

When the user presses a numeric character (0 through 9) while in a double-digit numeric selection field, the 5494 processes it in one of two ways:

- When a double-digit indicator field is null or filled-in and:
  - If the numeric character matches the second digit of a choice that accepts a cursor beginning with a blank, the selection cursor is moved to the choice. The choice is selected, and the selection indicator is set to ½ filled-in (*n* ) where *n* is the numeric character.
  - If the numeric character matches the first digit of a choice that accepts a cursor, the selection cursor is moved to the lowest numbered matching choice and the selection indicator is set to ½ filled-in (*n* ).
  - A zero is ignored (unless a match is found). Zero is a valid choice number.
- When a double-digit indicator field is ½ filled-in (the user has typed one valid numeric character) and:
  - If the numeric character matches the second digit of a choice that accepts a cursor and the first digit of the choice matches the number in the first position of the indicator field, the selection cursor is moved to the choice, the choice is selected, and the selection indicator is filled-in (*nm* where *n* and *m* are numeric characters).
  - If the numeric character matches the second digit of a choice that accepts a cursor beginning with a blank, the selection cursor is moved to the lowest numbered matching choice, the choice is selected, and the selection indicator remains ½ filled-in (*n* where *n* is the numeric character).
  - If the numeric character matches the first digit of a choice that accepts a cursor, the selection cursor is moved to the lowest numbered matching choice and the selection indicator remains ½ filled-in (*n* where *n* is the numeric character).

*Slash (/) Selection and Country-Specific:* Slash (/) selection is the selection of a choice by entering a slash (/) character when the selection cursor is positioned on the desired choice. You can use slash (/) selection within single choice or multiple choice selection fields.

A country-specific selection character can be specified. If one is specified, it functions like slash (/) selection. You can use country-specific selection within single choice or multiple choice selection fields.

*Space Bar Selection:* Space bar selection is the selection of a choice by typing a space bar character when the selection cursor is positioned on the desired choice ( as long as that choice has not been selected). The selection of this choice is canceled if the choice has already been selected when the Space Bar key is pressed. You can use space bar selection within single choice or multiple choice selection fields.

*Pointer Device Selection:* A PWS or an NWS that is using a pointer device enables pointer selection. Whenever the user selects a choice with a pointer device, the selection is mapped into a space bar selection.

*Changing a Selection:* For a single choice selection field, a selection is changed by selecting a different choice. In a multiple choice selection field, a choice must be explicitly selected or deselected.

In a single-choice or multiple-choice selection field, a selection can be deselected by pressing the Space Bar or Delete key while the selection cursor is positioned on the selected choice. In a single- or double-digit numeric selection field, the indicator field is set to null when a user deselects a choice.

*Scrolling the Choice List:* A selection list that can be scrolled consists of displayed choices and additional choices stored on the AS/400 system. The 5494 manages the presentation and selection of displayed choices. The AS/400 application recognizes a field scroll request (from the attention identifier [AID] value and cursor address that is returned) and responds by presenting the previous or following set of selection field choices.

*Cursor Up:* When the Cursor Up key is pressed and the selection cursor is on a choice that is defined as a top choice on the screen, cursor-sensitive scrolling can be used. The 5494 invokes the simulation of the Roll Down key by locking the keyboard and returning the roll down AID value of X'F4' and the field data to the AS/400 application. The selection cursor is not moved.

*Cursor Down:* When the Cursor Up key is pressed and the selection cursor is on a choice defined as a bottom choice on the screen, cursor-sensitive scrolling can be used. The 5494 invokes the simulation of the Roll Up key by locking the keyboard and returning the roll down AID value of X'F5' and the field data to the AS/400 application. The selection cursor is not moved.

*Cursor Left:* When the Cursor Left key is pressed and the selection cursor is on a choice defined as a left choice on the screen, cursor-sensitive scrolling can be used. The 5494 locks the keyboard and returns the roll left AID value of X'D9' and the field data to the AS/400 application. The selection cursor is not moved.

*Cursor Right:* When the Cursor Right key is pressed and the selection cursor is on a choice defined as a right choice on the screen, cursor-sensitive scrolling can be used. The 5494 locks the keyboard and returns the roll right AID value of X'D9' and the field data to the AS/400 application. The selection cursor is not moved.

*Pointer Device Scroll Bar Interaction:* A PWS or an NWS that uses a pointer device can generate roll requests using the scroll bar.

When a NWS user uses a pointer device in the scroll bar shaft above the slider or on the top arrow, a roll down AID is returned. The roll up AID is returned if the pointer is below the slider or on the bottom arrow.

A PWS responds with roll up and roll down AIDs based on standard pointer device interaction with the scroll bar. This is also true when a user drags and drops the slider to a user specified scroll increment (using a non-zero scroll increment in the inbound data).

The (text) cursor is optionally moved to the location in the scroll bar. If the cursor is not in the selection field, the cursor is moved to the scroll bar. If the (selection) cursor is in the selection field, the cursor is not moved. The cursor is moved because a screen has multiple scroll bars and the cursor location can be used to determine which data is going to be scrolled.

*Editing Keys Used in Selection Fields:* The following describes how the 5494 processes edit keys within the selection field presentation area, as well as the interaction of edit keys with selection fields when used outside a field.

*Field Advance:* Field Advance (the Tab key) and Field Exit cause the cursor to move to the next field. If the next field is a selection field, a selection cursor is created on the first choice that accepts a cursor. If the next field is a single- or double-digit numeric selection field, the indicator field is filled-in with the numeric character or characters.

When using Field Advance or Field Exit to exit a selection field, the cursor exits from the first choice, independent of where the selection cursor is located within the selection field.

*Field Backspace:* Field Backspace (Tab Backward key) causes the cursor to move to the previous field. If the previous field is a selection field, a selection cursor is created on the first choice that accepts a cursor. When the Field Backspace is used to exit a selection field, the cursor exits from the first choice, independent of where the selection cursor is located within the selection field.

*Field Exit:* Functions the same as Field Advance.

*Field Plus:* Functions the same as Field Advance.

*Field Minus:* Functions the same as Field Advance.

*Delete:* Deselects a choice if another choice is selected. The cursor does not move. If the selection field is a single- or double-digit selection field, the indicator field is set to null when the choice is selected.

*Insert:* Sets the insert mode to on or off (toggle function). The insert mode has no effect on how keystrokes are processed within selection fields.

*Erase Input:* Deselects selection field choices when the selection field MDT is set to on. The selection field MDT is not affected by this function.

### REMOVE GUI SELECTION FIELD Structured Field

It is recommended that you use this structured field with caution. The REMOVE GUI SELECTION FIELD structured field can be used to delete a GUI selection field construct and the associated GUI scroll bar construct. For an PWS device, a selection field and the associated scroll bar (created by a define selection field major structure) are GUI constructs. For GUI-like NWSs, this command works with push buttons that have push button boxes created around them.

The current display address must be the same as the selection field that was created by a define selection field major structure. A PWS attempts to locate a match between the current display address and a GUI selection field. When a match is found, the GUI construct is deleted, but the display screen is not cleared.

For a GUI-like NWS, this command works with a push button box that is created around push button choice text. When the 5494 locates a match between the push button selection field and the push button boxes, the push button boxes are removed.

It is important to have a CLEAR FORMAT command or SOH order follow the REMOVE GUI SELECTION FIELD structured field in the same display data stream.

The remove GUI selection field major structure must follow the WDSF order (See "WRITE DATA Structured Field" on page 12-92).

Table 12-24 describes the format for the remove GUI selection field major structure.

*Table 12-24. Format for Remove GUI Selection Field Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | 6 | Length of structured field in bytes (including length bytes). |
| 3 | Class | X'D9' | Class of structured field. |
| 4 | Type | X'58' | Type of structured field. |
| 5 | Flag Byte | Bits 0–7 | Reserved (must be set to off). |
| 6 | Reserved | X'00' | Reserved (must be set to zero). |

## DEFINE SCROLL BAR FIELD Structured Field

The DEFINE SCROLL BAR FIELD structured field is used to define a vertical or horizontal scroll bar field. The vertical scroll bar is similar to the scroll bar that can be defined with selection fields. A scroll bar field has the flexibility of binding any type of data, not just selection field choices. No keyboard functions are defined for a scroll bar field.

A PWS or NWS that uses a pointer device responds with roll up, roll down, roll left (X'D9') and roll right (X'DA') AIDs when the user uses a pointer device on a scroll bar. The user must be interacting within a scroll bar shaft, on the arrows, or performing a slider drag and drop action.

When a roll AID is sent as the result of a user pointing the device on a scroll bar, the text cursor is optionally moved to the location within the scroll bar. This is done because the screen can have multiple scroll bars and the cursor location is used to determine which data is to be scrolled.

On a PWS, the scroll bar is a GUI construct. This means that screen data is covered by the GUI construct. Simply writing over the scroll bar does not remove the GUI construct (for example, if you issue an SBA order followed by characters). A create window structured field creates a GUI window that can write over part or all of a GUI scroll bar. Use the following commands to remove a GUI scroll bar created by a define scroll bar field major structure:

- CLEAR UNIT command
- CLEAR UNIT ALTERNATE command
- RESTORE command

- RESTORE PARTIAL SCREEN command
- REMOVE GUI SCROLL BAR FIELD structured field
- REMOVE ALL GUI CONSTRUCTS structured field.

The GUI construct requires equal or less space on the display screen than the character equivalent of a scroll bar.

***DEFINE SCROLL BAR Field Major Structure:*** The define scroll bar field major structure must follow the WDSF order (See "WRITE DATA Structured Field" on page 12-92).

Table 12-25 describes the format for the define scroll bar field major structure.

*Table 12-25. Format of Define Scroll Bar Field Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | >14 | Length of structured field in bytes (including length bytes). |
| 3 | Class | X'D9' | Class of structured field. |
| 4 | Type | X'53' | Type of structured field. |
| 5 | Flag Byte | Bits 0 | Vertical scroll bar is set to off and horizontal scroll bar is set to on. |
| | | Bit 1 | The cursor is moved to the scroll bar on a pointer device scroll bar interaction if set to on. |
| | | Bits 2–6 | Reserved (must be set to off). |
| | | Bit 7 | Field MDT. |
| 6 | Reserved | X'00' | Reserved (must be to zero). |
| 7–10 | TotalRows or TotalCols That Can Be Scrolled | | The specified value is the total number of rows of data that can be scrolled that are available to the AS/400 application. This is for a vertical scroll bar or columns for a horizontal scroll bar. |
| 11–14 | SliderPos | | The number of rows or columns of data that can be scrolled that are available to the AS/400 application user above the first row or column on the display screen. |
| 15 | Rows or Columns | >2 or >6 | Number of screen rows a vertical scroll bar can occupy (maximum number of rows allowed depends on the display screen size). The number of columns a horizontal scroll bar can occupy (including the leading and trailing horizontal scroll bar attributes). |
| 16–n | Minor Structures | | Optional minor structures. |

*DEFINE SCROLL BAR Field Major Structure Parameters:* The scroll bar field major structure parameters are defined as follows:

> **Vertical or Horizontal:** The flag that defines the orientation of a scroll bar.
>
> **Move Cursor to Scroll Bar:** The cursor is moved to the scroll bar on a pointer device scroll bar interaction if set to on. If multiple scroll bars are on a display screen, the cursor location can be used to determine which data to scroll.

**Field MDT:** The scroll bar field MDT (as in entry fields) can be initially set on by the AS/400 application. The 5494 or PWS only sets the field MDT when a pointer device establishes a scrolling request.

**TotalRows or Cols:** The totalrows parameter defines the total number of rows available to the AS/400 application for a vertical scroll bar or columns for a horizontal scroll bar. For data that can be scrolled, this parameter is used to determine the slider size in the scroll bar.

**SliderPos:** The sliderpos parameter determines the position of the top of the slider (or leftmost position of the slider for a horizontal scroll bar) within the scroll bar. The sliderpos parameter defines the total number of rows for a vertical scroll bar or number of columns for a horizontal scroll bar, above or to the left of the slider. The sliderpos and totalrows parameters enable the 5494 to determine the size of the space before the slider, the size of the slider, and the size of the space after the slider in the scroll bar.

If the sliderpos value and the rows and columns values are greater than the totalrows or columns value, a negative response is returned.

**Rows or Columns:** The rows or columns parameter defines the number of screen rows to be used to present a vertical scroll bar (including the top and bottom scroll bar characters). The minimum value is 3 for a vertical scroll bar and 7 for a horizontal scroll bar. For a horizontal scroll bar, the rows or columns parameter defines the number of screen columns to be used to present a horizontal scroll bar (including the leading attribute, the left scroll bar character, the right scroll bar character, and the trailing attribute).

*Vertical Scroll Bar Field Presentation Area:* A vertical scroll bar field presentation area that is a 3-column wide rectangular area. The first column contains the scroll bar attribute. The default scroll bar attributes are the same for a scroll bar in a selection field. See "Leading Scroll Bar Attribute for Selection Fields" on page 12-81. The second column contains the scroll bar characters. The default scroll bar characters are the same for a scroll bar in a selection field (See "Scroll Bar Characters for Selection Fields" on page 12-82). The scroll bar attributes and scroll bar characters can be customized by using the scroll bar indicator minor structure. See "Scroll Bar Indicators Minor Structure" on page 12-90. The third column contains a normal display attribute value of X'20'. The rows and columns parameter defines the number of rows in a rectangular area. A minimum of 5 rows are recommended because no top or bottom scroll bar characters are presented for 3- or 4-row scroll bars.

*Horizontal Scroll Bar Field Presentation Area:* A horizontal scroll bar field presentation area is 1 row specified by the rows and columns parameter. The first column contains the scroll bar attribute. The default scroll bar attributes are the same for a scroll bar in a selection field. See "Leading Scroll Bar Attribute for Selection Fields" on page 12-81. The second column contains the left horizontal scroll bar character. The following default scroll bar characters are used for a non-GUI-like NWS:

| | |
|---|---|
| **Less Than Sign (<)** | Left scroll bar character. |
| **Greater Than Sign (>)** | Right scroll bar character. |
| **Hyphen (–)** | Empty scroll bar shaft position. |
| **Asterisk (*)** | Slider scroll bar shaft position. |

The following default scroll bar characters are used for a GUI-like display device.

| | |
|---|---|
| **Left Arrow** | Left scroll bar character (default). |
| **Right Arrow** | Right scroll bar character (default). |
| **Filled-In Block** | Slider scroll bar shaft position. |
| **Blank with Horizontal Borders** | Empty scroll bar shaft position (default). |

Scroll bar attributes and scroll bar characters can be customized by using the scroll bar indicator minor structure. See "Scroll Bar Indicators Minor Structure" for more information. The trailing attribute contains a normal display attribute value of X'20'. The rows and columns parameter defines the number of columns, including the leading attribute, left scroll bar character, shaft characters, right scroll bar character, and trailing attribute.

*Scroll Bar Field Rules and Restrictions:* The scroll bar field address is the current display address in effect when the structured field is received by the 5494. This address defines the upper-left position of the scroll bar field presentation area (upper-left scroll bar attribute). The current display address is not modified as a result of scroll bar field processing.

The following rules must be followed when defining a scroll bar field, or a negative response is returned:

- The scroll bar field presentation area must fit within the display screen.
- Resequencing and scroll bar fields cannot be used together for the same display device.
- All fields, including scroll bar fields, must be defined in descending left-to-right order on the screen. Other entry, selection, or scroll bar fields can be subsequently defined following a scroll bar field.
- The scroll bar field presentation area must not overlap the presentation area of any other input fields. The AS/400 application user must be aware of this, since the 5494 may not detect overlapping errors, depending on the workstation controller.

***Scroll Bar Indicators Minor Structure:*** The optional scroll bar indicators minor structure enables the AS/400 application to specify the character values and highlighting to be used when presenting a scroll bar. The 5494 uses default characters in the scroll bar if alternative characters are not specified by this optional minor structure. When this minor structure is issued, the alternate characters are applied to the scroll bar field only. When the scroll bar field is updated, it is necessary to resend the scroll bar indicators minor structure. The format of the scroll bar indicators minor structure is the same as a scroll bar on a selection field. See "Scroll Bar Indicators Minor Structure" on page 12-64.

***How the 5494 Processes the Define Scroll Bar Field:*** The 5494 processes the define scroll bar field as:

**Scroll Bar Field Definition Limitations:** Scroll bar field data is stored in the FFT storage area. Three FFT entries are made for a scroll bar field. A maximum of 256 FFT entries are allowed. If you specify more than 256 FFT entries, a negative response is returned.

**Scroll Bar Field Redefinition:** The AS/400 application can redefine a scroll bar field by sending another scroll bar field major structure to the same screen buffer address that was used when the field was initially defined. Rows, columns, and vertical and horizontal orientation must remain the same when a scroll bar field is redefined. A negative response is returned if you attempt to change these parameters.

***Inbound Scroll Bar Field Data:*** Each scroll bar field returns 4 bytes of inbound data (a scroll increment). These bytes will be zero unless the requested key is a roll up, roll down, roll left, or roll right request. However, one of the following conditions must have occurred:

- A PWS or NWS user has used the scroll bar arrows. In this case, the scrolling increment is set to the value of X'00000001' to indicate a single row or column scroll request.
- A PWS or NWS user has dragged and dropped the scroll bar slider using a pointer device. The scroll increment specifies the number of rows or columns that are to be scrolled. The increment could be larger than the number of rows that the AS/400 had specified for the (up or down) direction when the selection field was defined.

*READ MODIFIED FIELDS Command Processing:* For all READ MODIFIED type commands, inbound data is returned only if the scroll bar field MDT is set to on. The SBA address that is returned before the field data is the scroll bar field address.

## REMOVE GUI SCROLL BAR FIELD Structured Field

It is recommended that you use this structured field with caution. The REMOVE GUI SCROLL BAR FIELD command can be used to delete a GUI scroll bar construct. For a PWS, a scroll bar created by a define scroll bar field major structure can be a GUI construct. Because NWS scroll bars are made up of characters, the 5494 ignores this command.

The current display address must be the same as when the scroll bar was created by a define scroll bar field major structure. A PWS attempts to find a match between the current display address and a GUI scroll bar. When a match is found, the GUI construct is deleted but the display screen is not cleared.

It is important to have a CLEAR FORMAT command or SOH order follow the REMOVE GUI SCROLL BAR FIELD structured field in the same display data stream.

***REMOVE GUI SCROLL BAR FIELD Major Structure:*** The remove GUI scroll bar field major structure must follow the WDSF order (See "WRITE DATA Structured Field" on page 12-92).

Table 12-26 describes the format for the remove GUI scroll bar field major structure.

*Table 12-26 (Page 1 of 2). Format of Remove GUI Scroll Bar Field Major Structure*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | 6 | Length of structured field in bytes (including length bytes). |
| 3 | Class | X'D9' | Class of structured field. |
| 4 | Type | X'5B' | Type of structured field. |
| 5 | Flag Byte | Bits 0–7 | Reserved (must be set to off). |

Table 12-26 (Page 2 of 2). Format of Remove GUI Scroll Bar Field Major Structure

| Byte | Name | Value | Description |
|---|---|---|---|
| 6 | Reserved | X'00' | Reserved (must be set to zero). |

## WRITE DATA Structured Field

The WRITE DATA structured field can be used to write data to any type of entry field, or to initialize an entry field. Writing data to an entry field or initializing an entry field is complicated by the introduction of continued fields, especially ideographic continued entry fields, and word wrap fields. The WRITE DATA structured field offloads the task of splitting data between segments of continued entry fields, and between lines of a multiple row entry field to the 5494 if word wrap is specified.

Typically the current display address should be set using an SBA order to the first position of the desired entry field. If the entry field is a continued entry field, the current display address must be set to the first position of the first segment. For a right-to-left entry field, the current display address must be set to the leftmost position—the same as a left-to-right field. However, the data is written starting from the rightmost position of the right-to-left entry field.

**Note:** Write Data processing into a right-to-left entry field is consistent with inbound data from a right-to-left Word Wrap entry field; the AS/400 system does not need to reverse the entry field data.

The current display address is not modified as a result of this command.

***WRITE DATA Major Structure:*** The structured field must follow a Write to Display Structured Field order (see "WRITE DATA Structured Field").

Table 12-27. Format of Write Data Major Structure

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | >6 | Length of structured field in bytes (including length bytes). |
| 3 | Class | X'D9' | Class of structured field. |
| 4 | Type | X'54' | Type of structured field. |
| 5 | Flag byte | Bit 0 | Write data to entry field, if set to on. |
| | | Bits 1–7 | Reserved (should be set to off—ignored by the 5494). |
| 6 | Reserved | X'00' | Reserved (should be zero—ignored by the 5494). |
| 7–n | Field Data | | The data which is to be written to the entry field. |

*WRITE DATA Major Structure Parameters:* The Write Data Major structure parameters are defined as follows:

**Write Data to Entry Field**
Indicates the data in the Field Data parameter can be written to the entry field at the current display address. If this flag is set to off, a negative response is returned.

**Field Data** Specifies the data to write to a field at the current display address. A negative response is returned if the major length is valid, but the field data is too long for the entry field. Field data should not include display attributes (X'20'–X'3F') or X'FF'.

***Writing Data to Entry Fields:*** If the current display address is not the first position of an entry field, a negative response is returned. Otherwise, the following algorithm is used to write the field data:

- If the host elects to null a non-double-byte entry field (or null an ideographic either field into single byte mode), the field data type can be 1 null. If the entry field is a continued field, all entry field segments are nulled.
- Each consecutive character is put into the next consecutive character position starting at the first entry field position, and going left-to-right and downward through the entire field or set of continued field segments, until all the characters have been placed into the field. For right-to-left fields, the data is written starting at the right side of each field or field segment. Any remaining field positions are nulled.
- If the field is an ideographic only entry field, the first data character must be an SO. At least 1 double-byte character must be included, and the last data character must be an SI. Otherwise the 5494 will return a negative response. No other SO or SI characters should be included in the data. The 5494 writes the SI at the last field position and fills in with double-byte nulls from the last double-byte character to the SI to completely fill the field. If the entry field is a continued entry field, the 5494 adds SI characters to the end of first and middle continued field segments, and adds SO characters to the start of middle and last field segments. If the field is to be nulled, the data must consist of a SO, double-byte null (X'0000'), and an SI.
- If the field is a ideographic either entry, the field is set to single- or double-byte mode; double-byte mode if the first character is an SO. If double-byte data is being written, the first character must be an SO, at least one double-byte character must be included, and the last character must be an SI. No other SO or SI characters should be included in the data. If the field is set to double-byte mode and nulled, the data should consist of an SO, double-byte null (X'0000'), and an SI. If the first character is not an SO, the ideographic either field is set to single-byte mode.
- If the field is an ideographic open continued field, ideographic data that does not completely fit on a segment is automatically split between segments. This can require extra SI, SO character pairs to be inserted—at the end of the current segment and start of the next segment, respectively. Nulls can also be required following the SI on the current segment to pad to the end of the segment. A double-byte character does not fit in a segment when there are only 2- or 1-character positions remaining on a segment. When a double-byte character does not fit on a segment, the double-byte data on the current segment is terminated with an SI character. Or if the preceding character is the SO character, it is removed. The current segment is then padded to the end with nulls. An SO is placed at the beginning of the next segment. If the field is to be nulled, the field data should be 1 null (X'00').
- If the field is an ideographic data type, the first 3 bytes of the data must be an extended SO attribute (X'120581' which is a WEA extended SO), at least 1 double-byte character must be included, and the last 3 bytes of data must be

an extended SI attribute (X'120580' which is a WEA extended SI). Otherwise, the 5494 returns a negative response. If the field is to be nulled, the field data must be an extended SO attribute, a double-byte null (X'0000'), and an extended SI attribute.

- If the field has word wrap specified and an entire word does not fit on the current segment of a continued field, or the current line of a field that spans lines, the segment or line is padded with nulls, and the whole word is moved to the next segment or line. See page 12-28 for details on word wrap entry fields. If all of the data does not fit within a word wrap field, the data is rewritten to the field as without word wrap set to on.

## PROGRAMMABLE MOUSE BUTTONS Structured Field

The Programmable Mouse Buttons structured field can be used to associate AIDs with various pointer device (mouse) events. Single-event AIDs and two-event AIDs can be programmed.

Single-event AIDs can be used for such action as to reorder the layering of windows, or to select objects. For example, the middle button down can be programmed as a single-event AID when multiple windows are on the screen, to enable window reordering. Then when the user presses the middle button, the cursor is moved to the pointer device cursor location and the host-defined AID is returned. The application uses the host-defined AID to recognize a reorder request, and uses the inbound row/column cursor address to determine if the pointer device event occurred within an overlayed window. If yes, the windows can be reordered by the application.

Two-event AIDs can be used for actions such as to enable windows to be moved and sized. For example, the right button down/right button up can be programmed as a two-event AID to enable a window to be moved. Then, when the user presses the right button, a marker box is drawn at the pointer device cursor location on a capable NWS and the color of the pointer device cursor is changed to white on a capable color NWS. Then, the user can move the pointer device cursor and when the user releases the right button, the marker box is removed, the pointer device cursor color is set to the input inhibited color, the cursor is moved to the location of the pointer device cursor, and two AIDs and two row and column addresses are returned to the application. The application uses the two-event AID (X'80') and the second host-defined AID to recognize a window move request. If the second inbound row and column cursor address is on the window title (where the user pressed the right button), then the application uses the first row and column address (which is the text cursor location where the right button was released) to determine the number of rows and columns that the window must move.

**Note:** Using programmable mouse buttons can prohibit other lower-priority pointer device functions on the display screen.

***PROGRAMMABLE MOUSE BUTTONS Major Structure:*** The structured field must follow a Write to Display Structured Field order as described in "Write to Display Structured Field Order" on page 12-33.

Table 12-28. Format of Programmable Mouse Buttons Major Structure

| Byte | Name | Value | Description |
|---|---|---|---|
| 1–2 | Major Length | > 6 | Length of structured field in bytes (including length bytes). A length = 7 causes the programmable mouse button table to be reset. The length must be a multiple of 4, plus 7 (for example, 7, 11, 15, and so on). Because programmable mouse button event definitions are 4 bytes each, a negative response is returned if the length is not valid. |
| 3 | Class | X'D9' | Class of structured field. |
| 4 | Type | X'55' | Type of structured field. |
| 5 | Reserved | X'00' | Reserved (must be zero—ignored by the 5494). |
| 6 | Reserved | X'00' | Reserved (should be zero—ignored by the 5494). |
| 7 | Reserved | X'00' | Reserved (should be zero—ignored by the 5494). |
| 8–n | Programmable Mouse Button Event Definitions | | Optional Programmable Mouse Button Event Definitions. See Table 12-29 on page 12-95. The programmable mouse button table is reset if no event definitions are included. One or more definitions can be included. |

Table 12-29. Format of Each Programmable Mouse Button Event Definition

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Flag byte | Bit 0 | Single-event definition is set to off and two-event definition if set to on. |
| | | Bit 1 | The text cursor is moved to the location of the mouse cursor when set to on. |
| | | Bit 2 | The single mouse event is queued if the keyboard is locked when set to on. |
| | | Bit 3 | A marker box is drawn on the first event of a two-event definition when set to on. |
| | | Bits 4–7 | Reserved (should be set to off—ignored by the 5494). |
| 2 | First Mouse Event (leading edge event) | | The mouse event for a single-event, or the leading edge of a two-event sequence. |
| 3 | Second Mouse Event (trailing edge event) | | This parameter is used if this is a two-event sequence. The mouse event for the trailing edge of a two-event sequence. This parameter is ignored if this is a single-event sequence. |
| 4 | AID to be returned | | The host-defined AID to be returned to the host, when a user completes the single- or two-event sequence. |

*PROGRAMMABLE MOUSE BUTTONS Event Definitions:* These definitions specify mouse events. If none are present, the programmable mouse button table is reset. If multiple event definitions exist for the same event, only the last definition is used. You may not identify the same event as both a single event and the first event of a two-event sequence. A first event may have only one second event. You may not define the same first event a second time with a different second event. However, the same second event may be defined for multiple different first events.

*PROGRAMMABLE MOUSE BUTTONS Parameters:* The programmable mouse buttons parameters are defined as follows:

**Single-Event Definition** This flag specifies whether this definition is for a single event or a two-event sequence. The flag is set to on for a two-event sequence.

**Text Cursor is Moved** This flag should normally be set to on to indicate that the text cursor should be moved to the location of the mouse cursor when the host-defined AID is sent. However, if this flag is set to off, the text cursor is not moved.

**Single Event is Queued** In some cases, an application elects to program two different event definitions for the same button. For example, program a right button down single-event definition and a right button double click single-event definition. Using this example, the keyboard is probably locked when a right button double click occurs because the previous right button event AID was sent to the host. If this flag is set to on for a single-event definition and the keyboard is locked when the mouse event occurs, the AID is queued in the 5494 until the keyboard is unlocked. Using the above example, the application detects the first right button AID, but can ignore this event (based on text cursor position) by unlocking the keyboard again. Or the application can update the display screen and unlock the keyboard. Then, the application detects the right button double click AID and performs some other action. This flag is ignored for two event definitions.

**Draw a Marker Box** This flag is normally set to on for two-event definitions. If this flag is set to on, the user sees the location where the first event occurred. However, if this flag is set to off, no marker box is drawn. This flag is ignored for single-event definitions.

**Mouse Events** The following event values are used in the first and second mouse event parameters. There are 18 mouse events possible: 3 buttons with 3 events; each event (up, down, and double click) two keyboard states (shifted and unshifted). Each mouse event has a corresponding 1-byte value. Reserved values cause the programmable mouse button event definition to be ignored. The mouse event values are:

- X'00'–Reserved
- X'01'–Left button pressed
- X'02'–Left button released
- X'03'–Left button double click
- X'04'–Right button pressed
- X'05'–Right button released
- X'06'–Right button double click
- X'07'–Middle button pressed
- X'08'–Middle button released

- X'09'–Middle button double click
- X'0A'–Shifted left button pressed
- X'0B'–Shifted left button released
- X'0C'–Shifted left button double click
- X'0D'–Shifted right button pressed
- X'0E'–Shifted right button released
- X'0F'–Shifted right button double click
- X'10'–Shifted middle button pressed
- X'11'–Shifted middle button released
- X'12'–Shifted middle button double click
- X'13' through X'FF'–Reserved

**AID to be Returned** The AID associated with a mouse event can be any currently defined AID, or a host-defined AID value between X'70' and X'7F'. Invalid AID values cause the mouse event/AID pair to be ignored.

Also, a new AID is defined: the Programmable Mouse Button Two-Event AID, X'80'. This AID is not specified by the host, but this AID is returned in the inbound data for a two event sequence. See Table 12-31 on page 12-98.

***PROGRAMMABLE MOUSE BUTTONS Operations:*** The table of AIDs associated with mouse events is always cleared when any new Programmable Mouse Button structured field is received. This table is also cleared when any of the following commands are received:

- CLEAR UNIT or CLEAR UNIT ALTERNATE
- RESTORE or RESTORE PARTIAL SCREEN (recreates a previous display screen, including the programmable mouse buttons AID table).

When a mouse event occurs that has been programmed as a single event by using this structured field and no other function has higher priority (such as selecting a selection field choice for an unshifted left button press event), the keyboard is locked, the cursor is optionally moved to the pointer device cursor location, and the specified AID is returned to the host. If the specified AID normally returns inbound entry field data, inbound data entry field is included. The format of the inbound data is like typical inbound data:

*Table 12-30. Format of Single Event Inbound Data*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Row | 1–27 | The row address of the text cursor |
| 2 | Column | 1–132 | The column address of the text cursor |
| 3 | AID | | The host-defined AID for this single event definition |
| 4–n | Field Data | | Optional field data (depending on the host-defined AID and the field MDTs) |

When a programmable two-event definition is specified, inbound data is not returned until the trailing edge event also occurs. When the leading edge event is received, a programmable-two-event state is entered, the mouse cursor location is saved, a marker box is optionally drawn around the location of the mouse cursor on a capable NWS, the mouse color is changed to white on a capable color NWS, and the trailing edge event is located. Such actions as keystrokes or host data streams cancel the programmable-two-event state. Some mouse events are ignored while waiting for the trailing edge. When the trailing edge event is received, the marker box is erased, the mouse cursor color is changed to input inhibited, the keyboard is locked, the text cursor is optionally moved to the location of the mouse cursor, and inbound data returned to the host. If the specified host-defined AID normally returns inbound entry field data, inbound data entry field is included (note that this AID is stored in byte 6 for two-event inbound data).

The format of the two-event inbound data is as follows:

*Table 12-31. Format of Two-Event Inbound Data*

| Byte | Name | Value | Description |
|---|---|---|---|
| 1 | Row | 1–27 | The row address of the text cursor. |
| 2 | Column | 1–132 | The column address of the text cursor. |
| 3 | AID | X'80' | The programmable mouse button two-event AID is returned—this is the only time this AID is returned to the host |
| 4 | Row | 1–27 | The row address of where the first event occurred (leading edge). |
| 5 | Column | 1–132 | The column address of where the first event occurred (leading edge). |
| 6 | AID | | The host-defined AID for this two-event definition. |
| 7–n | Field Data | | Optional field data (depending on the host-defined AID and the field MDTs). |

## WRITE ERROR CODE Command

The AS/400 system issues the WRITE ERROR CODE command to force the keyboard into the pre-help error state. The pre-help error state is the same state that occurs when the workstation operator makes a keying error. The command code is X'21'.

| ESC X'04' | WRITE ERROR CODE X'21' | IC@@ | Data |
|---|---|---|---|

IC @@ Optional insert cursor order

Data Optional data. A maximum of 80 characters for the 5250 workstation, or 132 for an IBM 3180 Model 2, an IBM 3197 Model D or W, an IBM 3477 (all models), or an IBM 3487 (all models), is allowed. The first byte should be an attribute of high-intensity blink and the last byte should be an attribute of nondisplay.

**Note:** A parameter error negative response results if either an IC order or data does not follow the WRITE ERROR CODE command byte.

When the AS/400 system issues this command, processing proceeds as follows:

1. The keyboard enters pre-help error state. In this state, the keyboard clicker is off, the Insert, Diacritic, and Command modes are cleared, and the cursor is blinking. The AS/400 system clears the lock state if the workstation is locked and is not in post-help error state.
2. If an IC order appears in the command, the cursor moves immediately to the specified location. This operation does not affect the system IC address that the WTD command sets. However, all past knowledge of processing at the former cursor location disappears.
3. The 5494 saves data on the error line, including any extended attributes, if the data is not already being used for error presentation. The line is cleared to prepare for writing the error data. If the display is capable of extended attributes, a normal display extended attribute is written to column 1 of the extended attribute plane. Any data found between the command byte and the end of the SNA chain or next escape character, other than the 3-byte IC order, appears on the error line.
4. The 5494 clears any outstanding AID request.

This command alters the normal processing sequence as follows:

- When the command includes an IC order, the cursor responds without regard for the exit criteria normally imposed on fields having self-check capabilities.
- When the workstation operator presses the Help key in the pre-help error state, the 5494 inserts an attribute of high intensity non-blink in column 1 of the error line, regardless of its previous definition.
- When the workstation operator presses the Help key, the 5494 transmits the dezoned, packed bytes from columns 2 through 5 of the error line.

## WRITE ERROR CODE TO WINDOW Command

The AS/400 system issues the WRITE ERROR CODE TO WINDOW command to force the keyboard into the pre-help error state, the same state that occurs when the workstation operator makes a keying error. This command is similar to the WRITE ERROR CODE command except that 2 parameter bytes follow the command that describe the start and end columns. The command code is X'22'.

| | | | |
|---|---|---|---|
| ESC<br>X'04' | WRITE ERROR CODE TO<br>WINDOW<br>X'22' | START<br>COLUMN<br>1 through 131 | END<br>COLUMN<br>2 through 132 |

The WRITE ERROR CODE TO WINDOW command can be used inside of a window. The screen characters to the left and right of the window remain unchanged.

The end column must be greater than the start column. The remaining data has the same format as the WRITE ERROR CODE command data. If the data you send is too large to fit between the specified start and end columns, the data is truncated.

When the 5494 receives a WRITE ERROR CODE TO WINDOW command, it sets the error line to null from the start column to the end column and then writes the message text starting at the specified start column. If the display is capable of extended attributes, a normal display extended attribute is written to the start column of the extended attribute plane.

If a separate display error line is being used (row 25 for a 24 x 80 screen or row 28 for a 27 x 132 screen), the 5494 will return a negative response.

## READ INPUT FIELDS Command

The AS/400 system issues the READ INPUT FIELDS command to the 5494 to initiate input of the data residing in every field defined by the format table. The command code is X'42'.

| | | |
|---|---|---|
| ESC<br>X'04' | READ INPUT<br>X'42' | Control Character<br>2 Bytes |

The format of the control character following the READ INPUT command is identical to that in the WTD command. The 5494 completes the actions indicated by this character after servicing the READ INPUT command.

When the 5494 receives a READ INPUT command, the command remains pending until the workstation operator presses an AID key. Once this requirement has been satisfied, the 5494 services the command and clears the AID request immediately or upon receipt of the next CD bit.

The format of data returned to the AS/400 system in response to a READ INPUT FIELDS command is:

| | | | | |
|---|---|---|---|---|
| Cursor Address In<br>Row/Column FMT<br>2 bytes | AID Code<br>1 byte | Field Data | Field Data | Field Data |

The code immediately after the cursor address indicates the particular AID key pressed by the workstation operator. These codes are defined in Table 13-1 on page 13-5.

When the 5494 returns the data to the AS/400 system, it converts all null fields to blanks. If a field is a signed numeric field, the 5494 checks the last location of the field for a negative sign. If the 5494 detects a negative sign, it changes the zone portion of the second-to-last character of the field to X'D' and strips off the last character of the field.

The workstation sends the complete contents of each field defined in the format table to the AS/400 system in the order that the fields appear in the table. The AS/400 system can alter this order with FCWs that request resequencing.

The starting and ending addresses of each field reside in the format table. All attributes within a field (excluding field boundary markers) are transferred to the AS/400 system along with the actual character codes.

The 5494 does not edit transparent data returned to the AS/400 system, nor does it send any intervening control information. If a field is both transparent and signed numeric, it could affect the accuracy of field data.

A resequencing error occurring while a READ INPUT FIELDS command is active causes the 5494 to issue a corresponding LUSTAT command on the normal LU-LU flow.

## READ MDT FIELDS Command

The AS/400 system issues the READ MDT FIELDS command to read only those format table fields that have the MDT bit on. The MDT bit can be set by the input from a workstation or by the AS/400 system. The command code is X'52'.

| ESC X'04' | READ MDT FIELDS X'52' | Control Character 2 bytes |
|---|---|---|

The format of the control character following the READ MDT FIELDS command is identical to that in the WTD command. The 5494 completes the actions indicated by this character after servicing the READ MDT FIELDS command.

When the 5494 receives a READ MDT FIELDS command, the command remains pending until the workstation operator presses an AID key. Once this requirement has been satisfied, the 5494 services the command and clears the AID request immediately or upon receipt of the next CD bit.

The format of data returned in response to a READ MDT FIELDS command is:

| Cursor Row/ Column 2 bytes | AID Code 1 byte | SBA X'11' | Field Row/ Column 2 bytes | Field Data | SBA X'11' | Field Row/ Column 2 bytes | Field Data |
|---|---|---|---|---|---|---|---|

The cursor address and AID code fields contain the same information as an input data stream for a READ INPUT FIELDS command. However, because this data stream only includes those fields having the MDT bit on, the 5494 inserts an SBA code and the field address before the field data. The SBA codes serve as a delimiter between successive fields, and the field addresses enable the AS/400 system to determine which fields are included in the transmission. The 5494 processes this command as follows:

- The command remains pending until the workstation operator presses the Enter, Roll Up, Roll Down, or Command/PF key (SOH bytes 5 through 7 off).
- For non-transparent fields, the transmission only includes the SBA code and the address. Null data is suppressed.
- Signed numeric fields are configured the same as for a READ INPUT FIELDS command.
- Field resequencing remains the same as for a READ INPUT FIELDS command.

**Note:** When a transparent field is included in the data stream produced in response to a READ MDT FIELDS command, the 5494 changes transmission format as follows:

- The SBA code is replaced by the TD code (X'10').
- The field address is replaced by the TD field length parameter.

An attempt to transmit a field that is both signed numeric and transparent will produce unpredictable results.

**Note:** The inbound SBA is a value of X'04' from an ideographic data type field. The AS/400 SNA LU 7 component converts the SBA back to a value of X'11' before the AS/400 application user receives the inbound data.

## READ MDT ALTERNATE Command

The READ MDT ALTERNATE command is functionally similar to the READ MDT FIELDS command with the following exceptions:

- Leading and embedded nulls within the fields remain nulls. However, trailing nulls are stripped off.
- For fields consisting entirely of nulls, but with the MDT bit on, the 5494 returns only an SBA order followed by the fields address.

The command code is X'82'. See “READ MDT FIELDS Command” on page 12-101 for more information.

| | | |
|---|---|---|
| ESC<br>X'04' | READ MDT ALTERNATE<br>X'82' | Control Character<br>2 bytes |

## READ SCREEN Command

The AS/400 system issues the READ SCREEN command to obtain data currently on the screen. When the 5494 executes this command, it transmits screen data to the AS/400 system from the regeneration buffer without any data conversion or formatting. The command code is X'62'.

| | |
|---|---|
| ESC<br>X'04' | READ SCREEN<br>X'62' |

The 5494 does not clear pending AID requests or queued read commands when it processes the READ SCREEN command. It does lock the keyboard until data transmission is complete.

The 5494 rejects the READ SCREEN command if:

- It is not the last command in the SNA chain.
- The 5494 does not have a CD bit.
- The workstation is in pre-help error, post-help error, system request, or SS message states.

## READ SCREEN WITH EXTENDED ATTRIBUTES Command

The AS/400 system issues the READ SCREEN WITH EXTENDED ATTRIBUTES command to obtain screen data and any non-null extended attributes. A null attribute is X'00'. The command code is X'64'.

| | |
|---|---|
| ESC<br>X'04' | READ SCREEN WITH EXTENDED ATTRIBUTES<br>X'64' |

When the 5494 executes this command, it transmits all data on the display screen with the non-null extended attributes intermixed with the screen data. Trailing nulls on each line are truncated. The end of the line is indicated by the X'FF' end-of-row character. For a non-null extended attribute, the 5494 inserts 3 bytes within the returned data:

| Preceding Screen Data | Attribute ESC X'10' | Extended Attribute Plane | Extended Attribute | Screen Character | Following Screen Data |
|---|---|---|---|---|---|

Attribute Escape (X'10') indicates a non-null extended attribute in the returned data. The valid extended attribute planes are:

X'01' – Extended primary attributes
X'03' – Extended foreground color attributes
X'05' – Extended ideographic attributes.

The valid extended attributes are described under "Write Extended Attribute Order" on page 12-14.

The 5494 does not clear pending AID requests or queued read commands when it processes the READ SCREEN WITH EXTENDED ATTRIBUTES command. The keyboard state is not affected.

The 5494 rejects the READ SCREEN WITH EXTENDED ATTRIBUTES command under the same conditions as it rejects the READ SCREEN command. See "READ SCREEN Command" on page 12-102. The 5494 also rejects the command if the display does not have extended attribute capability.

## READ SCREEN TO PRINT Command

The AS/400 system issues the READ SCREEN TO PRINT command to obtain data currently on the screen. When the 5494 executes this command, it transmits screen data to the AS/400 system from the regeneration buffer with some data conversion. The command code is X'66'.

| ESC X'04' | READ SCREEN TO PRINT X'66' |
|---|---|

The READ SCREEN TO PRINT command is similar to the READ SCREEN command except that the 5494 maps GUI-like characters in the inbound data to their non-GUI-like character defaults (periods, colons). If your NWS has no GUI-like characters, the inbound data format is exactly the same as the READ SCREEN command format.

## READ SCREEN TO PRINT WITH EXTENDED ATTRIBUTES Command

The AS/400 system issues the READ SCREEN TO PRINT WITH EXTENDED ATTRIBUTES command to obtain screen data and any non-null extended attributes. A null attribute is X'00'. The command code is X'68'.

| ESC X'04' | READ SCREEN TO PRINT WITH EXTENDED ATTRIBUTES X'68' |
|---|---|

The READ SCREEN TO PRINT WITH EXTENDED ATTRIBUTES command is similar to the READ SCREEN WITH EXTENDED ATTRIBUTES command except that the 5494 maps GUI-like characters in the inbound data to their non-GUI-like character defaults (periods, colons). If your NWS has no GUI-like characters, the inbound data format is exactly the same as the READ SCREEN WITH EXTENDED ATTRIBUTES command format.

**Note:** The 5494 sends a negative response to the AS/400 system if your NWS does not have extended attribute support.

## READ IMMEDIATE Command

The READ IMMEDIATE command allows the AS/400 system to read the data from all input fields defined in the format table without depending on the workstation operator to press an AID request key. The command code is X'72'.

| ESC X'04' | READ IMMEDIATE X'72' |
|---|---|

Processing for this command is the same as the processing for the READ SCREEN command, with the exception that the READ IMMEDIATE command reads from the format table.

## READ MODIFIED IMMEDIATE ALTERNATE Command

The READ MODIFIED IMMEDIATE ALTERNATE command allows the AS/400 system to read data from modified input fields without depending on the operator to press an AID key. The command code is X'83'.

| ESC X'04' | READ MODIFIED IMMEDIATE ALTERNATE X'83' |
|---|---|

Processing of this command is the same as the processing for the READ IMMEDIATE command, except for the following differences in the format of data sent to the AS/400 system:

- The 5494 only returns data from those fields in the format table that have the MDT bit on.
- The data field is delimited by SBA orders in the same way as the response data field for a READ MDT FIELDS command.
- The leading and embedded nulls within the data for each field are not converted to blanks.
- Trailing nulls within the data for each field are suppressed.

## SAVE SCREEN Command

The AS/400 system issues the SAVE SCREEN command to preserve the current state of an addressed workstation. The specific data included in the input data stream is as follows:

- The contents of the format table
- The contents of the regeneration buffer
- The state of the keyboard
- Keystroke processing history
- The current location and state of the cursor
- The code returned in response to the Help key
- The requirement to send LU-LU LUSTAT command when the error line is available
- Any outstanding AID request
- Any outstanding READ command.

The following data is excluded from the input data stream:

- The condition of the Shift key and the associated indicator
- The state of the Message Waiting indicator
- The requirement to send SS-LU LUSTAT command if the error line is free
- The current status of the Diacritic, Hex Key, and Command Key modes.

When the 5494 processes a SAVE SCREEN command, it transmits an escape character and RESTORE SCREEN command as the first 2 bytes of the input data stream. The format and arrangement of the subsequent data depends upon the specific type of workstation being used, and the AS/400 system must not change this data in any way.

The SAVE SCREEN command does the following compression:

- Screen data (including IBM 3477, 3486, and 3487 extended attribute data). A series of 3 or more of the same characters in the screen image is compressed into a:
  - Flag byte (X'00')
  - Count byte
  - Byte containing the repeated character.

  A series of characters that are not the same is preceded by a count byte.
- Scale line table. The portion of the scale line table in use is returned to the AS/400 system preceded by a count byte.
- Ideographic shift-out/shift-in table. The portion of the ideographic shift-out/shift-in table in use is returned to the AS/400 system. It is preceded by a 2-byte pointer to the beginning of the table.

The command code is X'02'.

| | |
|---|---|
| ESC<br>X'04' | SAVE SCREEN<br>X'02' |

The 5494 rejects the SAVE command if:

- It is not the last command in the SNA chain.
- The 5494 does not have a CD bit.

## SAVE PARTIAL SCREEN Command

The AS/400 system issues the SAVE PARTIAL SCREEN command to preserve the current (partial) state of an addressed workstation. The command code is X'03'.

| ESC X'04' | SAVE PARTIAL SCREEN X'03' | RESERVED X'00' | TOP ROW 00 or 1 through 25 | LEFT COLUMN 00 or 1 through 126 | WINDOW DEPTH 00 or 1 through 25 | WINDOW WIDTH 00 or 1 through 126 |
|---|---|---|---|---|---|---|

RESERVED: Reserved field is set to zero.

TOP ROW: The row position of the window. It is the same value that is specified in the set buffer address (SBA) prior to issuing the CREATE WINDOW structured field. Set this parameter to X'00' if you want the entire display screen to be saved.

LEFT COLUMN: The column position of the window. It is the same value that is specified in the SBA prior to issuing the CREATE WINDOW structured field. Set this parameter to X'00' if you want the entire display screen to be saved.

WINDOW DEPTH: The number of rows inside the window. It is the same value that is specified in the CREATE WINDOW structured field. Set this parameter to X'00' if you want the entire display screen to be saved.

WINDOW WIDTH: The number of columns inside the window. It is the same value that is specified in the CREATE WINDOW structured field. Set this parameter to X'00' if you want the entire display screen to be saved.

**Note:** If any of the parameters, top row, left column, window depth, or window width, is zero or invalid, the entire display screen is saved. Currently, the 5494 saves the entire display screen in all cases (ignoring these four parameters). Some 5250 controllers may process these parameters and save only a portion of the display screen if specified in the four parameters.

The SAVE PARTIAL SCREEN command is similar to the SAVE SCREEN command except for:

- The SAVE PARTIAL SCREEN command does not have to be last in the data stream. However, a SAVE SCREEN command, another SAVE PARTIAL SCREEN command, or one of the IMMEDIATE READ commands cannot follow a SAVE PARTIAL SCREEN command.
- The 5494 saves the specified data when the SAVE PARTIAL SCREEN command is found in the data stream; however, it does not return the save data to the AS/400 system until the remainder of the data stream has been processed. This is to improve response time performance. This means that you can work with the updated screen while the save data is being sent to the AS/400 system.

**Note:** There are two AS/400-to-5494 exchanges involved in the save process. The AS/400 system reads the AID code and performs the save. The AS/400 system sends the SAVE PARTIAL SCREEN command with the updated screen. Then the AS/400 system waits for the save data and returns the change direction (CD) bit to the 5494. (The AS/400 application programmer should choose to send another pending read after the save data has been received.)

- The first 2 bytes of the inbound data are Escape and Restore Partial Screen bytes instead of Escape and Restore Screen bytes.
- Five parameter bytes follow the SAVE PARTIAL SCREEN command that define the specific area of the screen that you want to save. For example, a save operation can be done before placing a pop-up menu on the screen (it may be necessary for you to save only the area of the screen that will contain the pop-up menu).

**Warning:** If the SAVE PARTIAL SCREEN command specifies that only a portion of the display should be saved, either the corresponding RESTORE PARTIAL SCREEN command or an entirely new display screen should be sent.

## RESTORE SCREEN Command

The AS/400 system issues the RESTORE SCREEN command to return all data previously stored as the result of the SAVE command. This command restores all aspects of the original workstation state except for the following conditions:

- The condition of the Shift key and the associated indicator is lost.
- The state of the Message Waiting indicator is lost.
- The requirement to send SS-LU LUSTAT command, if the error line is free, is lost.
- The current status of the Diacritic, Hex Key, and Command Key modes are reset.

Data is decompressed as necessary and tables are restructured. Compression format is described under "SAVE SCREEN Command" on page 12-105.

The command code is X'12'. The 5494 rejects a RESTORE SCREEN command if any additional data stream commands follow the restore data.

| | | |
|---|---|---|
| ESC X'04' | RESTORE SCREEN X'12' | Data Previously Stored by SAVE SCREEN Command |

## RESTORE PARTIAL SCREEN Command

The AS/400 system issues the RESTORE PARTIAL SCREEN command to return all data previously stored as the result of the SAVE PARTIAL SCREEN command. The RESTORE PARTIAL SCREEN command restores all aspects of the original workstation except for the following conditions:

- The condition of the Shift key and the associated indicator is lost.
- The state of the Message Waiting indicator is lost.

- If the error line is free, the requirement to send the SS-LU LUSTAT command is lost.
- The current status of the Diacritic, Hex Key, and Command Key modes are reset.

The command code is X'13'.

| ESC X'04' | RESTORE PARTIAL SCREEN X'13' | LENGTH | Data Previously Stored by SAVE PARTIAL SCREEN Command |
|---|---|---|---|

LENGTH The length of the restored data (including the 2 length bytes).

The RESTORE PARTIAL SCREEN command is similar to the RESTORE SCREEN command except for:

- The RESTORE PARTIAL SCREEN command does not have to be last in the data stream. This enhances response time performance.
- The length parameter follows the RESTORE PARTIAL SCREEN command and specifies the length of the restored data (including the 2 length bytes).

The RESTORE PARTIAL SCREEN command should always be the first command in the data stream (SNA chain).

## ROLL Command

The ROLL command allows lines to be rolled on the screen. The direction and number of lines rolled are specified by the parameters following the ROLL command. The command will be rejected with a state error if the addressed display is in pre-help error, post-help error, system request, or SS message state. For an IBM 3180 Model 2, an IBM 3197 Model D or W, an IBM 3477 (all models), an IBM 3486 (all models), or an IBM 3487 (all models) that do not have the message line selected, state errors are generated in the same way as for 5250 workstations. If the message line is selected, then state errors are generated only for system request or SS message state. The command code is X'23'.

| ESC X'04' | ROLL X'23' | Parameters 3 bytes |
|---|---|---|

| | | | |
|---|---|---|---|
| Parameter | Byte 1: | Bit 0 | 0 = Roll up<br>1 = Roll down |
| | | Bits 1–2 | Reserved |
| | | Bits 3–7 | Number of lines that the designated area is to be rolled |
| | Byte 2: | Bits 0–7 | Line number defining the top line of the area that will participate in the roll. |
| | Byte 3: | Bits 0–7 | Line number defining the bottom line of the area that will participate in the roll. |

When the 5494 processes a ROLL command, the addressed workstation rolls the screen display up or down by the number of lines indicated in the command. Although this command does not clear any pending AID requests, affect the state of the keyboard, or change the position of the cursor, the following considerations limit its use:

- Lines vacated due to ROLL command are not cleared to nulls.
- This command does not change the format table. Consequently, the ROLL command should be avoided when it could produce discrepancies between the format table and the display.
- Data rolled out of the roll area is lost.
- If bits 3 through 7 of the ROLL command are all 0, command processing results in no change to the display.

The following conditions cause parameter errors:

1. A top line of zero
2. A bottom line greater than the number of display lines, excluding IBM 3180 Model 2, IBM 3197 Models D and W, IBM 3477 (all models), IBM 3486 (all models), and IBM 3487 (all models) message lines
3. A top line greater than or equal to the bottom line
4. Roll area greater than bottom line minus top line.

## WRITE SINGLE STRUCTURED FIELD Command

The WRITE SINGLE STRUCTURED FIELD (WSSF) command is available in DP mode only. The command code is X'F4'.

| | |
|---|---|
| ESC<br>X'04' | WSSF<br>X'F4' |

A WSFF command must be coded after the X'04F4' sequence in the outbound data stream. Unlike the WSF command (X'F3'), a WSSF does not have to be the last command in the outbound SNA chain.

## 5250 WSC CUSTOMIZATION Command

The 5250 WSC CUSTOMIZATION command allows the AS/400 system to customize 5494 functions. This is the only command that can be used with a WSSF command. This command remains in effect for any given function until:

- The 5494 receives another 5250 WSC CUSTOMIZATION command that changes the customization of the function.
- The operator changes customization of the function through local keyboard operations.
- The workstation is turned off and on again.

Table 12-32 shows the structure of this command and defines the function of each field. Table 12-33 and Table 12-34 show the format of the keystroke buffering control minor structure and the cursor control minor structure.

*Table 12-32. Format of 5250 WSC CUSTOMIZATION Command Major Structure*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | >X'0008' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'71' | Type code for WSC CUSTOMIZATION command. |
| F1 (1 byte) | | Null flags required. |
| F2 (1 byte) | | Bits 0–6: Reserved; null flags required.<br>Bit 7: Indicates that customization applies to entire 5494 if set to logic 1. Otherwise, customization applies only to workstation receiving command. |

*Table 12-33. Format of Keystroke Buffering Control Minor Structure*

| Field Designation | Value | Function |
|---|---|---|
| L (1 byte) | X'03' | Minor structure field. |
| T (1 byte) | X'01' | Type code for keyboard buffering control minor structure. |
| F (1 byte) | | Bits 0–4: Reserved; null flags required.<br>Bit 5: Indicates change type-ahead state if set to logic 1<br>Bit 6: Indicates type-ahead is on if set to logic 1 (and bit 5 set to 1). If bit 6 is set to 0 and bit 5 is set to 1, type-ahead is turned off. If bit 5 is set to 0, bit 6 is ignored.<br>Bit 7: Indicates that the Attention key is buffered if set to logic 1. (See note.) |

**Note:** Attention key buffering is the default setting in the 5494 and applies only if type-ahead is on (bit 6). If type-ahead is off, the Attention key buffering can be invoked if type-ahead is turned on with the Hex + K key sequence. Customization of Attention key buffering applies only to the workstation receiving the 5250 WSC CUSTOMIZATION command.

*Table 12-34. Format of Cursor Control Minor Structure*

| Field Designation | Value | Function |
|---|---|---|
| L (1 byte) | X'03' | Minor structure field. |
| T (1 byte) | X'02' | Type code for cursor control minor structure. |
| F (1 byte) | | Bits 0–6: Reserved; null flags required.<br>Bit 7: Indicates that the cursor will blink if set to logic 1, regardless of the cursor blink selection made in WCC byte 1. See Table 12-3 on page 12-9. |

## WRITE STRUCTURED FIELD (WSF) Command

The WRITE STRUCTURED FIELD (WSF) command introduces a data field into the SNA flows whose internal structure differs from those previously described. The AS/400 system uses this type of data structure to support the following operations:

- 5250 pass-through display support
- Receipt of 5250 workstation functional information
- Control over workstations during text support operation.

The command code is X'F3'.

| ESC X'04' | WSF X'F3' | Structured Field | Structured Field |
|---|---|---|---|

The format of data returned to the AS/400 system in response to a WSF command is:

| Row | Column | AID Code | Structured Field |
|---|---|---|---|

The contents of the Row, Column, and AID Code fields are determined by the type of information in the structured field. When structured fields are used for text support, the Row and Column fields define cursor location, and the AID Code field indicates which AID key the workstation operator pressed. When cursor location is not relevant to the contents of the structured field, these fields are set to 0 (X'0000'), and the AID Code is used as follows:

- X'FF'–Identifies a pass-through data stream reply
- X'88'–Identifies a 5250 QUERY reply or a 5250 QUERY STATION STATE reply.

The architecture governing structured fields defines several different control fields; the 5494 recognizes the following control fields:

LL – A 2-byte field that identifies the total length of the structured field, including the length bytes.

C – A 1-byte class code that supplies a first level of command identification.

T – A 1-byte type code that supplies a second level of command identification.

P – A 1-byte partition subaddress field (always X'00').

F – A 0- to 3-byte field containing format control flags.

I – A 1-byte field that indicates the revision level of a table identified by the C and T fields.

Any particular structured field is a construct assembled from several control fields and a data field of varying length. The 5494 accepts the following constructs as valid formats for structured fields:

| | | | |
|---|---|---|---|
| LL | C | T | Data Field |

| | | | | |
|---|---|---|---|---|
| LL | C | T | I | Data Field |

| | | | | |
|---|---|---|---|---|
| LL | C | T | F | Data Field |

| | | | | | |
|---|---|---|---|---|---|
| LL | C | T | P | FF | Data Field |

| | | | | | |
|---|---|---|---|---|---|
| LL | C | T | P | FFF | Data Field |

The following sections identify specific functions associated with each of these structured field formats.

Table 12-35 lists the *c* and *t* fields, the description, and the table location of each structured field format. Use the *c* and *t* fields as the index.

*Table 12-35. Structured Field Formats Quick Reference Table*

| c Field | t Field | Description | See |
|---|---|---|---|
| X'D9' | X'30' | DEFINE AUDIT WINDOW TABLE | Table 12-42 on page 12-119 |
| X'D9' | X'31' | DEFINE COMMAND KEY FUNCTION | Table 12-43 on page 12-120 |
| X'D9' | X'32' | READ TEXT SCREEN | Table 12-44 on page 12-121 |
| X'D9' | X'33' | DEFINE PENDING OPERATIONS | Table 12-47 on page 12-122 |
| X'D9' | X'34' | DEFINE TEXT SCREEN FORMAT | Table 12-48 on page 12-123 |
| X'D9' | X'35' | DEFINE SCALE LINE | Table 12-49 on page 12-125 |
| X'D9' | X'36' | WRITE TEXT SCREEN | Table 12-50 on page 12-126 |
| X'D9' | X'37' | DEFINE SPECIAL CHARACTERS | Table 12-52 on page 12-128 |
| X'D9' | X'38' | PENDING DATA | Table 12-53 on page 12-128 |
| X'D9' | X'39' | DEFINE OPERATOR ERROR MESSAGES | Table 12-54 on page 12-130 |
| X'D9' | X'3A' | DEFINE PITCH TABLE | Table 12-55 on page 12-130 |
| X'D9' | X'3B' | DEFINE FAKE DP COMMAND KEY FUNCTION | Table 12-56 on page 12-131 |
| X'D9' | X'3F' | PASS-THROUGH | Table 12-36 on page 12-113 |
| X'D9' | X'70' | 5250 QUERY | Table 12-38 on page 12-114 |
| X'D9' | X'72' | 5250 QUERY STATION STATE | Table 12-40 on page 12-118 |

## Pass-Through Workstation Support

The 5494 can support operation of a 5250 pass-through workstation. This workstation can process keystrokes, maintain a format table, and decode commands received from the AS/400 system. Table 12-36 shows the fields required to support communications and defines the functions.

*Table 12-36. Structure of Pass-Through Commands and Responses*

| Field Designation | Value | Function |
|---|---|---|
| | | PASS-THROUGH Command to 5494 |
| LL (2 bytes) | X'0006' to X'0819' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (2 bytes) | X'3F' | Type code for transfer data from AS/400 system. |
| DATA | | The pass-through data stream consists of a 2-byte LL field followed by up to X'0800' bytes of data. The 5494 does not check either the validity of this LL field or the internal structure of the data field. |
| | | PASS-THROUGH Response to AS/400 system |
| LL (2 bytes) | X'0002' to X'089A' | Total length of response structured field. |
| DATA | | This field contains up to X'0898' bytes of data formatted by the pass-through display. The 5494 does not check the internal structure of this data. |

## 5250 QUERY Command

The AS/400 system issues the 5250 QUERY command to obtain information about the functional capabilities of a 5250 workstation attached to the 5494. When the 5494 receives this command, it returns a 5250 QUERY reply to the AS/400 system.

The 5250 QUERY command is valid for both the DP and WP modes, and it can be sent any time that an attached 5250 workstation is in session with the AS/400 system. When a 5250 QUERY command is sent to a workstation, the AS/400 system must configure the command at the end of an SNA chain, and the LU must receive a CD indication. If the command is sent to a printer, the AS/400 system must configure the command as a single RU with CD. Table 12-37 and Table 12-38 show the structure of 5250 QUERY commands and responses. Table 12-39 shows the contents of a 5250 QUERY response data field.

*Table 12-37. Structure of the 5250 QUERY Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0005' | Total length of structured field |
| C (1 byte) | X'D9' | 5250 structured field command class |
| T (1 byte) | X'70' | Type code for query function |
| F1 (1 byte) | X'00' | Null flags are required |

*Table 12-38. Structure of the 5250 QUERY Response*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'003A' | Total length of structured field |
| C (1 byte) | X'D9' | 5250 structured field command class |
| T (1 byte) | X'70' | Type code for query function |
| F1 (1 byte) | X'80' | Fixed code for a 5250 QUERY response |
| Data Field | | This field contains parameters that define the characteristics of a designated LU. See Table 12-39 for detailed field definitions. |

*Table 12-39 (Page 1 of 4). Structure of the 5250 QUERY Response Data Field*

| Field Designation | Value | Function |
|---|---|---|
| Workstation Control Unit | X'0043' | Identifies the controller as a 5494 |
| Code Level | | Identifies the code release level as:<br>X'040200'–Release 2.0 |
| Reserved field (16 bytes) | | Nulls required |
| Workstation Type Code (1 byte) | | Identifies workstation type as:<br>X'01'–display station<br>X'02'–printer |
| Machine Type Code (4 bytes) | | Contains an EBCDIC code for the machine type |
| Model Number (3 bytes) | | Contains an EBCDIC code for the machine model number |
| Keyboard ID (1 byte) | | Device code for standard 5250 keyboards (X'00' printers) |

*Table 12-39 (Page 2 of 4). Structure of the 5250 QUERY Response Data Field*

| Field Designation | Value | Function |
|---|---|---|
| Extended Keyboard ID (1 byte) | | Device code for extended 5250 keyboards (X'00' for printers) |
| PC Keyboard ID (1 byte) | | Device code for PC keyboards |
| Reserved (1 byte) | | Set to X'00' |
| Serial Number (4 bytes) | | Field for device serial number. This field is set to zero for workstation with no serial number. |
| Input Fields (2 bytes) | X'0100' | Field that indicates the maximum number of input fields available (256). |
| Control Unit Customization (2 bytes) | | Field that indicates customization parameters as:<br>Byte 0<br>• Bit 0: Indicates that the AS/400 system can send a 5250 WSC CUSTOMIZATION command when set to logic 1<br>• Bit 1: Indicates that the AS/400 system can send a 5250 QUERY STATION STATE command when set to logic 1<br>• Bits 2–7: Reserved.<br>Byte 1: Reserved |
| Reserved Field (1 byte) | | Nulls required |
| Device Capabilities (12 bytes) | | This field defines the operating capabilities of the designated LU as:<br>Byte 0 (X'00' for printers)<br>• Bits 0–1: Indicate Row 1/Column 1 support as:<br>B'00' no support<br>B'01' limited support<br>• Bit 2: Indicates the READ MDT ALTERNATE command is supported when set to logic 1<br>• Bit 3: Indicates the workstation and 5494 have PA1 and PA2 support when set to logic 1<br>• Bit 4: Indicates the workstation and 5494 have PA3 support when set to logic 1<br>• Bit 5: Indicates the workstation and 5494 have cursor select support when set to logic 1<br>• Bit 6: Indicates the 5494 has Move Cursor order, Transparent Data order, and Transparent entry field FCW support when set to logic 1<br>• Bit 7: Indicates the READ MODIFIED IMMEDIATE ALTERNATE command is supported when set to logic 1 |

*Table 12-39 (Page 3 of 4). Structure of the 5250 QUERY Response Data Field*

| Field Designation | Value | Function |
| --- | --- | --- |
| | | Byte 1—display screen capabilities<br>• Bits 0–1: Reserved<br>• Bit 2: Indicates 27 x 132 screen size is supported when set to logic 1<br>• Bit 3: Indicates 24 x 80 screen size is supported (always set to logic 1)<br>• Bit 4: Indicates SLP is supported when set to logic 1<br>• Bit 5: Indicates MSR is supported when set to logic 1<br>• Bits 6–7: Define color support as:<br>B'00' monochrome display<br>B'01' color support |
| | | Byte 2<br>• Bit 0: Indicates text symbols support when set to logic 1<br>• Bit 1: Indicates workstation and 5494 have extended primary attribute support in WP mode when set to logic 1<br>• Bits 2–4: Indicate Office Editor/Text support as:<br>B'000' no Office Editor/Text support<br>B'001' single language Office Editor/Text support<br>B'010' dual language Office Editor/Text support<br>• Bit 5: Indicates workstation and 5494 have extended primary attribute support in DP mode when set to logic 1<br>• Bits 6–7: Indicates extended foreground color attribute support<br>B'00' No extended foreground color attribute support<br>B'01' Available in DP mode. Fourteen colors are defined, but only 7 are available. The other 7 colors are mapped into the available colors.<br>B'10' Available in DP mode. Fourteen colors are supported. |
| | | Byte 3<br>• Bits 0–2: Indicate ideographic capability as:<br>B'000' no ideographic capability<br>B'001' ideographic capability for presentation screen only<br>B'010' Presentation screen ideographic capability and extended ideographic attribute support<br>• Bits 3–5: Indicate bidirectional support as:<br>B'000' no bidirectional capability<br>B'001' bidirectional capability<br>• Bit 6: Ideographic SO and SI characters may require an entry in the FFT when set to logic 0. Ideologic SO and SI characters do not require an entry in the FFT when set to logic 1.<br>• Bit 7: Reserved |
| Byte 4<br>Rumba = OE<br>Ref'n = 08 | | Byte 4<br>• Bits 0–2: Indicate graphics capability as:<br>B'000' no graphics capability<br>B'001' 5292-style graphics<br>B'010' GDDM-OS/2 Link Graphics<br>• Bit 3: Indicates extended 3270 data stream capability when set to logic 1<br>• Bit 4: Indicates pointer device (mouse) available when set to logic 1<br>• Bit 5: Indicates GUI-like characters available when set to logic 1<br>• Bit 6: Indicates 5494 supports enhanced user interface commands and FCWs when set to logic 1 (See note.)<br>• Bit 7: Indicates WRITE ERROR CODE TO WINDOW command is supported when set to logic 1. |

Table 12-39 (Page 4 of 4). Structure of the 5250 QUERY Response Data Field

| Field Designation | Value | Function |
|---|---|---|
| | | Byte 5<br>• Bit 0: Indicates the Write Data and Programmable Mouse Buttons structured field commands, the Word Wrap FCW, and ideographic continued entry fields are supported when set to logic 1.<br>• Bit 1: Indicates this is a GUI device that uses all-points-addressable constructs for windows, selection fields, and scroll bars, when set to logic 1.<br>• Bits 2–7: Reserved<br>Bytes 6–9: Reserved<br>Byte 10<br>• Bit 0: Indicates printer type as:<br>B'0' SCS printer<br>B'1' IPDS printer<br>• Bits 1–7: Reserved<br>Byte 11: Reserved |

**Note:**

The commands include:

- CREATE WINDOW Structured Field
- UNRESTRICTED WINDOW CURSOR MOVEMENT Structured Field
- DEFINE SELECTION FIELD Structured Field
- DEFINE SCROLL BAR FIELD Structured Field
- REMOVE ALL GUI CONSTRUCTS Structured Field
- REMOVE GUI WINDOW Structured Field
- REMOVE GUI SELECTION FIELD Structured Field
- REMOVE GUI SCROLL BAR FIELD Structured Field
- READ SCREEN TO PRINT Command
- READ SCREEN TO PRINT WITH EXTENDED ATTRIBUTES Command
- WRITE ERROR CODE TO WINDOW Command
- SAVE PARTIAL SCREEN Command
- RESTORE PARTIAL SCREEN Command.

The FCWs include:

- Continued
- Cursor Progression
- Highlighted
- Mouse Selection.

## 5250 QUERY STATION STATE Command

The AS/400 system issues the 5250 QUERY STATION STATE command to obtain information about the customization state of the addressed workstation. When the 5494 receives this command, it returns a 5250 QUERY STATION STATE reply to the AS/400 system.

The 5250 QUERY STATION STATE command is valid for both the DP and WP modes, and it can be sent any time that an attached 5250 device is in session with the AS/400 system. When a 5250 QUERY STATION STATE command is sent to a workstation, the AS/400 system must configure the command at the end of an SNA chain, and the LU must receive a CD indication. Table 12-40 on page 12-118 shows the structure of the 5250 QUERY STATION STATE command. Table 12-41 shows the structure of the 5250 QUERY STATION STATE response. The response is in the same format as the 5250 WSC CUSTOMIZATION command, so the data can be used to restore any customization parameters at a later time if desired.

*Table 12-40. Structure of the 5250 QUERY STATION STATE Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0006' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'72' | Query station state command type. |
| F1 (2 bytes) | Bit 0 | Must be set to off to indicate this is the command. If set to on, a negative response X'1005 0112' is returned. |
| | Bits 1–14 | Reserved (must be off). |
| | Bit 15 | Indicates to return all customization states when set to logic 1. If set to off, only the Keystroke Buffering Control Minor Structure is returned. In addition to state information, bit 5 of byte 3 of the Keystroke Buffering Control Minor Structure is set to logic 1 to make sure the type ahead state is updated if the 5250 QUERY STATION STATE response data is used later in a 5250 WSC CUSTOMIZATION command. |

*Table 12-41. Structure of the 5250 QUERY STATION STATE Response*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | ≥X'0009' | Total length of structured field and all minor structures. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'72' | Query station state command type. |
| F1 (2 bytes) | X'8000' | Fixed code for a 5250 QUERY STATION STATE response. |
| Data Field | | This field contains one or more customization minor structures, returned in the same format as specified for the 5250 WSC CUSTOMIZATION command. See "5250 WSC CUSTOMIZATION Command" on page 12-109 for more information about the 5250 WSC CUSTOMIZATION command. |

# Text Support Data Streams

The text support function requires that the AS/400 system support DisplayWrite software. This software uses structured fields to control most aspects of workstation operation. The following sections describe the function of each structured field associated with the text support data stream.

## DEFINE AUDIT WINDOW TABLE Command

The DEFINE AUDIT WINDOW TABLE command determines the contents of audit window messages and the character associated with each message. When a workstation cursor is positioned under one of these characters, the 5494 transmits the appropriate message to the audit window of that workstation. Because the 5494 maintains only one audit window table, changing a table entry affects all displays.

**Note:** The 5494 actually maintains two tables, one for the primary language and one for the secondary language. These tables contain the same information but in different languages.

Table 12-42 shows the structure of this command and defines the function of each field.

*Table 12-42. Structure of the DEFINE AUDIT WINDOW TABLE Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0005' to X'0204' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'30' | Type code for audit window parameters. |
| ID (1 byte) | X'00' to X'7F' | Indicates if update of primary audit window table is necessary. If this byte matches the ID of the existing primary audit window table, the rest of this command is discarded. |
| | X'80' to X'FE' | Indicates if update of secondary audit window table is necessary. If this byte matches the ID of the existing secondary audit window table, the rest of this command is discarded. |
| | X'FF' | Indicates the value of the ID bytes set by the 5494 when the table is built initially. If an ID value of X'FF' is received, both the primary and secondary tables are initially emptied. Updates occur only if this byte does not match the existing audit window table ID. |
| Table Entries | | Each table entry consists of a 1-byte L-field, a 1-byte character code, and up to 20 bytes of message text. These entries determine the characters and messages that appear in the audit window on the workstation screen. |
| L (1 byte) | X'02' to X'16' | Total length of single table entry. |
| Character (1 byte) | | This field defines a single character to be entered in AUDIT WINDOW TABLE. |
| Message (0 to 20 bytes) | | This field contains the text to be displayed in audit window. |

## DEFINE COMMAND KEY FUNCTION Command

The DEFINE COMMAND KEY FUNCTION command assigns specific functions to the Home key, the Del key, and the top row of command keys on the workstation keyboard. The 5494 uses this command to build a table in which key codes are associated with one of seven functions. Because the 5494 maintains only a single command key function table, changing a table entry affects all attached workstations.

**Note:** The 5494 actually maintains two tables, one for the primary language and one for the secondary language. These tables contain the same information but in different languages.

Table 12-43 shows the structure of this command and defines the function of each field.

*Table 12-43. Structure of the DEFINE COMMAND KEY FUNCTION Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0005' to X'0184' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'31' | Type code for Command key function data. |
| ID (1 byte) | X'00' to X'7F' | Indicates if update of primary command key function table is necessary. If this byte matches the ID of the existing primary command key function table, the rest of this command is discarded. |
| | X'80' to X'FE' | Indicates if update of secondary command key function table is necessary. If this byte matches the ID of the existing secondary command key function table, the rest of this command is discarded. |
| | X'FF' | Indicates the value of the ID bytes set by the 5494 when the table is built initially. If an ID value of X'FF' is received, both the primary and secondary tables are initially emptied. Updates occur only if this byte does not match the existing command key function table ID. |
| Table Entries | | Each table entry defines the function of a single Command key. |
| L (1 byte) | X'03' to X'52' | Total length of a single table entry. |
| Key Code (1 byte) | | Supplies the ID code for the Command key whose function is being set. Key codes are:<br>• X'01' to X'18'–Command key number<br>• X'FB'–Symbols Support (Cmd + A) message<br>• X'FC'–Formatted text usage<br>• X'FD'–Stop code advance key<br>• X'FE'–Del key<br>• X'FF'–Home key |
| Function Code (1 byte) | | Assigns a specific function to the selected command as:<br>• X'01'–Perform general prompt<br>• X'02'–Perform locate<br>• X'03'–Perform copy text<br>• X'04'–Perform move text<br>• X'05'–Perform delete text<br>• X'06'–Perform hyphenate text<br>• X'07'–Display AS/400 system-defined prompt line message |
| \| Prompt Text (0–79 bytes) | | Message text to be displayed on prompt line. |

## READ TEXT SCREEN Command

The AS/400 system uses the READ TEXT SCREEN command to initiate transfer of text data from a workstation during WP mode operation. When the 5494 receives this command, it ordinarily remains pending until the operator presses an AID-generating key. However, if the Continuous Insert mode is active at the workstation, the 5494 generates the AID request internally. Table 12-44 on page 12-121 and Table 12-45 on page 12-121 show the general structure of READ TEXT SCREEN commands and responses. Table 12-46 on page 12-121 shows the internal structure of the READ TEXT SCREEN response data field.

*Table 12-44. Structure of the READ TEXT SCREEN Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0008' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'32' | Type code for read text screen data. |
| P (1 byte) | X'00' | Partition code. |
| F1 (1 byte) | X'80' | This flag indicates that:<br>• The data field is in IBM 5250 line format.<br>• The structured field command form is used.<br>• Command pending format is used.<br>• No pending data is included with the command. |
| FF (2 bytes) | X'0000' | Null flags bits are required. |

*Table 12-45. Structure of the READ TEXT SCREEN Response*

| Field Designation | Value | Function |
|---|---|---|
| Cursor Position (2 bytes) | X'rrcc' | Identifies the cursor row (rr) and column (cc). |
| AID (1 byte) | | Identifies AID that satisfied READ. |
| LL (2 bytes) | ≥X'000C' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'32' | Type code for read text screen data. |
| P (1 byte) | X'00' | Partition code. |
| F1 (1 byte) | B'110z0000' | This flag indicates that the read data is contained in a structured field and presented in IBM 5250 line format. The value of z (bit 3) is set to logic 1 when pending data is included after the line data field. |
| FF (2 bytes) | X'0000' | Null flag required. |
| Home Position (4 bytes) | | This field contains the row and column address for the home position. |
| Line Data | | This field contains modified line data read from the screen. See Table 12-46 for field definitions. |

*Table 12-46 (Page 1 of 2). Structure of the READ TEXT SCREEN Response Line Data*

| Field Designation | Function |
|---|---|
| L (1 or 2 bytes) | Indicates the length of the line data field. It is 2 bytes for all displays with extended attribute ability and 1 byte for all others and includes the length byte or bytes. |
| FF (2 bytes) | Contains the same flag bits as F1 and F2 of the WRITE TEXT SCREEN command line data. |
| Row (2 bytes) | Identifies the physical row where this line of data is located. Its value is from X'01' to the screen height. |
| F3 (1 byte) | Contains the same flag bits as F3 of the WRITE TEXT SCREEN command line data. |
| Page Number (2 bytes) | Identifies the document page number that contains this line of data. |

*Table 12-46 (Page 2 of 2). Structure of the READ TEXT SCREEN Response Line Data*

| Field Designation | Function |
|---|---|
| Line ID (3 bytes) | Identifies this line of data to the AS/400 system. |
| Left Margin Offset (1 byte) | Indicates the effective left margin of this line of data. Its value is from X'00' to X'nn', where *nn* = right margin – left margin – 1. |
| Indent Offset (1 byte) | Contains the same value as the indent offset parameter in the WRITE TEXT SCREEN command. Its value is from X'00' to X'nn', where *nn* = right margin – left margin – left margin offset – 1. |
| Scale Line ID (1 byte) | Identifies the scale line associated with this line of data. |
| Line Image | Data on screen at a specified row. This field may also contain control data. |

## DEFINE PENDING OPERATIONS Command

The AS/400 system uses the DEFINE PENDING OPERATIONS command to transmit information about the operating state to the 5494 for a specific workstation. Table 12-47 shows the structure of this command and defines the function of each field.

*Table 12-47. Structure of the DEFINE PENDING OPERATIONS Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0007' or X'000E' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'33' | Type code for pending operations data. |
| P (1 byte) | X'00' | Partition code. |
| F1 (1 byte) | | The bits in this field control the following WP mode functions:<br>Bit 0 Enables the Insert mode when this bit is set to logic 1.<br>Bit 1 Enables the Locate mode when this bit is set to logic 1.<br>Bit 2 Determines whether the 5494 or the AS/400 system controls the text delete function. When this bit is set to logic 1, the AS/400 system controls text delete.<br>Bit 3 Determines how the 5494 responds to the Error Reset key. If this bit is set to logic 1, the 5494 responds by locking the workstation keyboard and sending an X'4E' AID request to the AS/400 system.<br>Bit 4 Determines if the 5494 notifies the AS/400 system on completion of a copy, move, or delete operation. When this bit is set to logic 1, host notification is required.<br>Bit 5 Enables AS/400 system assisted locate function when this bit is set to logic 1.<br>Bit 6 Enables tab function independent of shift status when this bit is set to logic 1.<br>Bit 7 0 = Insert mode is reset by Error Reset key.<br>1 = Insert mode is toggled by the Insert key. |
| F2 (1 byte) | X'00'<br>X'80' | Copy, move, or delete is not pending.<br>Copy, move, or delete is pending. |
| Displaced Characters (3 bytes) | | Contains codes for any character that was displaced during a copy, move, or delete operation. |
| Start Location (4 bytes) | | Contains the row and column address for the starting position for a copy, move, or delete operation. |

## DEFINE TEXT SCREEN FORMAT Command

The AS/400 system uses the DEFINE TEXT SCREEN FORMAT command to clear any outstanding error conditions and place a workstation in the WP mode. This command must precede all other WP commands. Table 12-48 shows the structure of this command and defines the function of each field.

*Table 12-48 (Page 1 of 2). Structure of the DEFINE TEXT SCREEN FORMAT Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0007'<br>X'0009'<br>X'000B'<br>X'000C'<br>X'000D'<br>X'000E' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'34' | Type code for a WP screen. This code causes the 5494 to enter WP mode operation. |
| P (1 byte) | X'00' | Null partition code required. |
| F1 (1 byte) | | Indicates the current status of text screen functions as:<br>Bit 0 — 0 = Column edit is not active; 1 = Column edit active<br>Bit 1 — 0 = No data outside left margin; 1 = Data exists outside left margin<br>Bit 2 — 0 = No data outside right margin; 1 = Data exists outside right margin<br>Bit 3 — 0 = No cursor-sensitive scrolling active; 1 = Cursor-sensitive scrolling active<br>Bit 4 — 0 = No fake DP mode active; 1 = Fake DP mode active<br>Bit 5 — 0 = Clear screen as normal; 1 = Do not clear screen<br>Bit 6 — 0 = Document orientation is left to right; 1 = Document orientation is right to left<br>Bit 7 — 0 = Host has bi-directional (BIDI) support; 1 = Host does not have BIDI support. |

Table 12-48 (Page 2 of 2). Structure of the DEFINE TEXT SCREEN FORMAT Command

| Field Designation | Value | Function |
|---|---|---|
| F2 (1 byte) | | Supplies information about the AS/400 system as:<br>Bit 0 — 0 = Data stream from S/36 system.<br>1 = Data stream from AS/400 system.<br>Bit 1 — 0 = The screen data in READ and WRITE commands does not have extended attributes.<br>1 = The screen data does have extended attributes.<br>Bit 2 — 0 = OfficeVision/400* edit session<br>1 = WordPerfect/400* edit session<br>Bit 3 — 0 = Primary language tables should be used.<br>1 = Secondary language tables should be used.<br>Bits 4–7 — AS/400 system release level.<br>• B'0000'–Reserved<br>• B'0001'–AS/400 System Release 1.0<br>• B'0010'–AS/400 System Release 1.2<br>• B'0011'–AS/400 System Release 1.4<br>• B'0100'–AS/400 System Release 2.0<br>• B'0101'–AS/400 System Release 3.0<br>• B'0110'–AS/400 System Version 2 Release 1.0<br>• B'0111'–AS/400 System Version 2 Release 1.1<br>• B'1000'–AS/400 System Version 2 Release 2.0<br>• B'1001'–AS/400 System Version 2 Release 3.0<br>• B'1010'–B'1111' Reserved. |
| Text Body Height (2 bytes) | | Indicates the number of rows in the body of the text. Its value is from X'0005' to X'nnnn', where *nnnn*=screen height – row containing the first line of text. |
| Text Body Width (2 bytes)<br>or<br>Status Line Row (1 byte)<br>Scale Line Row (1 byte) | | **AS/400 Releases before Version 2 Release 3.0**: Indicates the width of text body in columns. These bytes are ignored by the 5494.<br>**AS/400 Release Version 2 Release 3.0 and higher**: Indicates the row to be used for display of the status line and scale line. If either is set to X'00', this line is not displayed.<br>**Note:** WordPerfect/400* editor always sets these bytes to X'00'. |
| Line Cmd Field Size (1 byte) | | Indicates the number of column positions in LINE command fields. Its value is from X'00' to X'nn', where *nn*=screen width – X'05'. |
| Location of Pitch (1 byte) | | Indicates the location of the pitch indicator on the status line. Its value is from X'01' to X'nn', where *nn*=screen width – X'05'. |
| First Line in Text Body (1 byte) | | Indicates the row number of the first line in the text body. |

## DEFINE SCALE LINE Command

The AS/400 system uses the DEFINE SCALE LINE command to control the scale lines of attached workstations. Each time the 5494 receives this command, it clears all scale lines for the specified workstation. As a result, defining a single scale line requires redefining all scale lines for that workstation. Table 12-49 on page 12-125 shows the structure of this command and defines the function of each field.

Table 12-49. Structure of the DEFINE SCALE LINE Command

| Field Designation | Value | Function |
|---|---|---|
| LL (1 byte) | X'0008' to X'0197' | Total length of structured field including length byte. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'35' | Type code for scale line parameters. |
| P (1 byte) | X'00' | Null partition code required. |
| F1 (1 byte) | X'00' | Null flag required. |
| RTL Offset (1 byte) | | Indicates the offset applied to a right-to-left scale line for displaying on the screen. Its value is X'nn', where *nn*=X'0100' - screen width. This offset is used only by a BIDI AS/400 system. A BIDI AS/400 system sends this byte to the 5494 only if the 5494 is running the text-assist function. Refer to *IBM 5494 Remote Control Unit National Language Support for Arabic* or *IBM 5494 Remote Control Unit National Language Support for Hebrew.* |
| Offset (1 byte) | | Indicates the offset applied to the scale line for display on the screen. Its value is from X'00' to X'nn', where *nn*=X'100' - screen width + LINE command field width + 1. |
| Scale Lines | | This field contains parameters for each scale line defined for the current WP task. |
| L (1 byte) | >X'02' | Indicates the length of a single scale line definition including length byte. |
| F (1 byte) | | Controls scale line symbols as:<br>Bit 0 When this bit is set to logic 1, it suppresses display of the right margin symbol.<br>Bit 1 When this bit is set to logic 1, it suppresses display of the left margin symbol.<br>Bit 2 When this bit is set to logic 1, it causes the indication of a tab stop located off the display if the absolute right margin is not defined.<br>Bits 3–7 Reserved. |
| ID (1 byte) | | Supplies an identification code for each scale line defined. |
| Location (1 byte) | | Identifies the column location of the special character listed in the function field. |
| Function (1 byte) | | Contains the code for the special character in the column position designated in the location field. The location and function fields can be repeated as often as required. The following values print the corresponding characters:<br>X'01' Left margin symbol<br>X'02' Right margin symbol<br>X'03' Left tab symbol<br>X'04' Right tab symbol<br>X'05' Center tab symbol<br>X'06' Decimal align tab symbol<br>X'07' Comma align tab symbol<br>X'08' Colon align tab symbol<br>X'09' Inactive tab stop symbol<br>X'0A' Center of margins symbol<br>X'0B' Paper edge symbol<br>X'0C' Pitch symbol<br>X'0D'–X'FF' Reserved. |

## WRITE TEXT SCREEN Command

The AS/400 system uses the WRITE TEXT SCREEN command to write data to a workstation during WP mode operation. Because the 5494 passes the data stream to the designated workstation without modification, the AS/400 system must supply all formatting parameters. Table 12-50 shows command structure and defines the function of each field. Table 12-51 on page 12-127 shows the structure of the line data field.

*Table 12-50. Structure of the WRITE TEXT SCREEN Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | ≥X'0008' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'36' | Type code for write text screen data. |
| P (1 byte) | X'00' | Null partition code required. |
| F1 (1 byte) | | Controls processing of command parameters as:<br>Bit 0 0 = 3270 format (not supported on 5494).<br>1 = 5250 format.<br>Bit 1 0 = First line in body is an even number of half-spacing units.<br>1 = First line in body is an odd number of half-spacing units.<br>Bit 2 0 = Cursor is not on a line that contains formatted text. No function is performed.<br>1 = Cursor is on a line of formatted text. The 5494 displays text message defined in the Define Command Key table.<br>Bit 3 0 = Do not display the primary attribute<br>1 = Display the primary attribute at the cursor location.<br>Bits 4–7 Reserved. |
| F2 (1 byte) | X'20' | Control flag locks keyboard to inhibit data input before any lines are written to screen. |
| F3 (1 byte) | | Determines display station actions after write operation is completed as:<br>Bit 0 Reserved.<br>Bit 1 Moves cursor to home position when this bit is set to logic 1. It suppresses the function when set to logic 0.<br>Bit 2 Resets Cursor Blinking mode when this bit is set to logic 1. It suppresses the function when set to logic 0.<br>Bit 3 Sets Cursor Blinking mode when this bit is set to logic 1. It suppresses the function when set to logic 0.<br>Bit 4 Resets keyboard locking function when this bit is set to logic 1. It suppresses the function when set to logic 0.<br>Bit 5 Enables audible alarm when this bit is set to logic 1. It suppresses the function when set to logic 0.<br>Bit 6 Resets Message Waiting indicator when this bit is set to logic 1. It suppresses the function when set to logic 0.<br>Bit 7 Sets Message Waiting indicator when this bit is set to logic 1. It suppresses the function when set to logic 0. |
| Home Position (4 bytes) | X'rrrrcccc' | Contains the row (rrrr) and column (cccc) addresses of the home position. |
| Line Data | | This field contains the actual contents to be written to designated fields of the display screen. See Table 12-51 for detailed field definitions. |

*Table 12-51 (Page 1 of 2). Structure of the WRITE TEXT SCREEN Command Line Data*

| Field Designation | Value | Function |
|---|---|---|
| Line Data | | This field contains the actual contents to be written to designated lines of the display screen. |
| L (1 or 2 byte) | | Total length of line data field. Two length bytes are sent with this command if bit 1 of byte F2 in the DEFINE TEXT SCREEN FORMAT command (Table 12-48 on page 12-123) was set to 1 when the text screen was defined. |
| F1 (1 byte) | | Includes the following control flags:<br>Bit 0 Writes nulls to the line before writing data when this bit is set to logic 1.<br>Bit 1 Inhibits changes to text on this line when this bit is set to logic 1.<br>Bit 2 Inhibits all input functions on this line when this bit is set to logic 1.<br>Bit 3 Indicates that this line has been modified by the operator when this bit is set to logic 1.<br>Bit 4 Indicates that the text body has been modified when this bit is set to logic 1.<br>Bit 5 Inhibits the word spill function on this line when this bit is set to logic 1.<br>Bit 6 Spills the last word on this line to the next line when this bit is set to logic 1.<br>Bit 7 Not used. |
| F2 (1 byte) | | Includes the following control flags:<br>Bit 0 Indicates that this row contains formatted text when this bit is set to logic 1.<br>Bit 1 Indicates that a required tab character exists left of absolute left margin when this bit is set to logic 1.<br>Bit 2 Indicates that a tab character exists left of absolute left margin when this bit is set to logic 1.<br>Bit 3 Indicates that a required tab character exists right of absolute right margin when this bit is set to logic 1.<br>Bit 4 Indicates that a tab character exists right of absolute right margin when this bit is set to logic 1.<br>Bits 5–7 Define line spacing in half-spacing units. The maximum value of this parameter is B'111'. |
| Row (2 bytes) | | Indicates the physical row where the line of data is located. |
| F3 (1 byte) | | Includes the following flags:<br>Bit 0 Indicates that line orientation is right to left when this bit is set to logic 1.<br>Bit 1 Indicates that 'begin reverse' exists to the left of left margin when this bit is set to logic 1.<br>Bit 2 Indicates that 'end reverse' exists to the right of right margin when set to logic 1.<br>Bit 3 Reserved.<br>Bit 4 Indicates that a primary attribute exists on the line when set to logic 1.<br>Bit 5 Indicates that an end attribute exists one position to the right of right margin if set to logic 1.<br>Bit 6 Indicates that one or more word underscore control characters (X'1D') exist on the line if set to logic 1.<br>Bit 7 Indicates that one or more half index up or half index down text attributes exist on the line if set to logic 1. |

*Table 12-51 (Page 2 of 2). Structure of the WRITE TEXT SCREEN Command Line Data*

| Field Designation | Value | Function |
|---|---|---|
| Page Number (2 bytes) | | Reserved. |
| Line ID (3 bytes) | | Identifies this line of data to the AS/400 system. |
| Left Margin Offset (1 byte) | | Determines the actual text margin. Its value is from X'00' to X'nn', where *nn* = right margin – left margin – 1. |
| Indent Offset (1 byte) | | Indicates the amount of text indentation caused by required characters to the left of the margin. Its value is from X'00' to X'nn', where *nn* = right margin – left margin – left margin offset – 1. |
| Scale Line ID (1 byte) | | Identifies the scale line associated with this line of data. |
| Line Image | | This field contains 1 byte for each character to be written to the screen. If control characters are intermixed with data, this field can be longer than the screen width. |

## DEFINE SPECIAL CHARACTERS Command

The AS/400 system uses the DEFINE SPECIAL CHARACTERS command to establish an EBCDIC value for a Required Carrier Return character. Table 12-52 shows the command structure and defines the function of each field.

*Table 12-52. Structure of the DEFINE SPECIAL CHARACTERS Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0007' or X'0009' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'37' | Type code for special character data. |
| P (1 byte) | X'00' | Null partition code required. |
| FF (2 bytes) | X'0000' | Null flag required. |
| Symbol Key (1 byte) | | This field contains a value that is paired with an EBCDIC value for the special character to be displayed. The value of X'01' corresponds to the Required Carrier Return symbol. |
| EBCDIC Value (1 byte) | X'06', X'1F', or ≥ X'40' | This field contains the 1-byte EBCDIC value to be displayed. |

## PENDING DATA Response

When the AS/400 system transmits a READ TEXT SCREEN command, the 5494 returns the screen data in a READ TEXT SCREEN response. If bit 3 of the F1 byte in the response is on (logic 1), the response data stream also includes pending data information. Table 12-53 shows the format of this data structure and defines the function of each field.

*Table 12-53 (Page 1 of 2). Structure of the PENDING DATA Response*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0010' | Total length of pending data message. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'38' | Type code for pending data. |

*Table 12-53 (Page 2 of 2). Structure of the PENDING DATA Response*

| Field Designation | Value | Function |
|---|---|---|
| P (1 byte) | X'00' | Null partition code required. |
| F1 (1 byte) | | This byte contains the following status flags:<br>Bit 0 — Indicates that Insert mode is on when this bit is set to logic 1.<br>Bit 1 — Indicates that Locate mode is on when this bit is set to logic 1.<br>Bits 2–3 — Indicate current status of delete text operations. Bit 2 is set to logic 1 when an active operation is completed if the AS/400 system previously requested notification. Bit 3 is set to logic 1 when an active operation is canceled by the operator and the AS/400 system previously requested notification.<br>Bit 4 — Indicates that a delete text operation is currently in progress when this bit is set to logic 1.<br>Bit 5 — Indicates that a copy text operation is currently in progress when this bit is set to logic 1.<br>Bit 6 — Indicates that a move text operation is currently in progress when this bit is set to logic 1.<br>Bit 7 — Indicates that a general prompt is currently active when this bit is set to logic 1. |
| F2 (1 byte) | | This byte contains the following status flags:<br>Bit 0 — Indicates that the + character is used to display half-line spacing for this 5291 display when set to logic 1.<br>Bit 1 — Indicates a primary attribute was displayed at the cursor location when set to logic 1.<br>Bit 2 — Indicates a text attribute was displayed at the cursor location when set to logic 1.<br>Bit 3 — Indicates a primary attribute was displayed at the copy, move, or delete start position when set to logic 1.<br>Bit 4 — Indicates a text attribute was displayed at the copy, move, or delete start position when set to logic 1.<br>Bits 5–7 — Reserved. |
| Displaced Characters (3 bytes) | | Contains codes for any character that was displaced by attributes during a copy, move, or delete operation. |
| Start Location (4 bytes) | | Identifies the row and column where a copy, move, or delete operation starts. |
| Locate Character (1 byte) | | Contains the code for the character to be located during a AS/400 system-assisted locate operation. |
| AID (1 byte) | | Contains the AID code corresponding to the key that invoked a general prompt operation. |

## DEFINE OPERATOR ERROR MESSAGES Command

The AS/400 system uses the DEFINE OPERATOR ERROR MESSAGES command to download error messages to two message tables in the 5494 for messages in two languages. Table 12-54 on page 12-130 shows the structure of this command and defines the function of each field.

Table 12-54. Structure of the DEFINE OPERATOR ERROR MESSAGES Command

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0005' to X'0304' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'39' | Type code for error message data. |
| ID (1 byte) | X'00' to X'7F' | Indicates if update of primary operator error message table is necessary. If this byte matches the ID of the existing primary operator error message table, the rest of this command is discarded. |
| | X'80' to X'FE' | Indicates if update of secondary operator error message table is necessary. If this byte matches the ID of the existing secondary operator error message table, the rest of this command is discarded. |
| | X'FF' | Indicates the value of the ID bytes set by the 5494 when the table is built initially. If an ID value of X'FF' is received, both the primary and secondary tables are initially emptied. Updates occur only if this byte does not match the existing operator error message table ID. |
| Table Entries | | Each table entry defines a single error message. |
| L (1 byte) | X'03' to X'53' | Total length of entry. |
| Error Code (2 bytes) | | Contains the code associated with this message. |
| Message Text | | Contains up to 80 bytes of text to be displayed on the error line when this error is detected. |

## DEFINE PITCH TABLE Command

The AS/400 system uses the DEFINE PITCH TABLE command to control the value that appears in the pitch field of the command line. The 5494 allows two pitch tables for messages in two languages. Table 12-55 shows the structure of this command and defines the function of each field.

Table 12-55. Structure of the DEFINE PITCH TABLE Command

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | X'0005' to X'0055' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'3A' | Type code for pitch table parameters. |
| ID (1 byte) | X'00' to X'7F' | Indicates if update of primary pitch table is necessary. If this byte matches the ID of the existing primary pitch table, the rest of this command is discarded. |
| | X'80' to X'FE' | Indicates if update of secondary pitch table is necessary. If this byte matches the ID of the existing secondary pitch table, the rest of this command is discarded. |
| | X'FF' | Indicates the value of the ID bytes set by the 5494 when the table is built initially. If an ID value of X'FF' is received, both the primary and secondary tables are initially emptied. Updates occur only if this byte does not match the existing operator error message table ID. |
| Table Entries | | Each table entry consists of a 1-byte L-field and a 4-byte EBCDIC code for the value of text pitch that is displayed on the status line. |

## DEFINE FAKE DP COMMAND KEY FUNCTION Command

The AS/400 system uses this command to determine how the 5494 responds to inputs from command keys when the workstation is in the Fake DP mode. The command includes two different data structures. The first of these (F = X'01') defines the function of core area command keys. The second (F = X'02') defines the function of the top row command keys. Table 12-56 shows the structure of this command, and Table 12-57 shows the structure of the data field.

*Table 12-56. Structure of the DEFINE FAKE DP COMMAND KEY FUNCTION Command*

| Field Designation | Value | Function |
|---|---|---|
| LL (2 bytes) | ≥X'0007' | Total length of structured field. |
| C (1 byte) | X'D9' | 5250 structured field command class. |
| T (1 byte) | X'3B' | Type code for Fake DP command definitions. |
| P (1 byte) | X'00' | Null partition code required. |
| FF (2 bytes) | X'0000' | Null flags required. |
| Data Field | | This field defines the functions performed by command keys while the workstation is operating in the Fake DP mode. |

*Table 12-57. Structure of the DEFINE FAKE DP COMMAND KEY FUNCTION Core Area Command Keys*

| Field Designation | Value | Function |
|---|---|---|
| L (1 byte) | X'04' | Total length of core area Command key definitions. |
| F (1 byte) | X'80' | Indicates that the data field defines core area Command key functions. |
| Data Field (2 bytes) | | Controls core area Command key functions as:<br>Bit 0 When this bit is set to logic 1, typing Cmd u (begin underscore) causes the operator error '77'.<br>Bit 1 When this bit is set to logic 1, typing Cmd j (end attribute) causes the operator error '77'.<br>Bit 2 When this bit is set to logic 1, typing Cmd b (begin bold) causes the operator error '77'.<br>Bit 3 When this bit is set to logic 1, typing Cmd w (word underscore) causes the operator error '77'.<br>Bit 4 When this bit is set to logic 1, typing Cmd y (half-index-up) causes the operator error '77'.<br>Bit 5 When this bit is set to logic 1, typing Cmd h (half-index-down) causes the operator error '77'.<br>Bit 6 When this bit is set to logic 1, typing Cmd s (stop code) causes the operator error '77'.<br>Bit 7 When this bit is set to logic 1, typing Cmd space (required space) causes the operator error '77'. |

*Table 12-58 (Page 1 of 2). Structure of the DEFINE FAKE DP COMMAND KEY FUNCTION Top Row Command Keys*

| Field Designation | Value | Function |
|---|---|---|
| L (1 byte) | X'06' | Total length of top row Command key definitions. |
| F (1 byte) | X'40' | Indicates that data field defines top row Command key functions. |

*Table 12-58 (Page 2 of 2). Structure of the DEFINE FAKE DP COMMAND KEY FUNCTION Top Row Command Keys*

| Field Designation | Value | Function |
|---|---|---|
| Data Field (4 bytes) | | Bit 0 through Bit 23 control the operation of the corresponding top row Command key. When one of these bits is set to logic 1, pressing that Command key causes the operator error '77'. Bits 24 through 31 are reserved. |

### Reserved WRITE STRUCTURED FIELD Orders

Suborders D8 20 and D8 21 of the WSF are reserved.

## COPY-TO-PRINTER Command

The COPY-TO-PRINTER command causes the 5494 to copy a screen image from a workstation to a designated printer during customer setup (CSU), concurrent mode operation, or normal sessions with the AS/400 system. During normal sessions, the AS/400 system determines which printer the 5494 uses for output. During CSU or concurrent mode operation, the 5494 uses data from a special input field on the workstation screen to select a printer. The command code is X'16'.

| ESC X'04' | COPY-TO-PRINTER Command X'16' | Printer LSID X'nn' | Max lines per page X'nn' |
|---|---|---|---|

Printer LSID is computed using the formula: (port number x 7)+ station address. If the maximum lines per page parameter is X'00', then the 5494 sets the printer page length equal to the number of lines on the display screen.

## COPY-TO-PRINTER with AS/400 System Participation

If an operator presses the Print key while the workstation is in session with the AS/400 system, the 5494 recognizes the keystroke and sends AID byte X'F6' to the AS/400 system. The AS/400 system then sends the COPY-TO-PRINTER command to the 5494 with the LSID and lines per page specified. If the specified printer is turned off or already in session (LU-LU), the 5494 returns the negative response X'08010200'. If the specified LSID is not a printer, then the 5494 sends negative response X'10050181'. If the LSID is not assigned, the 5494 sends X'10050180'. The AS/400 system must send this command LIC or OIC.

The operator can cancel the copy operation by pressing the Cancel key. The 5494 cancels the operation and sends negative response X'08110200' (X'08110201' if the printer is in error state).

The 5494 uses negative responses rather than the SNA SIGNAL, which is normally used to report printer errors to the AS/400 system.

If the 5494 receives an ACTLU for a printer that is performing a COPY-TO-PRINTER, it then sends a response indicating that the printer is unavailable, followed by LUSTAT X'00010000' when the printer becomes available. The 5494 sends negative response X'08010000' to a BIND for a busy printer, again followed by LUSTAT X'00010000' when the printer is available.

When the copy operation is complete, the 5494 sends a response to the AS/400 system indicating completion. The AS/400 system then returns the workstation to the state it was in before the Print key was pressed. The AS/400 system is responsible for error messages and unlocking the keyboard in the event of hardware errors during the copy.

## COPY-TO-PRINTER without AS/400 System Participation

The 5494 can generate the COPY-TO-PRINTER command internally if no AS/400-to-5494 session is active. This capability allows the operator to copy the CSU screen or a Concurrent Diagnostics screen without the participation of the AS/400 system. The LSID for the printer is supplied from a field on the CSU or Concurrent Diagnostics screen, and X'00' is written in the maximum lines per page byte of the Copy-to-Printer command. If no printer was selected during CSU or Current Diagnostics, the 5494 attempts to locate a printer that is ready to run a print operation. If this attempt fails, the 5494 posts X'520000' to the workstation (X'520001' if the selected LSID is not a printer). The 5494 cancels the print operation and posts X'520002' to the workstation if:

- The printer is in a hardware error state when the operator presses the Print key.
- The printer is turned off or in session with the AS/400 system when the operator presses the Print key.
- The printer is not ready.

The 5494 cancels the print operation and posts X'520003' to the workstation if the operator presses the Cancel key or turns off the printer during the print operation.

The keyboard remains locked during the entire copy operation. If an error occurs, the operator must press the Reset key to continue. This causes the 5494 to clear the error code and unlock the keyboard.

## Continued Processing

Whether the COPY-TO-PRINTER command is received from the AS/400 system or generated internally, the 5494 manages the entire exchange of information from display to printer. After sending the appropriate printer setup commands, the 5494 reads data from the display screen and directs the printer line by line. See Chapter 15, "Printer Data Streams," for a complete description of the printer data streams sent to each type of printer. Refer to the *IBM 5494 Remote Control Unit User's Guide* for all possible error codes and negative responses.

# Chapter 13. Keyboard Functions

This chapter discusses keyboard states and describes key functions.

## States and Modes

The workstation can be in one of several states (conditions) with their accompanying modes (methods of operation). An explanation of each follows this list.

- Hardware error
- Normal locked
- Normal unlocked
  - Command mode
  - Hex mode
  - Diacritic mode
  - Front-face mode
  - Insert mode
  - Replace mode
- Power-on
- Pre-help error
- Post-help error
- SS message
- System request.

## 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 keyboard enters the normal unlocked state (format level 0 selected).

## Normal Locked State

The keyboard enters normal locked state when the workstation operator presses a key that requires AS/400 system attention or when the AS/400 system issues a command that locks the keyboard. These are the valid commands the AS/400 system can use to put the workstation into this state:

- CLEAR UNIT
- CLEAR UNIT ALTERNATE
- CLEAR FORMAT TABLE
- WRITE-TO-DISPLAY (if the format table is altered)
- RESTORE SCREEN (if SAVE SCREEN 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.

Pressing the Sys Req key puts the workstation in the system request state. The operator can exit the normal locked state by:

- Issuing an unlock control character in a AS/400 system command that will unlock the keyboard

- Entering the SS message state
- Issuing an ACTLU, DACTLU, BIND, or UNBIND command.

## Normal Unlocked State

The characteristics of the normal unlocked state are:

- The keyboard is unlocked, the clicker is on, and the Input Inhibited indicator is off.
- Keys that are not valid cause errors.

The keyboard enters the normal unlocked state as follows:

- The AS/400 system sends commands that contain control characters to unlock the keyboard.
- The workstation operator presses the Error Reset key after a keying error.
- The workstation operator does one of the following reset operations when the original operation is initiated during a normal unlocked state:
  - Error reset following a WRITE ERROR CODE command
  - Error reset following a WRITE ERROR CODE TO WINDOW command
  - Error reset following a Sys Req key activation
  - Error reset following an SS message
  - Error reset following a Cmd key activation.

Three modes can be selected within the normal unlocked state: Command mode, Insert mode, and Data mode.

### Command Mode

Command mode only exists on keyboards that have a Cmd key. It is not needed on other keyboards.

The workstation operator selects the Command 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 workstation operator can exit from Command mode by pressing the Error Reset key or any of the top row function keys.

### Insert Mode

The workstation operator selects the Insert mode by pressing the Insert 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 operator presses the Error Reset key to exit this mode.

### Replace Mode

The workstation operator selects the Replace mode by keying, or the programmer selects it with a control character. During this mode, the workstation operator can do any of the normal keying functions; the keyboard clicker is on, the Input Inhibited indicator is off, and the keyboard is unlocked.

## Power-On State

The power-on state occurs between the time the 5494 receives electrical power and the time it enters another state such as the system request state. During this time, the 5494 is in a Free Key mode. Free keying cannot occur if the 5494 is not running. During Free Key mode, all functions that do not require the AS/400 system, but can be performed under the control of the 5494, 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.
- 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 5494 can handle without the AS/400 system are operational. These are functions such as delete, insert, clear, and display.
- Errors result from pressing a function key that requires the AS/400 system.

## Pre-Help Error State

The keyboard enters the pre-help error state when the display station operator makes a keying error. The workstation operator can also enter this error state by receiving the WRITE ERROR CODE or WRITE ERROR CODE TO WINDOW 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 system reference code (SRC) is posted.
- The cursor blinks.

The workstation operator can exit this state by pressing the Error Reset key. This returns the keyboard to its previous state. The workstation operator can also choose to press the Help key and enter the post-help error state.

## Post-Help Error State

The workstation operator selects the post-help error 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 is highlighted.
- A signal is sent to the AS/400 system.

## SS Message State

The keyboard enters the SS message state when the AS/400 system transmits a message (on the SS-LU flow) to the workstation screen. The characteristics of this state are:

- The keyboard is locked, the clicker is off, and the Input Inhibited indicator is on.

- Keys that are not valid are ignored.
- The error line is saved.

The keyboard re-enters the previous state when the workstation operator presses the Error Reset key.

## System Request State

The keyboard enters the system request state when the workstation operator presses the Sys Req key. The characteristics of the system request state are:

- The keyboard is unlocked.
- The error line is saved and filled with null characters.
- Keys that are not valid cause an exit to the error state.

If the system request state is entered from the normal unlocked state by using the Sys Req key, the keyboard re-enters the normal unlocked state when the workstation operator presses the Error Reset key. Otherwise, Input Inhibited remains on.

# Keys

The basic types of keys on both typewriter and data entry keyboards are:

- Alphanumeric keys (typewriter-like in nature; including letters, numbers, and special characters).
- Numeric keys; these are used for typing numeric data only.
- Special function keys:
  - Attention identifier (AID) generating
  - Cursor movement
  - Field exit
  - Signal
  - Special control
  - Special host
  - Diacritic.

**Note:** Some of these keys are combinations of keystrokes on some keyboards. Refer to your workstation operator's guide.

The following sections describe the special function keys.

## AID-Generating Keys

The AID-generating keys generate AID codes, which are transmitted to the AS/400 system in response to the LU-LU READ commands. Valid AID functions are:

- Clear
- Enter/Record Advance (Enter/Rec Adv)
- Help (from non-error state)
- Roll Up and Roll Down
- Print
- Record backspace function

**Note:** Record backspace is not a key; it is a function performed by the workstation operator using the Home key when the cursor is at the home position.

- Auto Enter
- Program Access (PA) 1 through 3 (See "Program Access (PA) 1-3" on page 13-15)
- Command function 1 through 24.

Table 13-1 shows the AID keys and their associated codes for keyboards with 24 PF/Cmd keys. These codes alert the AS/400 system that the 5494 requires some action. The AID 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. Depending on the key that is pressed, the AID code either goes immediately to the AS/400 system if a READ command is pending, or is kept pending until the 5494 receives a READ command. When this happens, the AID code is sent to the AS/400 system in the normal LU-LU flow.

*Table 13-1 (Page 1 of 2). AID Keys and Their Codes*

| Key | Code |
|---|---|
| Clear | BD |
| Enter or Record Adv | F1 |
| Help | F3 |
| Roll Down | F4 |
| Roll Up | F5 |
| Roll Left | D9 |
| Roll Right | DA |
| Print | F6 |
| Record Backspace | F8 |
| SLP Auto Enter | 3F |
| Forward Edge Trigger Auto Enter | 50 |
| PA1 | 6C |
| PA2 | 6E |
| PA3 | 6B |
| Cmd 01 | 31 |
| Cmd 02 | 32 |
| Cmd 03 | 33 |
| Cmd 04 | 34 |
| Cmd 05 | 35 |
| Cmd 06 | 36 |
| Cmd 07 | 37 |
| Cmd 08 | 38 |
| Cmd 09 | 39 |
| Cmd 10 | 3A |
| Cmd 11 | 3B |

*Table 13-1 (Page 2 of 2). AID Keys and Their Codes*

| Key | Code |
|---|---|
| Cmd 12 | 3C |
| Cmd 13 | B1 |
| Cmd 14 | B2 |
| Cmd 15 | B3 |
| Cmd 16 | B4 |
| Cmd 17 | B5 |
| Cmd 18 | B6 |
| Cmd 19 | B7 |
| Cmd 20 | B8 |
| Cmd 21 | B9 |
| Cmd 22 | BA |
| Cmd 23 | BB |
| Cmd 24 | BC |
| Application Use | 70-7F |

## Clear Key

The session environment determines the results of the clear function as follows:

- If the LU is not involved in a session, the Clear key clears the entire display regeneration buffer (fills it with nulls and selects format level 0).
- If the LU is involved in a session, the Clear key issues the AID code X'BD', which requests that the AS/400 system issue a CLEAR UNIT command to the LU to clear the display.

## Enter/Rec Adv Key

In the normal unlocked state, when the workstation operator presses the Enter/Rec Adv key:

1. The 5494 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 workstation operator has begun entering data.) If the requirements of the field have not been satisfied, an error occurs.
2. The 5494 locks the keyboard.
3. If the master MDT bit is on, the 5494 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 5494 sends the cursor address, AID code, and data in the input fields to the AS/400 system. The 5494 formats this data by:

   a. Setting the zones on signed numeric fields

   b. Sending the entire input field and changing nulls to blanks on the READ INPUT command

   c. Stripping trailing nulls from the fields and changing leading and embedded nulls to blanks for the READ MDT command

   d. Resequencing the field as specified by the FCW.

When the AS/400 system unlocks the keyboard, the cursor moves to the address specified by the IC, to the first non-bypass field if no IC is specified, or to row 1, column 1, if neither of these is given.

### Help Key (from Non-Error State)

If the display is not in an operator-error state and the workstation operator presses the Help key, the workstation issues an X'F3' AID byte to the AS/400 system. If, however, the workstation operator presses the Help key after pressing the Cmd key or the Sys Req key, an error results.

### Roll Up and Roll Down Keys

(Page Down = Roll Up, and Page Up = Roll Down.)

These keys send a request to the AS/400 system to roll the information on the display. Roll Up issues AID code X'F5', and Roll Down issues AID code X'F4'. The workstation operator must first press a Shift key, then press the appropriate Roll key.

The following conditions cause errors:

- Using a roll key after the Sys Req key
- Using a roll key after the Cmd key
- Using a roll key when the workstation is in Insert mode.

### Print Key

The Print key informs the 5494 that the workstation operator wants to print the contents of the present display. See "COPY-TO-PRINTER Command" on page 12-132 for more information.

### Record Backspace Function

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 (X'F8') and cursor address are sent to the AS/400 system. The AS/400 system should respond by repeating the writing of the previous record to the display.

### Command Function Keys 1-24

The command function keys are accessed 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.

When the workstation operator presses a command function key in the normal-unlocked state, the 5494:

1. Checks for the completion of mandatory-fill, self-check, and right-adjust fields when the workstation operator is keying in an active field. An active field is one in which the workstation operator has begun entering data.
2. Locks the keyboard.
3. Checks for unentered mandatory-enter fields, positions the cursor where there is such a field, and posts an operator error (if the master MDT bit is on).
4. Sends the cursor address, AID code, and data in the input fields to the AS/400 system (for a READ command and CD). The 5494 formats this data by:
   a. Setting the zones on signed numeric fields
   b. Sending the entire input field and changing nulls to blanks on the READ INPUT command
   c. Stripping trailing nulls from the fields and changing leading and embedded nulls to blanks for the Read MDT command
   d. Resequencing the field as specified by the FCW.

When the AS/400 system unlocks the keyboard, the cursor moves to the address specified by the IC, to the first non-bypass field, or to row 1, column 1, if neither the address specified by the IC nor the first non-bypass field is given.

The associated Cmd AID byte is generated and sent to the AS/400 system preceding the first input field; sending the input fields can be inhibited by coding bytes 5-7 of the SOH order.

## Signal Keys

The signal keys cause the 5494 to send an SNA command to the AS/400 system. These keys are:

- Attn
- Help (from error state).

When the operator presses a signal key, the 5494 sends a SIGNAL command to the AS/400 system.

### Attention Key

The Attention (Attn) key is valid when the keyboard is locked or unlocked. Pressing the key does not affect the state of the keyboard or of the cursor position. The workstation operator uses the Attn key to alert the AS/400 system that a requested function (such as enter) is not being honored.

### Help Key (from Error State)

The workstation operator uses the Help key during an error condition to request that the AS/400 system send data about the error to the display. The 5494 sends a SIGNAL command to the AS/400 system containing columns 2 through 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 workstation operator uses the Help key a second time, bytes 2 through 5 of the error line return to the AS/400 system.

## Special Control Keys

The special control keys and key sequence allow the workstation operator to alter operator-generated information on the display. They do not work when the keyboard is locked. The following are special control keys for workstations (not all apply to every workstation):

- Delete
- Display Mode (key sequence)
- Erase Input
- Error Reset
- Hex
- Home
- Insert
- Shift (Shift Lock on typewriter-like keyboard)
- Alpha (Numeric Shift on data entry keyboards)
- Alternate cursor.

### Delete Key

To use the Delete key, the workstation operator first presses and holds one of the Shift keys, and then presses the Delete key. (On some keyboards, the Delete key can be pressed by itself.) 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

This is not a single key but rather a key sequence. The workstation operator uses the following sequence to enter Display mode:

1. Press the Cmd key.
2. Press and hold the Shift key.
3. Press the leftmost blank key on the top row of the keyboard.

The workstation operator can adjust the display while in the Display mode. Normally, the screen displays light characters on a dark background. Using Display mode, the workstation operator can change this to dark characters on a light background.

**Note:** Display mode is not available on the IBM 5292, 3179, 3180, 3196, or 3197 display stations.

### Erase Input Key

This key works only on the unprotected fields that the workstation operator has modified. When the workstation operator presses either the Shift key along with the Erase Input key, or 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 first input field. The MDT bit remains on.

### Error Reset Key

Depending on the state of the system, pressing the Error Reset key resets one of these states or modes:

- Operator error state
- Command mode
- System request state
- Insert mode.

During these states, using the Error Reset key restores the original data on the error line of the display and resets the state. However, during the operator error state, this key is not operational from the time the workstation operator uses the Help key to the time the workstation operator receives the WRITE ERROR CODE command and contents from the AS/400 system. (The WRITE ERROR CODE command and contents are issued by the AS/400 system in response to the workstation operator using the Help key.)

### Hex Key

On keyboards having a Hex key, hexadecimal codes are entered from the keyboard to generate any EBCDIC characters needed for input or display. The workstation operator:

1. Presses and holds the Alt key, then presses the Hex key.
2. Enters the two-digit hex code for the character to be displayed. Valid entries are X'40' through X'FE'.

On keyboards having a Cmd key, hexadecimal codes are entered from the keyboard to generate any EBCDIC character needed for input or display. The workstation operator:

1. Presses the Cmd key, then presses the key to the right of the Cmd key.
2. Enters the two-digit hex code for the character to be displayed. Valid entries are X'40' through X'FE'.

Characters generated via hex mode are not valid in alphabetic only, numeric only, signal numeric, or digits only field.

**Note:** FF is not a valid hexadecimal combination that can be typed on the workstation. Diacritics entered in this manner cannot be combined with another character.

### Home Key

The Home key moves the cursor to the position specified by the IC address. The IC is in the last WRITE-TO-DISPLAY command. If there is no IC order, the default is to the first non-bypass 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 workstation operator uses the key, the key functions as the record backspace key.

### Insert Key

The Insert key sets the insert state for the field the workstation operator is in. The state must be reset before the workstation operator can leave the field. Pressing the Reset key or pressing the Insert key again resets the state.

### Shift and Shift Lock or Caps Lock Keys

There are two shift keys and one Shift Lock or Caps Lock key on a typewriter-like keyboard. The shift keys not only put the keyboard into an uppershift condition, but also act in conjunction with the Sys Req, Delete, and Roll keys to do special functions.

When pressed, the Shift Lock key sets the keyboard in the uppershift condition, and this condition remains when the key is released. To exit from keyboard shift lock state, the workstation operator must press one of the two shift keys. If the workstation operator presses a shift key along with a special function key, the inhibit downshift function will be enabled. If your keyboard has a Caps Lock key, press this key to get the mono case values of alphabetic characters that are on the keys. To leave Caps Lock mode, press the Caps Lock key again.

### Alpha and Numeric Shift Keys

There are two shift keys on the data entry keyboards. The Alpha Shift key puts the keyboard into lower shift when the workstation 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 uppershift command functions.

There is no shift lock on the data entry keyboards.

### Alternate Cursor

Some displays allow the selection of either the bar-type or block-type cursor. Refer to the workstation operator's guide.

## Special AS/400 System Keys

The special AS/400 system keys are:

- Sys Req
- Test Request.

### Sys Req Key

The Sys Req key allows the display to enter the system request state. The key will not work when the display is in an error or SS state, or when the 5494 is processing a READ, WRITE, ROLL, SAVE, RESTORE, WRITE ERROR, or COPY command. 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.

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 workstation operator presses the Enter/Rec Adv key, the 5494 sends the message to the AS/400 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.

Any replies sent on the SS-LU (FMD) session are posted on the error line. When the workstation 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.

### Test Request Key Sequence

When the 5494 is enabled to access CSU or concurrent diagnostic information the 5494 operator and service personnel use the Test Request key sequence to access CSU and diagnostic routines. The 5494 does not send information or AID codes to the AS/400 system when an operator enters this key sequence.

For specific Test Request key sequences, refer to the *IBM 5494 Remote Control Unit User's Guide*.

## Diacritic Keys

Using a diacritic key places a diacritic (modifying) mark above or below a character to indicate a different sound or meaning for that character.

Various diacritic keys are available. However, the only diacritic marks that can be entered are those that appear on the diacritic keys on the keyboard. Examples of the available diacritics are:

` (Grave Accent)
´ (Acute Accent)
˜ (Tilde)
∧ (Circumflex)
.. (Diaeresis)
Ç (Cedilla)

To enter a diacritic above a character, the workstation operator presses the Diacritic key and then types the character. The 5494 or the AS/400 system then checks to see that the Diacritic key and the character key pressed are a valid combination. Valid combinations vary by country; examples of possible valid combinations are:

| 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 lowercase character) |
| Ç (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.

## Additional Keyboard Functions

The 5494 supports four additional keyboard functions:

- Type-ahead
- Extended graphics
- 3270 local keyboard functions
- Dual keyboard support.

## Type-Ahead

Type-ahead allows a workstation operator to continue typing after the keyboard is locked. Keystrokes entered while the keyboard is locked are saved in a buffer that can hold up to 32 keystrokes. When the keyboard becomes unlocked, these keystrokes are processed before new keystrokes.

The default state for any workstation is type-ahead inactive (no keystrokes are saved when the keyboard is locked). To change from one state to the other, the workstation operator enters Hex mode and presses the K key.

The operator can determine the current state of the workstation by entering Hex mode and pressing the M key. If 1111 is displayed on the error line, type-ahead is active. If 9999 is displayed, type-ahead is inactive.

When the keystroke buffer is full, the workstation enters Buffer Full mode. In this mode, the Input Inhibited indicator is set, and the keyboard clicker is disabled. Only new keystrokes from the Sys Req and Error Reset keys are processed. If a Shift key is pressed, the key is flushed, the alarm sounds, and the keyboard clicks.

The 5494 processes the Sys Req, Error Reset, and Shift keys as:

**Sys Req:** The 5494 processes the Sys Req key whether the display is in Type-Ahead mode, Buffer Full mode, or if keystrokes are being processed from the buffer. In Buffer Full mode, however, the operator must press the Error Reset key prior to the Sys Req key to clear the buffer (if the Sys Req key is accessed through a Shift or Alt key). This is necessary because an input from the Shift or Alt key is flushed in Buffer Full mode and the shifted Sys Req key will not be recognized.

When the operator presses the Sys Req key, Type-Ahead mode is not reset (if set) but the buffer is cleared and the display is put into system request state. All new keystrokes are processed while in system request state even if in Type-Ahead mode. When system request state is reset by pressing the Enter or Error Reset key, normal keystroke processing continues.

**Error Reset:** The Error Reset key is processed whether the display is in Type-Ahead mode, Buffer Full mode, or if keystrokes are being processed from the buffer. When the operator presses the Error Reset key, Type-Ahead mode is not reset. The buffer is cleared and Buffer Full mode is reset (if set). After the 5494 processes the Error Reset key, normal processing of the buffer continues. If Type-Ahead mode is active, new keystrokes are buffered.

**Shift Keys:** The 5494 tracks current status of Numeric and Alpha shift keys for data entry keyboards or left Shift, right Shift, Caps Lock, and Shift Lock keys for data processing keyboards, continuously. The 5494 saves the current state of the left and right Alt keys, the Latin and language keys, and Layer Select, Katakana Shift and Katakana Symbol Shift keys, if they apply to the particular keyboard being used.

The shift indicators and states are kept updated in real time while keys are being buffered. The 5494 updates the current state of these keys (make or break) whenever the buffer is cleared (such as for Sys Req or Error Reset keys, operator errors, the WRITE ERROR command, programming errors, or hard errors) or when Buffer Full mode is reset (after a keystroke space is freed up in the buffer).

This is done because the “break” of these scan codes could be lost while flushing them in Buffer Full mode or clearing the buffer. If the “make” of these keys was already processed, users would be left in the make state when they do not want to be.

## Extended Graphics - Layer 100

The 5494 supports an additional graphic layer on some Enhanced keyboards. This layer is comprised of accents and special characters. It is an addition to the primary layer on the keyboard and is accessed with the Alt + Shift key sequence.

**Note:** This function is not supported on Enhanced keyboards for some countries. Contact your IBM customer service representative for additional information.

## 3270 Local Keyboard Functions

Several 3270 local keyboard functions are available for the 5494. The following IBM keyboards support these functions:

- Typewriter keyboard
- 122-key keyboard
- Enhanced (102-key) keyboard.

IBM Typewriter Data Entry keyboards do not support the 3270 keyboard functions.

3270 keyboard functions are available in DP mode only. If an operator selects any of these functions while in DP mode, operator error 0077 is posted.

When the keyboard is in shift state, an operator can invoke the 3270 keyboard functions only by manual shifting, even if the keyboard is in Caps Lock or Shift Lock state.

The 5494 supports the following 3270 keyboard functions:

- Erase to End of Field (EOF)
- Field Mark
- Cursor Select
- Program Access (PA) 1-3.

### Erase End of Field

The Erase EOF function is valid within any unprotected entry input field. When an operator presses the Erase EOF key:

- All character positions from and including the current cursor position through the end of the field are filled with null characters.
- Any character attributes associated with the nulled characters are reset to their default values.
- The current field MDT bit is set to on.
- The cursor remains in its current position.

If an operator presses the Erase EOF key within a protected field, operator error 0005 is posted.

### Field Mark

The Field Mark function is valid within any unprotected entry input field in which the Dup or Field Mark key is allowed (FFW bit 3 set to on). The 5494 processes Field Mark the same as it does a data character key. The Field Mark character (X'1E') is displayed as an overscore on IBM 3180 and IBM 5251 display stations and as a space on all other supported workstations.

If an operator presses the Field Mark key in an entry field that does not allow the Dup or Field Mark key, operator error 0019 is posted. The Field Mark code point is allowed in an outbound data stream.

### Cursor Select

The Cursor Select function allows an operator to select an input field using the keyboard. This function can be used instead of the selector light pen (SLP) in these fields.

Cursor Select is valid only in selectable fields. If an operator presses the Cursor Select key in a nonselectable field, operator error 0037 is posted. The AS/400 system defines a selectable field by coding an FCW value of X'8102' or X'8103'.

When an operator presses the Cursor Select key from any position on the screen, it is processed the same as an SLP tip switch in that position.

### Program Access (PA) 1-3

The 5494 processes the PA keys the same as it does nondata AID-generating keys such as Help, Print, or Clear. When an operator presses a PA key, one of the following AID codes is returned along with the current cursor address on the normal LU-LU flow:

- PA1-AID X'6C'
- PA2-AID X'6E'
- PA3-AID X'6B'.

No data is returned to the AS/400 system with any PA key AID.

## Dual Keyboard Support

You can attach workstations that support dual keyboards to the 5494. These workstations allow you, when configuring your workstations, to select either a Japanese Katakana keyboard or a U.S. English keyboard without changing the physical keyboard. In Japanese Katakana mode, the 5494 processes scan codes from the display the same as it would for a Katakana typewriter keyboard. In U.S. English mode, the 5494 processes scan codes from the display the same as it would for a U.S. English typewriter keyboard.

# Chapter 14. Display Pointer Device (Mouse) Support

The 3486, 3487 and 3488 displays can attach a pointer device, which is typically a mouse. The mouse functions that are supported by the 5494 are explained in the following sections.

The display has two modes for mouse operations:

- In the normal mode, the display sends events to the 5494 any time a button is pressed or released. In other words, typically the user presses and releases a mouse button and the 5494 receives and acknowledges a button-pressed event and a button-released event.

  The display sends a button double-click event to the 5494 if a button is pressed, released, and pressed again within a user-specified double-click time. In this instance, the 5494 receives and acknowledges a button-pressed event, a button-released event, a button double-click event, and another button-released event.

- In the mouse cursor movement mode, the display sends mouse cursor movement events to the 5494 at a predetermined rate, for example, once every 100ms.

**Note:** The displays have a setup option to switch the functions of the left and right buttons within the display. The 5494 is not involved in this action.

## 5494 Mouse Function Overview

The 5494 provides default processing for the mouse buttons. The following list provides an overview of the functions available. For details on how the functions are processed, see the specific buttons listed in "Event Processing Specifics" on page 14-3.

## Copy and Paste Function

The 5494 provides linear and block mode copy and paste for a display screen in DP mode. Linear and block mode are different if multiple rows are involved in the copy and paste.

- Linear mode copies all the data between the two end points.
- Block mode copies a rectangular area within the two end points.

When the Shift key and the left mouse button are pressed, the mouse cursor marks an end point of the linear data to be copied. The user now moves the mouse cursor while holding down the left button. The bounds of the copy may be continually updated and presented to the user, by drawing lines around the copy data. When the left button is released, the mouse cursor now marks the other end point of the linear copy data. A block copy is performed by pressing the Shift key and double clicking the left mouse button, marking an end point. The other end point of the block copy data is determined when the left button is released.

The marked copy of the data is stored in the 3486, 3487 or 3488 for later use. The user then positions the text cursor (not the mouse cursor) in the entry field where the data is to be pasted. When the user presses the Shift key and the right mouse button, the data previously marked is pasted at the location of the text cursor.

**Note:** Copy data remains in the display buffer until it is replaced with new data or until the display is turned off. It may be pasted to multiple locations if desired by moving the text cursor to a new location and again using the Shift key and the right mouse button.

## Reset Operator Error State Function

If an operator error is displayed, placing the mouse cursor on the operator error line and pressing the left button performs the Reset key function and clears the error.

## Hot Spot Function

Hot spots enable an older application to use the mouse functions without reprogramming. For example, the 5494 attempts to recognize such screen areas as:

- Function key descriptions
- +/– for scrolling
- Menu items

The 5494 returns the appropriate AID and information to the AS/400 when the mouse cursor is positioned on one of these areas and the left button is pressed.

The 5494 also provides an Enter key AID function. When the left button is double clicked, the text cursor is moved to the position of the mouse cursor and the Enter key AID is sent to the AS/400 system.

## Operate Against a Scroll Bar Function

The 5494 provides a Roll AID and cursor repositioning information to the AS/400 system in response to pressing and releasing the left button with the mouse cursor on a scroll bar.

- Pressing the left button on a scroll bar arrow typically causes a one-row or one-column scroll (this is dependent on application support).
- Pressing the left button in the scroll bar shaft, above, below, or beside the scroll bar slider, typically causes a one-page scroll.
- Pressing and holding the left button on the slider enables the mouse cursor to drag the scroll bar slider. When the left button is released, the drop function is performed and the appropriate AID information is sent to the AS/400 system.

## Select an Item in a Selection Field Function

If the mouse cursor is placed on a selection field choice and the left button is pressed, the text cursor is moved to the position of the mouse cursor and the Space Bar selection function is performed.

## Program the Mouse Buttons Function

An AS/400 application program uses the PROGRAMMABLE MOUSE BUTTONS structured field to provide the 5494 with instructions for specific mouse button events. The 5494 processes mouse button events according to the information in the command.

## Light Pen Function

If the mouse cursor is in a light pen field, pressing the left button provides the same function as if a light pen tip switch were activated.

## Position the Text Cursor Function

Pressing the left mouse button can be used to position the text cursor to the location of the mouse cursor.

## Mouse Button Event Processing Exceptions

A mouse button event is ignored by the 5494 if any of the following are true:

- The keyboard is locked, except single-event programmable mouse buttons which may be defined as queued.
- The 5494 does not have a pending read, except single-event programmable mouse buttons which may be defined as queued.
- The keyboard is in system request state or SS message state.
- The keyboard is in operator error state, except left button pressed, which can reset an operator error.
- The 5494 has any stored type-ahead keystrokes.
- The display is in WP mode.

## Event Processing Specifics

The Shift key on the keyboard may be used in conjunction with mouse events. Therefore, there are 18 possible mouse events defined: three buttons (left, right, and center) with three events (press, release, and double click) in two keyboard states (shifted and unshifted).

**Note:** The Shift key or Shift Lock key must be held down for a shifted mouse event. Releasing the Shift key will not reset the Caps Lock state or the Shift Lock state if used for a shifted mouse event.

The 5494 processes these events in the order described under each event. This processing order allows certain default events to take precedence over other default events or application-defined events. Once one of the conditions is satisfied, the processing completes and no further checking is performed.

## Unshifted Left Button Pressed Event Processing

If the Shift key is not pressed and the 5494 receives a left button pressed event, the 5494 determines the position of the mouse cursor and attempts to perform one of the functions described in this section.

1. If the display is in operator error state, and the mouse cursor is on the operator error line, the operator error is reset. Otherwise, the mouse event is ignored in operator error state. This means no further checking is performed.
2. If the mouse cursor is on a selection field choice, the text cursor is moved to the location of the mouse cursor and the function of a Space Bar is performed. If the selection field choice cannot accept the cursor or the choice is null, the text cursor is not moved and operator error 0084 is posted.

3. If the mouse cursor is on a scroll bar, a Roll AID may be sent to the host. If a Roll AID is sent to the host, the field MDT is set to on, the text cursor may be moved to the position of the mouse cursor (if requested in the DEFINE SCROLL BAR FIELD structured field) and the keyboard is locked.

   The scroll bar is made up of a top and bottom arrow (or a right and left arrow), a shaft, and a slider that moves on the shaft. The location of the mouse cursor on the scroll bar determines the action that the 5494 takes when the event occurs:

   - If the mouse cursor is on the shaft above the slider, a Roll Down AID with a scroll increment of X'00000000' is sent to the AS/400. Similarly, if it is below the slider it causes a Roll Up AID, to the left of the slider a Roll Left AID, and to the right of the slider a Roll Right AID.
   - If the mouse cursor is on an arrow character and the slider is not already at the end of the scroll bar, a Roll AID for the correct direction with a scroll increment of X'00000001' is sent to the AS/400. If the slider is already at the end of the scroll bar, the left button pressed event is ignored.
   - If the mouse cursor is on the slider, a drag and drop function is started. The 5494 periodically calculates the row of the mouse cursor and compares this value with the last row that was processed. If the values are different, the scroll bar characters are rewritten by repositioning the slider within the shaft. When the left button is released, the drop function is performed. See "Unshifted Left Button Released Event Processing" on page 14-5 for a description of the drop function. If another mouse button event or keyboard event occurs before the left button is released, the scroll bar is rewritten to the original position and no AID is sent.

4. If the mouse cursor is in a pointer device selection entry field, the text cursor is moved to the position of the mouse cursor, the keyboard is locked, and the specified AID is returned to the AS/400.

5. If the mouse cursor is in a light pen field, the 5494 acknowledges the event as if a light pen tip switch were activated at the position of the mouse cursor.

6. If this event has been programmed using the PROGRAMMABLE MOUSE BUTTONS structured field, the event is handled as described in "PROGRAMMABLE MOUSE BUTTONS Structured Field" on page 12-94.

7. If none of the above conditions is satisfied, the 5494 attempts to provide some simple hot spot functions. Hot spots enable a mouse to assist in driving older applications. To be considered a hot spot, the mouse cursor must not be in an entry field.

   The 5494 attempts to recognize and process the following left-button-pressed events as hot spots:

   - Using command key emulation, the 5494 attempts to recognize the mouse cursor positioned on the command key text (for example, "F12=Cancel"). The keyboard is locked and the specified AID is returned to the host.
   - The 5494 attempts to recognize the mouse cursor positioned on scrolling requests based on a plus (+) or minus (–). In some cases, More –/+ is used to indicate the data is scrollable. If the mouse cursor is on a –, the keyboard is locked and a Roll Down AID is sent to the host. Similarly, if the mouse cursor is on a +, the keyboard is locked and a Roll Up AID is sent to the host.

- The 5494 attempts to recognize the mouse cursor positioned on a menu choice (for example, "2. Office Tasks"). The number is placed in the entry field and an emulated Enter key AID is sent to the host.

  **Note:** The Enter key can also be emulated by a left button double click. See "Unshifted Left Button Double Click Event Processing" on page 14-5.

8. If the mouse cursor was outside a selection field and the pull-down cancel mode is active that is, a selection field was written to the display screen and a pull-down cancel AID was specified in the DEFINE SELECTION FIELD major structure, the text cursor is moved to the position of the mouse cursor, the keyboard is locked, and the specified AID is returned to the host.
9. If none of the preceding conditions is true, the 5494 moves the text cursor to the position of the mouse cursor.

   **Note:** The 5494 allows the text cursor to move to a non-cursorable text location, even if cursor movement to input-capable positions only is set to on.

## Unshifted Left Button Released Event Processing

If the shift key is not pressed and the 5494 receives a left-button-released event, the 5494 determines the position of the mouse cursor and attempts to perform one of the following functions:

1. If the scroll bar slider is being dragged (see "Unshifted Left Button Pressed Event Processing" on page 14-3), this button event results in a drop of the slider. The following may occur depending on mouse cursor position:
   - If the row position of the mouse cursor is different from the row position when the slider was last written, the scroll bar characters are rewritten.
   - If the final slider position (drop position) is different from the slider position when the drag was started, the MDT is set to on, the text cursor may be moved to the scroll bar slider, a Roll AID is sent to the AS/400 with a scroll increment indicating the number of rows or columns to be scrolled, and the keyboard is locked. The specific Roll AID depends on the direction the slider moved. If the slider did not move, no AID is sent.
2. If a copy is active for the copy and paste function, this event is processed as a shifted left button released event (see Step 1 on page 14-6 in "Shifted Left Button Released Event Processing").
3. If this mouse button event has been programmed by using the PROGRAMMABLE MOUSE BUTTONS structured field, the event is handled as described in "PROGRAMMABLE MOUSE BUTTONS Structured Field" on page 12-94.
4. If none of the preceding conditions is met, the 5494 ignores this event.

## Unshifted Left Button Double Click Event Processing

If the shift key is not pressed and the 5494 receives a left-button double-click event, the 5494 determines the position of the mouse cursor and attempts to perform one of the following functions:

1. If this mouse button event has been programmed by using the PROGRAMMABLE MOUSE BUTTONS structured field, the event is handled as described in "PROGRAMMABLE MOUSE BUTTONS Structured Field" on page 12-94.

2. If the previous left-button-pressed event positioned the text cursor (see Step 9 in "Unshifted Left Button Pressed Event Processing"), the keyboard is locked and the Enter AID is sent to the host.

   **Note:** When a user double clicks the left mouse button, the 5494 receives a left-button-pressed event, a left-button-released event, a left-button double-click event, and another left-button released event.

3. If none of the preceding conditions is met, the 5494 ignores this event.

## Shifted Left Button Pressed Event Processing

If the Shift key is pressed and the 5494 receives a left-button-pressed event, the 5494 determines the position of the mouse cursor and attempts to perform one of the following functions:

1. If this mouse button event has been programmed by using the PROGRAMMABLE MOUSE BUTTONS structured field, the event is handled as described in "PROGRAMMABLE MOUSE BUTTONS Structured Field" on page 12-94.

2. The 5494 enters copy state (see copy and paste function in "5494 Mouse Function Overview" on page 14-1). The location of the mouse cursor is marked. This position marks the first of two locations that define the limits of the linear copy data; the locations can be marked in either order. If a keyboard event (other than Shift key release) or another mouse event occurs before the left button is released, copy state is reset.

   **Note:** The 5494 supports copy and paste only on single-byte character set displays (not capable of double-byte mode) with line drawing capability. 3486 and 3487 displays are not capable of double-byte mode and do have line drawing capability.

3. If none of the preceding conditions is met, the 5494 ignores this event.

## Shifted Left Button Released Event Processing

If the Shift key is pressed and the 5494 receives a left-button-released event, the 5494 determines the position of the mouse cursor and attempts to perform one of the following functions:

1. If the 5494 is in copy state (see copy and paste function in "5494 Mouse Function Overview" on page 14-1), the user has now marked the limits of the copy. The copy operation takes place even if the user releases the Shift key before the left button. The marked copy data is stored in the 348x display memory for later use or until the 348x is switched OFF. The type of copy, linear or block, is stored with the copy data, for use during a paste operation.

2. If this mouse button event has been programmed by using the PROGRAMMABLE MOUSE BUTTONS structured field, the event is handled as described in "PROGRAMMABLE MOUSE BUTTONS Structured Field" on page 12-94.

3. If none of the preceding conditions is met, the 5494 ignores this event.

## Shifted Left Button Double Click Event Processing

If the Shift key is pressed and the 5494 receives a left-button double-click event, the 5494 determines the position of the mouse cursor and attempts to perform one of the following functions:

1. If this mouse button event has been programmed by using the PROGRAMMABLE MOUSE BUTTONS structured field, the event is handled as described in "PROGRAMMABLE MOUSE BUTTONS Structured Field" on page 12-94.
2. The 5494 enters copy state (see copy and paste function in "5494 Mouse Function Overview" on page 14-1). The location of the mouse cursor is marked. This position marks the first of two locations that define the limits of the block copy data; the locations can be marked in either order. If a keyboard event (other than Shift key release) or another mouse event occurs before the left button is released, copy state is reset.

   **Note:** The 5494 supports copy and paste only on single-byte character set displays (not capable of double-byte mode) with line drawing capability. The 3486 and 3487 displays are not capable of double-byte mode and do have line drawing capability.
3. If none of the preceding conditions is met, the 5494 ignores this event.

## Shifted Right Button Pressed Event Processing

If the Shift key is pressed and the 5494 receives a right-button-pressed event, the 5494 determines the position of the mouse cursor and attempts to perform one of the following functions:

1. If this button event has been programmed using the PROGRAMMABLE MOUSE BUTTONS structured field, the event is handled as described in "PROGRAMMABLE MOUSE BUTTONS Structured Field" on page 12-94.
2. If user has previously performed a copy operation (see copy and paste function in "5494 Mouse Function Overview" on page 14-1), the 5494 attempts to paste the copied data. The copied data is entered into the entry field at the location of the text cursor (not the mouse cursor). The data is keyed into the entry field in the current keying mode, replace or insert mode, until all the data has been keyed, an operator error occurs, or an AID is sent to the host (paste into an auto-enter field). The 5494 performs the following checks and formats the data:
   - If the text cursor is not in an entry field, operator error X'0005' is posted.
   - The 5494 reads in the data from the display buffer.
   - Data following a non-display attribute is converted to blanks until another attribute is found.
   - Many code points less than X'40' (for example, attributes and GUI-like characters) are converted to blanks.
   - The 5494 then begins keying the copy data into the entry field, at the text cursor position. The 5494 performs normal field checks, such as numeric only or alpha only. This can result in an operator error.
   - If the field is a monocase field, the data is changed to monocase.

- If the copy data is block copy data, each line is pasted. At the end of each line, the text cursor is repositioned on the next line within an entry field, at the column position where the first line of copy data was pasted.

3. If none of the preceding conditions is met, the 5494 ignores this event.

## Other Mouse Button Events

1. If the mouse button event has been programmed by using the PROGRAMMABLE MOUSE BUTTONS structured field, the event is handled as described in "PROGRAMMABLE MOUSE BUTTONS Structured Field" on page 12-94.
2. If the preceding condition is not met, the 5494 ignores this event.

# Chapter 15. Printer Data Streams

The 5494 supports both Intelligent Printer Data Stream (IPDS) and SNA Character String (SCS) printers. The AS/400 system sends printer data streams consisting of control characters, commands, and the data required to print one or more lines of text. All standard printing functions are passed to the printer without parsing.

**Note:** IBM assures program transparency for different printer types only when all printers attached to the 5494 respond to the same command set. Refer to the documentation for specific printers to obtain complete definitions for their commands.

## Intelligent Printer Data Stream

Although the 5494 normally passes the IPDS through to the printer without parsing, it does monitor the data stream for two commands:

- READ MULTIPLE STATUS (X'0047 0100')
- RESET MULTIPLE STATUS (X'0047 0000').

These two commands regulate transfer of data from a status buffer in the printer to the AS/400 system. When the printer detects an error condition, it routes a single status byte (X'60') to the 5494 through the twinaxial interface. The status message prompts the 5494 to place a negative response of X'1005 0260' into the normal LU-LU flow for transmission to the AS/400 system. The AS/400 system then sends the READ MULTIPLE STATUS command to the printer through the 5494. As a result of this exchange, the printer sends 256 bytes of status data to the 5494 for transmission for the AS/400 system. When the exchange has been completed, the AS/400 system issues the RESET MULTIPLE STATUS command, which returns the printer to the normal mode of operation.

## SNA Character String

Because SCS printers respond directly to the data stream assembled by the AS/400 system, the 5494 passes the data to the addressed printer without parsing. If a failure condition is detected, the 5494 returns a negative response to the AS/400 system on the normal LU-LU flow.

# Chapter 16. Communications Interfaces

The 5494 supports the following communications interfaces to the modem or DCE:

- ANSI-EIA 232D
- CCITT X.21
- CCITT V.35.

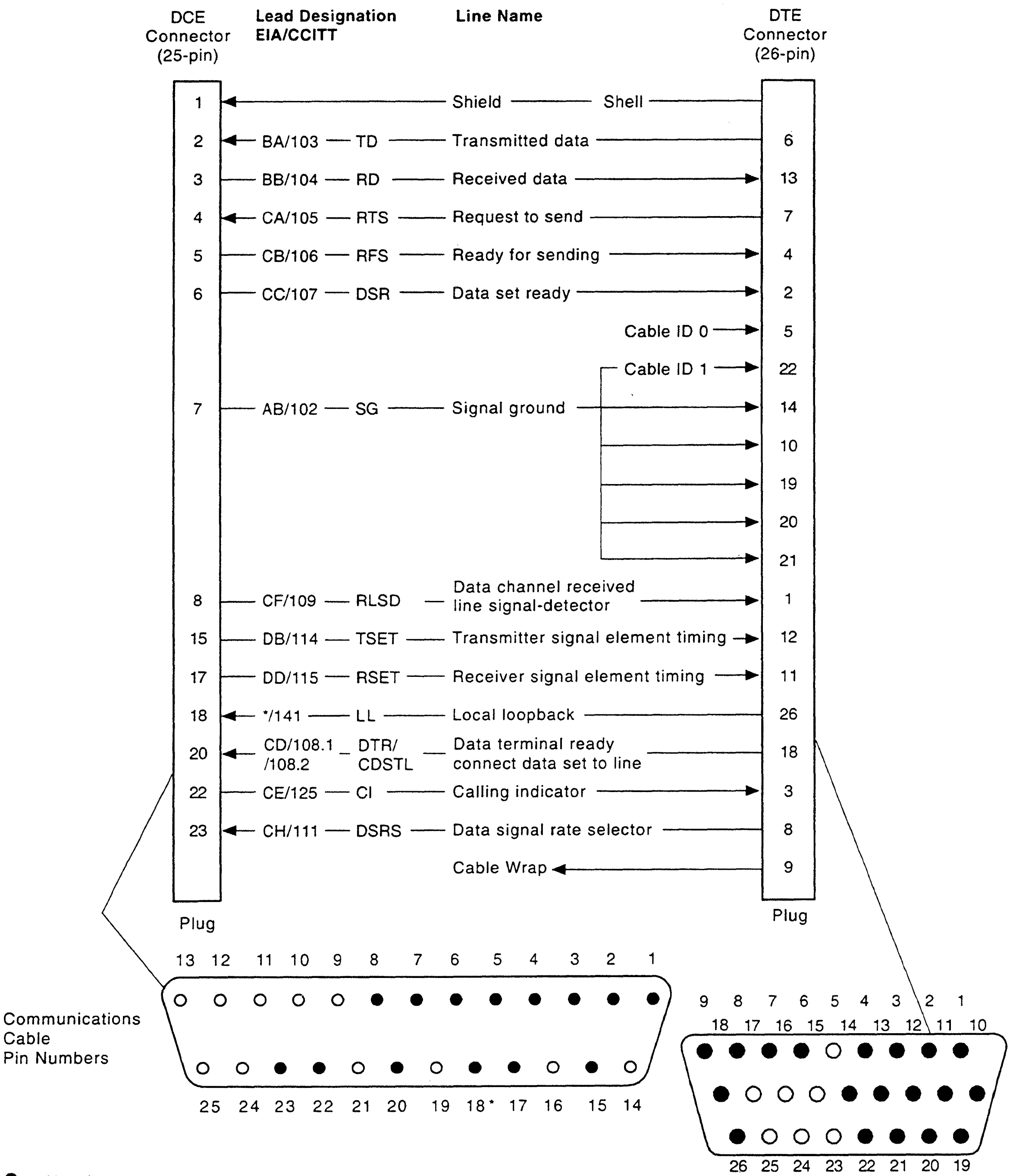
Any modem or DCE attached to the 5494 must meet these interface specifications.

When a communication line is activated, a cable wrap test is done. A cable wrap test checks signals sent from the sender to the receiver and back again. When the test is started, all transmitters and receivers are disconnected from the DCE. The DCE is isolated from the DTE during wrap testing. On CCITT X.21 connections, SET remains connected.

## EIA 232D Interface Lines between the DTE and DCE

The EIA 232D communications interface conforms with ANSI-EIA 232D and with CCITT Recommendation V.24/V.28 (X.21 bis interface).

Figure 16-1 on page 16-2 shows the interface lines, the EIA 232D lead names, and the signal path. Pin numbers not shown are not used by the 5494.




● = Used
O = Not used
* Not defined by CCITT X.21 bis. Lines with an * may be used for different or conflicting purposes by some attached devices.

*Figure 16-1. EIA 232D Interface Lines between the DTE and DCE*

## CCITT V.24/V.28 EIA 232D Signal Line Descriptions

**Transmitted Data (TD for V.24, TX for V.28):** Digital data signals generated and sent from the 5494 to the modem or DCE for transmission to the AS/400 system.

**Received Data (RD for V.24, TX for V.28):** Digital data signals generated by the modem or DCE from the signals received on the communication line and sent from the modem or DCE to the 5494.

**Request to Send (RTS):** A signal generated by the 5494 to put the modem or DCE in Transmit mode.

**Ready for Sending (RFS):** A signal generated by the modem or DCE that indicates to the 5494 that the modem or DCE is ready to transmit data. RFS is usually active in response to RTS active. This signal is also known as clear to send (CTS).

**Data Set Ready (DSR):** A signal generated by the modem or DCE that, when active, indicates one of the following:

- For a nonswitched line and a switched line with manual answer, DSR indicates the modem or DCE is ready to operate.
- For a modem or DCE with a switched line auto-answer setup, DSR indicates the modem or DCE is connected to the communication line and is ready to operate.

**Signal Ground:** The common ground for all signal lines.

**Data Channel Received Line Signal Detect (RLSD):** (Also known as carrier detect.) A signal generated by the modem or DCE to indicate to the 5494 that a carrier signal is present on the communication line.

**Transmitter Signal Element Timing (TSET):** Generated by the modem to supply timing pulses to the 5494. These pulses control the shift of data bits from the transmit buffer to the modem or DCE.

**Receiver Signal Element Timing (RSET):** Generated by the modem or DCE to supply timing pulses to the 5494. These pulses control the shift of data bits from the modem or DCE to the receive buffer.

**Local Loopback (LL):** A signal generated by the 5494 that conditions the modem or DCE to do a local modem or DCE wrap test. The wrap test is done if the modem or DCE supports the wrap function and the use of the signal line. The transmit data from the 5494 is looped back on the receive line to the 5494.

**Data Terminal Ready (DTR):** One of two uses (the other is CDSTL) that can be selected during configuration. Both use the same signal line (20). In DTR, this signal indicates to the modem or DCE that the 5494 is ready to operate.

When the modem or DCE has the auto-answer function, DTR also prepares the modem or DCE to answer a call, connects the modem or DCE to the communication line, and maintains that connection until DTR is inactive.

During automatic answering, the connection to the communication line is in response to the DTR being active. An acceptable connection (off hook) activates DSR. An inactive DTR causes the auto-answer function to deactivate the communication line connection (on hook). DTR usually goes inactive when the transmission of data completes.

**Connect Data Set to Line (CDSTL):** A usage similar to DTR that is used with some World Trade modems or DCEs. CDSTL uses the same signal line as DTR (20) and is selected by configuration bit 5. In CDSTL, this signal indicates to the modem or DCE that the 5494 is ready to operate.

On a nonswitched communication line, the CDSTL signal is active in response to the DSR being active.

On a switched communication line, CDSTL is active in response to DSR being active (this occurs when the line connection is made through a call placed to the AS/400 system), or in response to calling indicator being active (this indicates to the modem or DCE that the 5494 is ready to answer the incoming call).

**Calling Indicator (CI):** A signal generated by the modem or DCE to indicate to the 5494 that a ringing signal is being received on the communication line. This signal is also known as ring indicator (RI).

**Data Signal Rate Selector (DSRS):** (Also known as speed select.) A signal generated by the 5494 and used by modems or DCEs that can use either of two transmission speeds over the same communication line. When this signal is active, the lower speed is selected.

**Note:** The polarity for the *rate select* signal is opposite that for all other control lines.

## EIA 232D Connector Mechanical Information

Table 16-1 describes the EIA 232D connector.

*Table 16-1. EIA 232D Connector Description*

| Part | Description |
|---|---|
| DCE interface | ISO 2110 (25-pin) |
| Pin | 1 mm diameter |
| Thumbscrews | UNC 4.40[1] |

[1] M2.6 included for Japan and South Korea. M3 included for Germany.

## EIA 232D Cable Wrap

Figure 16-2 shows the cable wrap path for EIA 232D.

| Signal Line | DCE | 5494 | Wrap Path |
|---|---|---|---|
| TD | 2 | 6 | |
| RD | 3 | 13 | |
| TSET | 15 | 12 | |
| RSET | 17 | 11 | |
| DTR/CDSTL | 6 | 2 | |
| DSR | 20 | 18 | |
| RTS | 4 | 7 | |
| RFS | 5 | 4 | |
| DSRS | 23 | 8 | |
| RLSD | 8 | 1 | |
| LL | 18 | 26 | |
| CI | 22 | 3 | |
| Cable ID = 10 | | | |

*Figure 16-2. EIA 232D Cable Wrap*

## CCITT X.21 Interface Lines between the DTE and DCE

The X.21 communications interface conforms with the interface circuit and electrical characteristics defined in CCITT Recommendation X.24/X.27 (V.11). The interface operates as described in CCITT Recommendation X.21.

Figure 16-3 on page 16-6 shows the interface lines, the X.21 lead names, and the signal path. Pin numbers not shown are not used by the 5494.

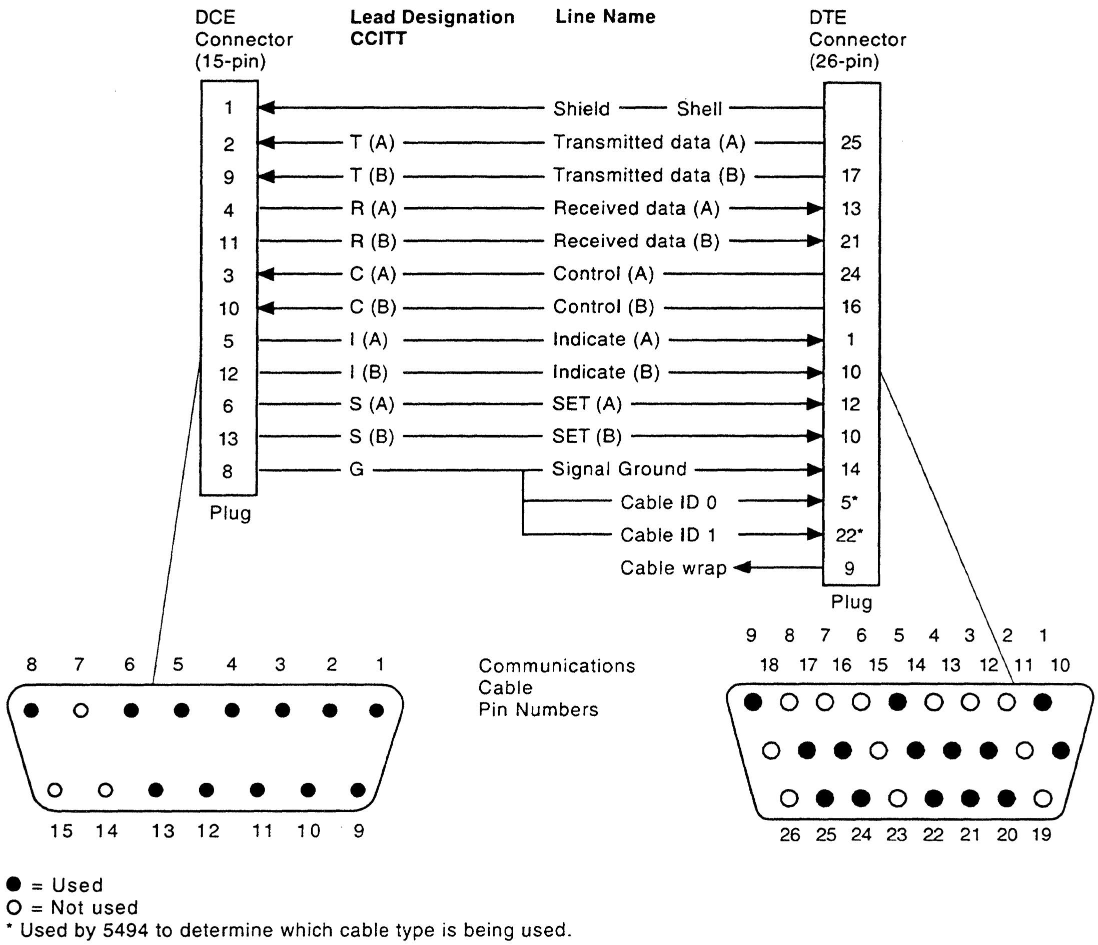



*Figure 16-3. X.21 Interface Lines between the DTE and DCE*

# X.21 Signal Line Descriptions

**Transmitted Data (TD(A) and TD(B)):** A differential pair of digital data signals containing data sent from the 5494 to the DCE.

**Received Data (RD(A) and RD(B)):** A differential pair of digital data signals containing data sent from the DCE to the 5494.

**Control (C(A) and C(B)):** A differential pair of digital data signals that transmits control status to the DCE.

**Indicate (I(A) and I(B)):** A differential pair of signals that transmits control status from the DCE to the 5494.

**Signal Element Timing (SET(A) and SET(B)):** A differential pair of signals generated by the DCE to provide data synchronization for both transmit and receive signals.

**Signal Ground**: The common ground for all signal lines.

**Byte Timing (BT(A) and BT(B))**: These signals are not used by the 5494.

## X.21 Connector Mechanical Information

Table 16-2 describes the X.21 connector.

*Table 16-2. X.21 Connector Description*

| Part | Description |
|---|---|
| DCE interface | ISO 4903 |
| Pin | 1 mm diameter |
| Thumbscrews | M3 |

## X.21 Signal Levels

The X.21 physical interface includes five balanced differential interchange circuits. Because the signal characteristics of these circuits are not compatible with logic levels used by the microprocessing unit (MPU), drivers and receivers on the planar supply the necessary signal conversion. Each driver and receiver controls a separate pair of interchange lines (designated A and B). Table 16-3 indicates valid voltage ranges for VA, VB, and VA-VB.

*Table 16-3. Signal Line Voltage Levels for the X.21 Interface*

| Voltage Reference | DC Voltage Range | Network Definition |
|---|---|---|
| VA | -10 V to +10 V | |
| VB | -10 V to + 10 V | |
| VA-VB | +0.3 V to +6.0 V | Mark |
| VA-VB | -0.3 V to -6.0 V | Space |
| VA-VB | -0.3 V to + 0.3 V | Not valid |

## CCITT X.21 Cable Wrap

Figure 16-4 shows the cable wrap path for CCITT X.21.

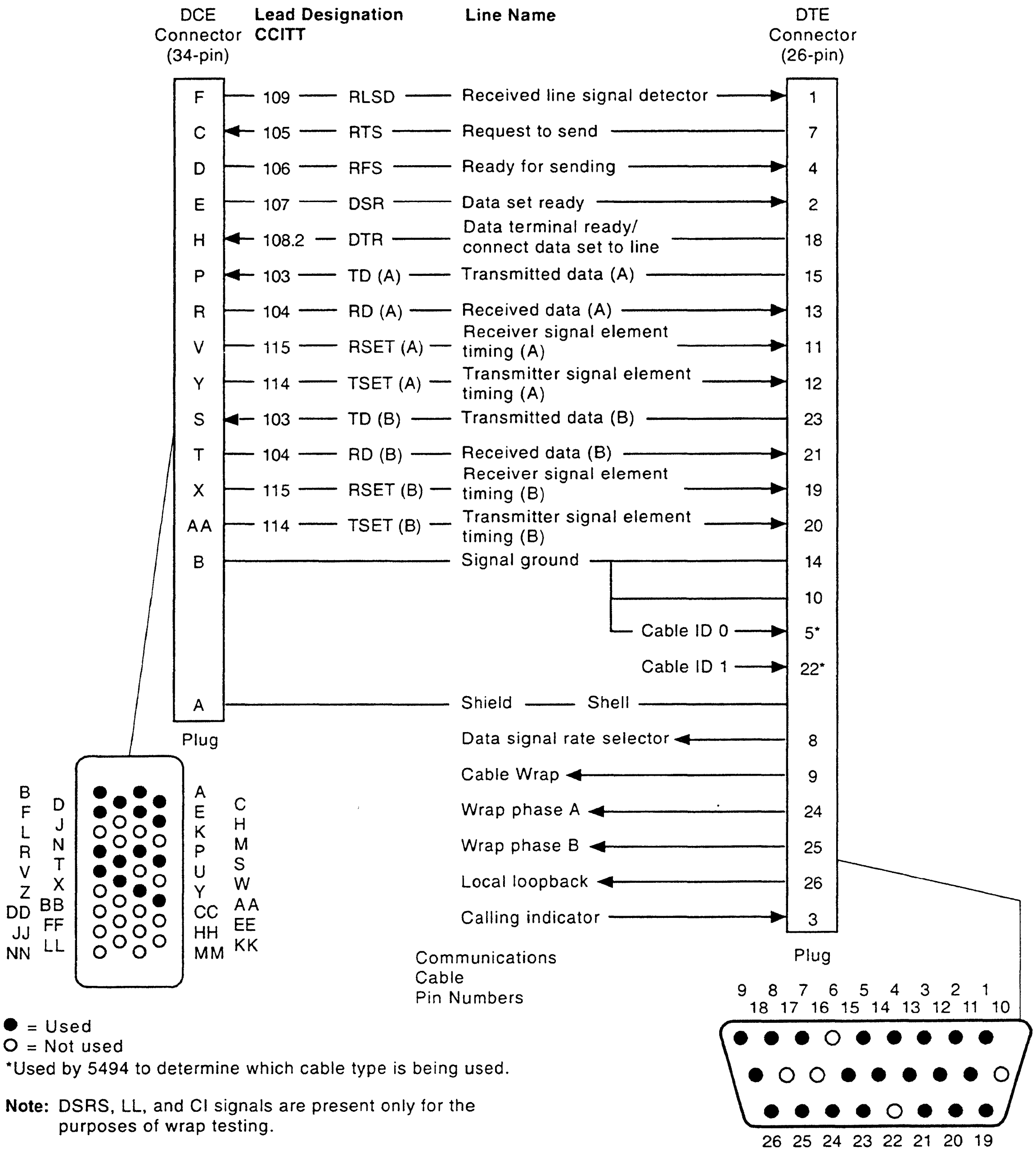
| Signal Line | DCE | 5494 | Wrap Path |
|---|---|---|---|
| T (A) | 2 | 25 | |
| R (A) | 4 | 13 | |
| T (B) | 9 | 17 | |
| R (B) | 11 | 21 | |
| C (A) | 3 | 24 | |
| I (A) | 5 | 1 | |
| C (B) | 10 | 16 | |
| I (B) | 12 | 10 | |

Set is connected to DCE during wrap. All other lines disconnected.
Cable ID = 00

*Figure 16-4. CCITT X.21 Cable Wrap*

## CCITT V.35 Interface Lines between the DTE and DCE

The V.35 communications interface conforms with the interface circuit and electrical characteristics defined in CCITT Recommendation V.35. Figure 16-5 on page 16-9 shows the interface lines, pin usage for the connectors, and labels for the signal lines. Pin numbers not shown are not used by the 5494.




● = Used
O = Not used
*Used by 5494 to determine which cable type is being used.

**Note:** DSRS, LL, and CI signals are present only for the purposes of wrap testing.

*Figure 16-5. V.35 Interface Lines between the DTE and DCE*

## V.35 Signal Line Descriptions

**Data Channel Receive Line Signal Detect or (RLSD)**: A signal generated by the modem or DCE that indicates to the 5494 that a carrier signal is present on the communication line. This signal is also known as data carrier detect (DCD).

**Request to Send (RTS)**: A signal generated by the 5494 that puts the modem or DCE into Transmit mode.

**Ready for Sending (RFS)**: A signal generated by the modem or DCE that indicates to the 5494 that the modem or DCE is ready to transmit data. RFS usually becomes active in response to RTS. This signal is also known as clear-to-send (CTS).

**Data Terminal Ready (DTR)**: DTR is not included in Recommendation V.35, but it is included in the communications cable and used for wrap testing. This signal cannot be used by V.35 modems or DCEs.

**Data Set Ready (DSR)**: A signal generated by the modem or DCE that indicates to the 5494 that it is ready to begin active operation.

**Transmitted Data (TD(A) and TD(B))**: A differential pair of digital data signals that the 5494 sends to the modem or DCE. These signals contain the information that is transmitted by the 5494 through the external communications network.

**Received Data (RD(A) and RD(B))**: A differential pair of digital data signals that the modem or DCE sends to the 5494. These signals contain the information that is transmitted to the 5494 through the external communications network.

**Receiver Signal Element Timing (RSET(A) and RSET(B))**: A differential pair of timing pulses generated by the modem or DCE. These pulses control the rate of data transfer from the modem or DCE to the 5494.

**Transmitter Signal Element Timing (TSET(A) and TSET(B))**: A differential pair of timing pulses generated by the modem or DCE. These pulses control the rate of data transfer from the 5494 to the modem or DCE.

**Signal Ground**: This signal line supplies a common reference level for the single-ended interchange lines (RLSD, RTS, RFS (CTS), DTR, and DSR).

## V.35 Connector Mechanical Information

Table 16-4 describes the V.35 connector.

*Table 16-4. V.35 Connector Description*

| Part | Description |
|---|---|
| DCE interface | ISO 2593 |
| Pin | 1.6 mm[1] |

[1] mm for France and Switzerland.

## V.35 Signal Levels

The V.35 interface includes both single-ended and differential signal lines. The single-ended signals operate within the same voltage range as EIA 232D signal lines. The differential lines consist of balanced, current-mode signals that develop line voltage across termination resistors. Table 16-5 identifies the voltage ranges associated with both types of signal lines.

*Table 16-5. Signal Line Voltage Levels for the V.35 Interface*

| Line Type | Voltage Reference | DC Voltage Range | Network Definition |
|---|---|---|---|
| Single-Ended Interchange Lines | Signal line to GND | +3 to +15 V | Off or Logic 0 |
| | | -3 to -15 V | On or Logic 1 |
| | | -3 to +3 V (exclusive) | Not valid |
| Differential Lines | VA to GND | -4 to +4 V | |
| | VB to GND | -4 to +4 V | |
| | VA-VB | +0.44 to +0.66 V | Off or Logic 0 |
| | VA-VB | -0.44 to -0.66 V | On or Logic 1 |
| | VA-VB | -0.44 to +0.44 V (exclusive) | Not valid |

**Note:** The state of data circuits is denoted by logic 0 (also called space) and logic 1 (also called mark). Corresponding states of interchange circuits are identified as Off and On.

# V.35 Cable Wrap

Figure 16-6 shows the cable wrap path for V.35.

| Signal Line | DCE | 5494 | Wrap Path |
|---|---|---|---|
| DSRS | | 8 | |
| RLSD | F | 1 | |
| LL | | 26 | |
| CI | | 3 | |
| DTR | E | 2 | |
| DSR | H | 18 | |
| RTS | C | 7 | |
| RFS | D | 4 | |
| T (A) | P | 15 | |
| R (A) | R | 13 | |
| RSET (A) | V | 11 | |
| TSET (A) | Y | 12 | |
| T (B) | S | 23 | |
| R (B) | T | 21 | |
| RSET (B) | X | 19 | |
| TSET (B) | AA | 20 | |
| Cable ID =01 | | | |

*Figure 16-6. V.35 Cable Wrap*

## Token-Ring Interface

This section describes the physical interfaces of the IBM Token-Ring network. For a complete description, refer to the IEEE 802.5 standard.

## Interface at Wall Connector

| Input (to attaching product) | 4 Mbps | | 16 Mbps | |
|---|---|---|---|---|
| | **Minimum** | **Maximum** | **Minimum** | **Maximum** |
| Receive data (RX) level **A B** | 50 mV p-p | – | 150 mV p-p | – |
| Maximum bit outage time **C** | – | 15 ms | – | 15 ms |
| Maximum freq error (operating) **D** | – | 0.01 % | – | 0.01 % |
| Maximum freq error (nonoperating) **E** | – | 400 kHz | – | 2.7 MHz |
| Input impedance **F** | 135 Ω | 165 Ω | 135 Ω | 165 Ω |
| Wire fault conditions **G** | – | – | – | – |
| DC termination **H** | – | 10 Ω | – | 10 Ω |

| Output (from attaching product) | Minimum | Maximum | Minimum | Maximum |
|---|---|---|---|---|
| Transmit data (TX) level | 3.0 V p-p | 4.5 V p-p | 3.0 V p-p | 4.5 V p-p |
| Rise times | 15 ns | 60 ns | **O** | **O** |
| Asymmetry | – | 11 ns | – | 3.0 ns |
| Jitter **I** | – | 2.2 ns | – | 3.0 ns |
| Jitter **J** | – | 7.0 ns | – | 4.7 ns |
| Jitter peaking **K** | – | 0.005 dB | – | 0.006 dB |
| Maximum bit outage **L** | – | 4 half-bits | – | 4 half-bits |
| Frequency error **E** | – | 400 kHz | – | 2.7 MHz |
| Bit error rate **M** | – | $10^{-11}$ | – | $10^{-9}$ |
| Phantom drive (at 4.1 V) | 1 mA | – | 1 mA | – |
| Phantom drive (at 0 V) | 4 mA | 20 mA | 4 mA | 20 mA |
| Output (line) impedance **N** | 135 Ω | 165 Ω | 135 Ω | 165 Ω |

| Physical (see Figure 16-9 on page 16-17) | |
|---|---|
| TX | orange, black |
| RX | red, green |

**Notes:**

**A** Occurring over 140° area at the center of the half-bit time and measured after a passive equalizer with:

- A pole at 2.7 MHz, a pole at 16 MHz, and a zero at 540 kHz for 4 Mbps operation
- A pole at 10.3 MHz, a pole at 25.0 MHz, and a zero at 2.4 MHz for 16 Mbps operation.

The signal should be measured with the data wrapped at the connector.

**B** The adapter must function with a peak-to-peak input jitter consisting of a single frequency for the following values:

*At 4 Mbps*

- Less than 687 ns below 2.0 kHz
- 20 dB/decade derating between 2.0 kHz and 55 kHz
- Less than 25 ns above 55 kHz.

*At 16 Mbps*

- Less than 937 ns below 1.8 kHz
- 20 dB/decade derating between 1.8 kHz and 270 kHz
- Less than 6.2 ns above 270 kHz.

**C** Because of switching time of wiring concentrator.

**D** Averaged for more than 60 seconds.

**E** Instantaneous frequency can be off by 400 kHz for as long as 50 μs during certain error conditions. The adapter must be able to recover from this condition.

**F** Impedance into either the receiver or the driver at 4 MHz.

**G** Values are effective resistances as seen from phantom drive. See Figure 16-7.

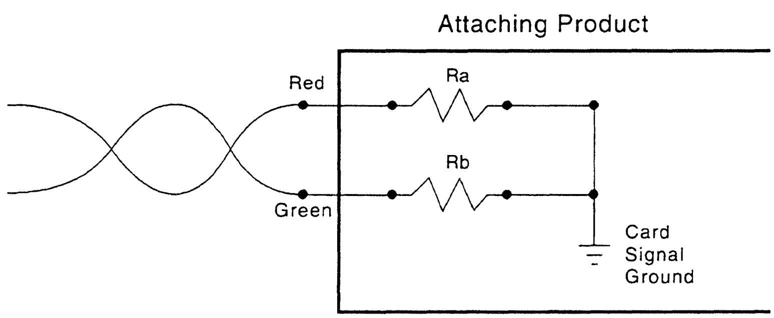



*Figure 16-7. Resistances Seen from Phantom Drive*

Wire fault must be active (fault indicated) when:

(4.3 KΩ ≤ Ra ≤ 5.5 KΩ) and (Rb > 50.0 KΩ) or (4.3 KΩ ≤ Rb ≤ 5.5 KΩ) and (Ra > 50.0 KΩ) or (Ra < 0.1 KΩ) or (Rb < 0.1 KΩ)

Wire fault must be inactive (fault not indicated) when:

(2.9 KΩ ≤ Ra ≤ 3.82 KΩ) and (2.9 KΩ ≤ Rb ≤ 3.82 KΩ) or (4.3 KΩ ≤ Ra ≤ 5.5 KΩ) and (4.3 KΩ ≤ Rb ≤ 5.5 KΩ)

These regions are shown in Figure 16-8, where A indicates an active wire fault, I indicates an inactive wire fault, and D is the region where the wire fault can be either active or inactive.

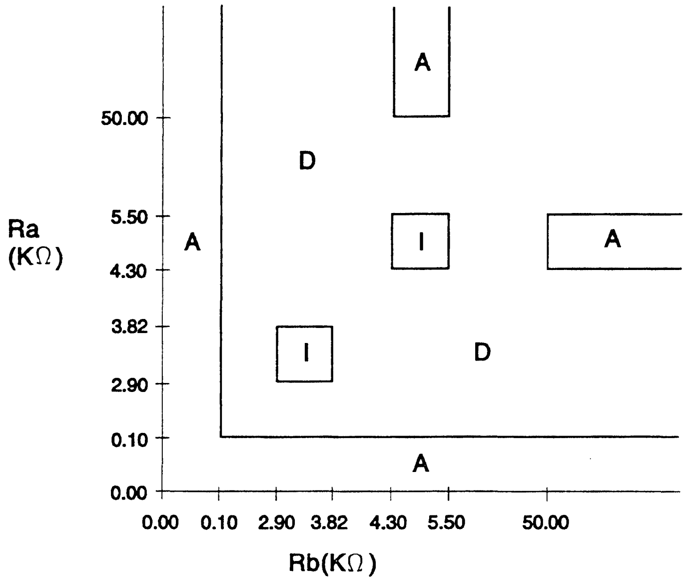



*Figure 16-8. Active and Inactive Wire Fault Regions*

**H** Resistance (dc) from receive lines to ground.

**I** Peak-to-peak phase error between the recovered clock and the clock of the upstream workstation when the data pattern is 500 bytes of B'0's alternating with 500 bytes of B'1's.

**J** Peak-to-peak phase error when the data pattern is all B'0's.

**K** Maximum gain of the phase transfer function of the timing recovery circuit.

**L** Maximum number of Manchester half-bits without a transition.

**M** Measured with the transmitter repeating the received data.

**N** Impedance into either the receive or the transmit twisted-pair cable at 4 MHz.

**O** At 16 Mbps, rise times are not adequate to describe transmitter waveform. Refer to frequency characteristics given in the IEEE 802.5 standard.

## Interface at Wiring Concentrator (Multistation Access Unit)

| Input (to wiring concentrator) | Minimum | Maximum |
|---|---|---|
| Phantom voltage | 3.9 V | 5.2 V |
| Phantom current (at 4.1 V) | 1 mA | – |
| Phantom current (at 0 V) | 4 mA | 20 mA |
| Phantom interruption **A** | – | 50 ms |

| Output (from wiring concentrator) | Minimum | Maximum |
|---|---|---|
| Attachment time **B** | – | 5 sec |
| Removal time **C** | 50 ms | 200 ms |
| DC resistance **D** | 4.3 kΩ | 5.5 kΩ |

**Insertion Loss (maximum)**

| | 10 kHz: | 0.5 to 4 MHz: | 4 to 16 MHz: | 16 to 32 MHz: |
|---|---|---|---|---|
| MRI to MRO | – | 0.3 dB | 0.6 dB | 1.2 dB |
| TX to RX **E** | 3.0 dB | 0.65 dB | 1.3 dB | 2.6 dB |
| MRI to RX | 3.0 dB | 0.55 dB | 1.1 dB | 2.2 dB |
| TX to MRO | 3.0 dB | 0.55 dB | 1.1 dB | 2.2 dB |
| TX to RX **F** | 3.0 dB | 0.8 dB | 1.6 dB | 3.2 dB |

**Crosstalk (maximum)**

| | 10 kHz: | 0.5 to 4 MHz: | 4 to 16 MHz: |
|---|---|---|---|
| TX to RX | 55 dB | 43 dB | 37 dB |
| Lobe wrap to MR | 55 dB | 43 dB | 37 dB |
| MR to BR | 59 dB | 47 dB | 41 dB |

**Return Loss (minimum)**

| 1 to 6 MHz: | 6 to 12 MHz: | 12 to 24 MHz: |
|---|---|---|
| 20 dB | 14 dB | 11 dB |

**Common Mode Rejection (minimum)**

| 1 to 6 MHz: | 6 to 12 MHz: | 12 to 24 MHz: |
|---|---|---|
| 40 dB | 28 dB | 25 dB |

**Physical (see Figure 16-9 on page 16-17)**

| | |
|---|---|
| Main Token-Ring path — In (MRI) | red, green |
| Main Token-Ring path — Out (MRO) | red, green |
| Backup Token-Ring path — In (BRI) | orange, black |
| Transmit data (TX) | orange, black |
| Backup Token-Ring path — Out (BRO) | orange, black |
| Receive data (RX) | red, green |

**Notes:**

**A** Attachment to the Token-Ring network must not be compromised by phantom interrupts up to the specified time.

**B** Time from application of phantom drive to attachment to the Token-Ring network.

**C** Time from removal of phantom drive to reconfiguration of the Token-Ring network.

**D** From transmit wire to receive wire (red-to-orange, green-to-black).

**E** Transmit to receive each lobe.

**F** Each transmit to receive last lobe.

Figure 16-9 shows the connector used throughout the Token-Ring network.

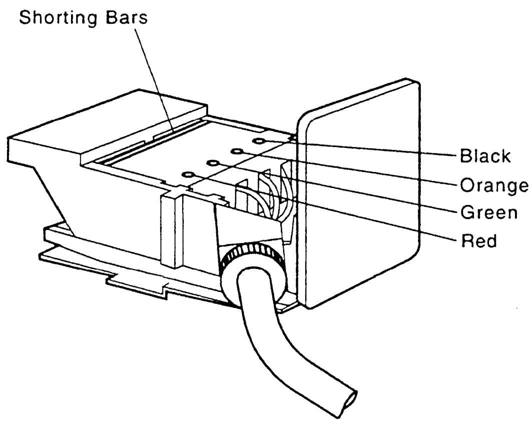



*Figure 16-9. IBM Cabling System Data Connector (Interior View)*

# Appendix A. Ideographic Enhancements

This appendix contains information about ideographic data entry and processing. Topics include:

- Double-byte and single-byte characters
- Alphanumeric and Ideographic modes
- Supported workstations
- Systems Network Architecture (SNA) support
- Display data streams
- AS/400 system extended ideographic support
- Keyboard functions.

## Double-Byte and Single-Byte Characters

The 5494 ideographic function allows you to print and display double-byte characters on Oriental language workstations.

Double-byte (ideographic) and single-byte (alphanumeric) characters differ in the following ways:

- Double-byte characters are enclosed by shift control characters. X'0E' begins the ideographic data stream. X'0F' or a screen attribute returns the keyboard to alphanumeric entry.
- Double-byte characters are enclosed by extended ideographic data type attributes.
- Double-byte characters, when displayed and printed, are usually twice as wide as single-byte characters and always occupy two screen positions.
- Each double-byte character uses 2 bytes of storage; single-byte characters use only 1 byte.

**Note:** When you enter double-byte versions of single-byte characters, the characters are considered double-byte, using 2 bytes of storage and occupying two screen positions.

Refer to your workstation documentation for more information on double-byte character sets (DBCS).

## Alphanumeric and Ideographic Modes

You can enter data at an ideographic workstation in either Alphanumeric or Ideographic mode. Use Alphanumeric mode to enter single-byte characters. To display and print double-byte characters, use either alternate entry or double-byte direct entry in the Ideographic mode.

### Alphanumeric Mode

Use Alphanumeric mode when entering single-byte characters into non-ideographic input fields or subfields. In Alphanumeric mode, the keyboard operates as it does on non-ideographic workstations.

## Ideographic Mode

Use either alternate entry or double-byte direct entry to enter data in Ideographic mode.

### Alternate Entry

Alternate entry allows you to enter a decimal code for the desired character. A dictionary of alternate characters provides the decimal code for the characters. Enter this code (5 digits maximum) with the most significant digit first. The 5494 converts the decimal code into a double-byte ideographic code. If the ideographic code is located in the display character-generating read-only storage (ROS), the 5494 loads the ideographic code into the workstation buffer to display the character.

Codes not located in display ROS are called *extension characters*. The 5494 sends these extension characters to the AS/400 system for comparison against an extension character random access memory (RAM) list that is maintained for the display. If the AS/400 system finds the extension character in the list, the AS/400 system sends the RAM address and the extension character back to the 5494 with a LOAD MATRIX command. The 5494 writes the RAM address into the workstation buffer to display the extension character. If the AS/400 system does not find the extension character in the RAM list, the list is updated with a new RAM address. The AS/400 system returns the extension character, the new RAM address, and a bit matrix (representing the character image) to the 5494. The 5494 loads the bit matrix into extension character RAM and writes the RAM address into the workstation buffer to display the character.

The following rules apply for alternate entry operations:

- The keyboard must be in Ideographic mode. The 5494 automatically selects this mode when the cursor enters an ideographic input field or subfield through automatic mode shift.
- Only the numeric pad keys (0–9) on the right side of the keyboard are valid for alternate entry. You must enter each decimal digit from the numeric pad. Although numeric digits (0–9) also appear on the top row of data keys, they are reserved for double-byte direct entry and are not used for alternate entry. All data keys outside the numeric pad are valid only for double-byte direct entry in Ideographic mode.
- The Enter key is interpreted as Alternate Enter when in alternate entry state.
- The Reset key is interpreted as Alternate Clear when in alternate entry state.
- Double-byte direct entry overrides alternate entry operation and clears alternate entry state.
- Use the space bar to enter double-byte blanks (X'4040'). If the keyboard is in alternate entry state, the space bar overrides the alternate entry operation and clears alternate entry state.

### Double-Byte Direct Entry

All characters and symbols on the keyboards have a double-byte representation in the IBM Ideographic Character Set and are implemented in the display character-generating ROS. This allows the 5494 to translate the data keys directly into double-byte characters for entry into ideographic input fields or subfields.

The following rules apply for double-byte direct entry:

- The keyboard must be in Ideographic mode. The 5494 automatically selects this mode when the cursor enters an ideographic input field or subfield through automatic mode shift.
- Only the data keys outside the numeric pad can be used for double-byte direct entry. The numeric pad is reserved for alternate entry sequences. A single exception is the numeric pad decimal point, which is a double-byte direct entry key.
- Double-byte direct entry is allowed during alternate entry state, but it overrides the alternate entry operation and clears alternate entry state.
- Numeric digits (0–9), which are keyed from the top row on the keyboard, are translated into double-byte numeric characters for direct entry.
- Numeric digits (0–9), which are keyed from the numeric pad of the keyboard, are translated into a decimal code for alternate entry.
- Data keys are translated as follows:
  - The right-half (point) is the single-byte EBCDIC translation for the character.
  - The left-half (ward) is either X'42' or X'43', depending upon the character. In either case, the double-byte code is assigned according to the IBM Ideographic Character Set standard.
- The space bar is used to enter double-byte blanks (X'4040'). If the keyboard is in alternate entry state, the space bar overrides the alternate entry operation and clears alternate entry state.

## Supported Workstations

The 5494 supports the following ideographic 5250 workstations:

- IBM 5295 Models 1, 2, 0C2, and LK1
- IBM Personal System/55* (PS/55*) using 5250 emulation programs
- IBM PS/55 using IBM Japanese 5250 Personal Computer/2 AD Support.

The 5494 supports the following ideographic 5250 printers:

- IBM 5227 Models 1, 2, 3, and 5
- IBM 5317 Model 1
- IBM 5327 Models 1, 2, and 3.

The 5494 also supports IBM PS/55 and IBM 5295-attached ideographic printers. Refer to your workstation documentation for supported printers.

## Systems Network Architecture Support

The 5494 Ideographic function modifies the LUSTAT command. Other systems network architecture (SNA) commands are unchanged.

The 5494 sends the LUSTAT command to the AS/400 system to report an extension character request.

The extension character request has a status extension value greater than or equal to X'4040'. The extension LUSTAT is sent on the LU-LU normal flow.

## Display Data Streams

For general information about data stream formats, see Chapter 12, "Display Data Streams." The following information describes the format of data stream commands and responses specifically required for the ideographic support function. The topics include:

- Commands
- Field control word
- Fields
- Format Level 0.

## Display Data Stream Commands

The following commands and responses have requirements specific to the ideographic support function:

- READ MDT FIELDS
- READ SCREEN (IMMEDIATE)
- SAVE
- CLEAR FORMAT TABLE
- CLEAR UNIT
- RESTORE SCREEN
- ROLL
- WRITE ERROR CODE
- WRITE-TO-DISPLAY.

### READ MDT FIELDS

Trailing nulls are removed only if they are not enclosed by shift control characters. Nulls between shift control characters are not considered trailing.

### READ SCREEN (IMMEDIATE)

On ideographic displays, all bytes, including those for shift control characters, are read from the display.

### SAVE SCREEN

The 5494 automatically saves the unlocked keyboard in the current mode (Command, Insert, or Data Key).

The 5494 does not save the following:

- Keyboard modes (Ideographic or Alphanumeric)
- History of previous keystrokes (shift status and accumulated extension character codes)

- Extension character RAM in the workstation
- Display of shift control characters
- Locked keyboard if caused by an extension character request.

## CLEAR FORMAT TABLE

The 5494 clears any accumulated extension character codes. It does not clear the extension character RAM in the workstation or the displayed shift control characters.

## CLEAR UNIT

The 5494 processes this command as follows:

- Any accumulated extension character codes are cleared.
- The cursor is set to nonblinking.
- The keyboard mode (Ideographic or Alphanumeric) is not affected.
- The display of shift control characters is not affected.
- The RAM character generator and the extension character RAM in the workstation are not reset.

## RESTORE SCREEN

The 5494 automatically restores the unlocked keyboard in the current mode (Command, Insert, or Data Key).

Any extension character request LUSTAT that has been issued but not run is cleared and not restored.

The following are *not* restored:

- Keyboard modes (Ideographic or Alphanumeric)
- History of previous keystrokes (shift status and accumulated extension character codes)
- Extension character RAM in the workstation
- Display of shift control characters
- Locked keyboard if caused by an extension character request.

## ROLL

Use caution when you roll ideographic fields that use more than one line. This ensures that shift characters and their associated characters are kept together to allow them to be displayed correctly.

## WRITE ERROR CODE

The following actions are taken during the WRITE ERROR CODE command:

- Any accumulated extension character codes are cleared.
- Any extension characters are not displayed.
- Any extension character request LUSTAT that has been issued but not run is not cleared and may be sent to the AS/400 system.

## WRITE-TO-DISPLAY

Double-byte characters should be enclosed by shift control characters, but the 5494 does not verify that this is done. When the format table is modified, the 5494 clears any accumulated extension character code.

When the format table is not modified, extension character request status is not affected by the WRITE-TO-DISPLAY command. Even if control character 2 (CC2) specifies that the keyboard should be unlocked, the keyboard stays locked until an extension character request is completed.

When the cursor is moved to home position by CC2, the 5494 places the cursor at the designated home position. However, if an input field has a shift-out character in the first field position and the home position is defined as position 1, 2, or 3, the cursor will be moved to position 2.

The 5494 leaves the cursor under a shift control character in an open field if that character is in the home position and is not in one of the first three positions.

If control character 1 (CC1) specifies write nulls to nonbypass input fields, the 5494 inserts nulls in the ideographic input fields as follows:

**Ideographic only:** The 5494 inserts nulls in all field positions between shift control characters. The Shift control characters are not changed.

**Ideographic data type**: The 5494 inserts nulls in all field positions.

**Ideographic either (Ideographic mode):** Same as ideographic only input field.

**Ideographic either (Alphanumeric mode):** The 5494 inserts nulls in all field positions from leading attribute to trailing attribute.

**Ideographic open:** The 5494 inserts nulls in all field positions from the leading attribute to the trailing attribute, regardless of shift control characters in the field.

***Start of Field Order:*** The start of field order may be used to define ideographic input fields. There is an ideographic field control word to define the type of field.

*Field Control Word:* The ideographic field control word (FCW) is a subfield that defines the specific ideographic field types. The ideographic FCW value is X'82' in the high-order byte. The low-order byte defines the ideographic field as shown in Table A-1.

*Table A-1. Ideographic Field Definition for Low-Order Byte*

| Bits | Binary Description |
|---|---|
| 0–2 | Ideographic field type<br>000 = Ideographic only field<br>001 = Ideographic data type<br>010 = Ideographic either field<br>100 = Ideographic open field |
| 3–7 | Reserved |

*Ideographic Field Types:* The ideographic FCW defines four ideographic field types:

**Ideographic only** — An input-capable field that contains only double-byte data, (shift-in and shift-out characters are within the input field).

**Ideographic data type** — An input-capable field that contains only double-byte data, (shift-in and shift-out characters are ideographic extended attributes and are not within the input field).

**Ideographic either** — An input-capable field that contains either double-byte or single-byte data with selection made at entry time.

**Ideographic open** — An input-capable or output field that contains a mixture of single-byte and double-byte data with shift-out (SO) and shift-in (SI) characters marking the transitions.

*General Ideographic Field Information:* Ideographic input fields are valid for all ideographic displays, regardless of the attached keyboard type. However, ideographic input fields appear as alphanumeric input fields on alphanumeric displays.

Additional restrictions in field length for ideographic input fields are:

- The field length must include shift control characters.
- The minimum field length for all ideographic input fields except ideographic data type is 4 bytes; space for at least 1 double-byte ideographic character must be between the required shift control characters. The minimum field length for ideographic data type is 2 bytes; space for at least one double-byte ideographic character.
- An even value must be specified for the field length of ideographic only, ideographic data type and ideographic either fields, because all double-byte characters require 2 bytes and may be enclosed by a pair of shift control characters.
- The field length may not be specified past the end of the display (the field will not wrap to the top of the display).

Any data stream that does not follow these restrictions is rejected with a negative response.

The AS/400 system can write data anywhere on the display. However, the AS/400 system program:

- Should maintain shift control character pairs and spacing with an even number of positions between shift control characters. Keyboard operations are unpredictable when shift control characters are misplaced or not paired.
- Should not include attribute characters between shift control characters. Attribute characters act like shift-in characters and switch the display into Alphanumeric mode.
- Must know that the operator can change data in ideographic input fields.

**Note:** The 5494 does not examine data written by the AS/400 system when processing keystrokes in ideographic input fields.

The start of field (SF) order does not cause nulls to be inserted in the input fields. Displayed data is not changed unless it is written over by a screen attribute or shift control character. Displayed data from a previous operation can determine the mode of a field or can be displayed in an incorrect mode unless you are aware of the previous operation.

All data following an SF order is placed one position past the field start attribute. If double-byte data follows an SF order, the AS/400 system must ensure correct positioning of shift characters.

***Ideographic Only Fields:*** For ideographic only fields, the 5494 writes the following, in order, on the display:

1. A leading attribute (determines how the character is displayed)
2. A leading shift-out character (X '0E'—indicates the start of a double-byte character string)
3. A trailing shift-in character (X '0F'—indicates the end of a double-byte character string)
4. A trailing attribute (determines how the next character is displayed).

The 5494 pointer determines the starting location for data or orders that follow the SF order in the data stream. The pointer points to the location immediately to the right of the leading attribute (the location of the SO character). The SO character can be overwritten unless the pointer is modified by the set buffer address (SBA) order.

***Ideographic Data Type:*** Ideographic data type fields require a display that supports ideographic extended attributes. These extended attributes are written to the extended attribute buffer and do not occupy a screen position.

If a WRITE-TO-DISPLAY command, Start of Field order, contains an Ideographic Data Type FCW and the display does not have extended ideographic attribute capability, the data stream is rejected with a negative response.

Ideographic data type fields can contain only two-byte ideographic characters. When an ideographic data type field is defined on an ideographic display, the 5494 writes a leading attribute and a leading SO attribute behind the first field position. An SI attribute is written behind the first byte beyond the last field position. If an ideographic data type field is written to a non-ideographic display, the FCW is ignored and no SO or SI attributes are written.

If an ideographic data type field occupies more than one line, the 5494 assumes that the AS/400 system has positioned the field such that a double byte of data is not split between lines.

The internal 5494 pointer points to the first field position as the starting location for data. This pointer may be modified by a set buffer address (SBA) order.

***Ideographic Either Fields:*** The operator can change field modes only when the cursor is under the first enterable character position of the field. When the field mode is changed from Alphanumeric to Ideographic, the 5494:

1. Nulls the entire field between leading and trailing attributes.
2. Writes an SO character in the position immediately following the leading attribute.

3. Writes an SI character in the position immediately preceding the leading attribute.
4. Places the cursor in the position immediately following the SO character. The cursor blinks and occupies two screen positions to indicate Ideographic mode.
5. Sets MDT in the field format word.
6. Sets the appropriate entry mode. Alphanumeric keyboards are set to Alternate Entry mode to allow you to enter characters with alternate character numbers or by double-byte direct entry.

When the field mode is changed from Ideographic to Alphanumeric, the 5494:

1. Nulls the entire field between leading and trailing attributes.
2. Places the cursor in the position immediately following the leading attribute. The cursor blinks and occupies one screen position to indicate Alphanumeric mode.
3. Sets MDT in the field format word.
4. Sets the keyboard to Alphanumeric mode for all keyboard types.

| When the AS/400 system defines an ideographic either field, the 5494 writes a leading attribute and a trailing attribute on the display. Shift control characters are not written on the display; therefore, the field is initially alphanumeric. The AS/400 system can write shift control characters into the fields.

For an ideographic either field, write the shift-out character only in the position immediately following the leading attribute.

***Ideographic Open Fields:*** After processing the SF order defining an ideographic open field, the 5494 address pointer points to the location immediately to the right of the leading attribute. The AS/400 system can write shift characters into the field provided that:

- Each SO character is followed by a closing SI character.
- An even number of screen positions exists between the SO and SI pair. Adjacent SO/SI or SI/SO pairs are allowed.
- The first shift character in the field is an SO, and SO and SI characters alternate. Consecutive SO or SI characters are not allowed.

When the AS/400 system defines an open field, the 5494 writes a leading attribute and a trailing attribute on the display. Shift control characters are not written on the display; therefore, the field is initially alphanumeric. The AS/400 system can write shift control characters into the fields.

| *Field Format Word:* Table A-2 on page A-10 identifies the fields and their characteristics for the ideographic field format word (FFW).

The information in parentheses immediately following the field type gives the byte and bit identifiers of the field and the FFW.

*Table A-2. FFW Field Types and Characteristics*

| Field Type | Description |
|---|---|
| Alphabetic shift (byte 1, bits 5–7 = 000) | Must be 000 if an ideographic FCW is present; otherwise, the ideographic FCW is ignored. |
| Auto enter (byte 2, bit 0) | For ideographic only and either fields, the last character of the field is the double-byte character before the shift-in character. The last double-byte character causes auto enter to occur. For ideographic open fields, auto enter occurs when the last enterable position of the field is filled. |
| Dup enable (byte 1, bit 3) | Allows the operator to press the Dup key to exit an ideographic only or an ideographic either field, leaving the field filled with double-byte Dup characters. The characters fill the space above the current cursor position through the end of the field. The shift control characters are not duplicated. Dup enable is valid for an open field if the cursor is located in the first enterable position of the field; otherwise, an error occurs. The result of Dup in an open field is that all positions will contain the Dup symbol. |
| Modify data tag (byte 1, bit 4) | This bit is set in an ideographic either field when the operator changes the field mode since this adds or deletes SO and SI characters in the field. Therefore, it is possible to send a field of all nulls to the AS/400 system by changing field mode. Modify data tag (MDT) is set in ideographic open fields when subfields are inserted or deleted. The following keys also cause MDT to be set:<br>• Alternate Enter (if a valid code is entered and written to the screen)<br>• Ideographic Shift/Data key combinations that cause data to be written to the screen<br>• Valid Repeat key operations (even if a null is written)<br>• Erase to End of Field (even if a null is written).<br>MDT is not set by pressing the Mode keys alone or by pressing a Command/Mode key sequence if the field mode is not changed, or if SO/SI are not inserted. |
| Field exit required (byte 2, bit 1) | For an ideographic field, moving the cursor one or two positions to the right does not make the cursor leave the field. If you move the cursor one position (single-wide cursor under the right half of the last character), you can type in the last character again.<br>Field exit required should not be specified for ideographic open fields. |
| Mandatory enter (byte 2, bit 4) | For ideographic either fields, switching field mode sets the modify data tag (MDT) bit and meets the mandatory enter requirement. Inserting or taking out an open field or subfield also sets the MDT bit and meets the mandatory enter requirement. |
| Mandatory fill (MF) (byte 2, bits 5–7 = 111) | Mandatory fill is set when an ideographic character is entered in an ideographic only or either field. This field is also set in an ideographic either field that has a changed mode (shift control characters are either added or taken out of the original field). This field is also set by ideographic open fields when double-byte or single-byte characters are entered, or a subfield is added or taken out. The field requirements are tested between the leading and trailing shift control characters in ideographic only and either fields. In ideographic open fields, testing is done from field start to field end. |
| Monocase (byte 2, bit 2) | This bit is ignored for Japanese ideographic systems. |
| Right adjust (byte 2, bits 5–7 = 110-blank) | In ideographic only and either fields, the data is right-adjusted to the ending shift-in character. X'4040' fills the null character positions to the left of the adjusted data. Zero fill should not be specified; blanks occur.<br>This function is not used in ideographic open fields and should not be specified. |

***Format Level 0:*** Initially, the field is set for alphanumeric entry. You can select Ideographic mode by pressing the Kanji key. Successive depressions of the Kanji key will alternately select Ideographic or Alphanumeric mode. When you select Ideographic mode, a shift-out character is written into the second position of the screen buffer (row 1, column 2) and a shift-in character is written into the last position (the last row, column 79). Screen attributes occupy the first and last positions on the display.

In Free Key mode, fields are initialized for alphanumeric entry. You can press any key that does not require AS/400 system action in Free Key mode. If you press a key that requires AS/400 system program action, system reference code 0099 is displayed.

Format level 0 for the 5494 has the following specific definition:

- The FFW is alpha shift and has an ideographic either FCW.
- No shift control characters are written on the display. The ideographic either field is initialized as an alphanumeric field. This allows alphanumeric entry.
- The input field starts at row 1, column 2, and ends in the last row, column 79. The field length is equal to the screen size, less 2 bytes. (Two bytes are used for screen attributes.)
- The leading attribute is set in row 1, column 1, and the trailing attribute is set in the last row, column 80.
- The cursor is initially set to row 1, column 2, and is blinking.
- The keyboard is set to Alphanumeric mode with auto-shift active.
- The 5494 translates any single-byte keystrokes while in Alphanumeric mode.
- The Kanji key causes the field to change to Ideographic mode.

Ideographic entry is forced in Ideographic mode, but no extension character requests are sent to the AS/400 system because the workstation is not communicating with the AS/400 system. The valid ideographic code for the extension character is written into the workstation buffer, but special default characters are displayed.

On ideographic displays, at Format Level 0, the following function keys are added to the valid function keys in Free Key mode:

- Display 0E/0F Character
- Erase End of Field
- Kanji
- Character Advance.

## AS/400 System Extended Ideographic Support

The AS/400 system sends the extended double-byte character data to the 5494 when:

- The AS/400 system recognizes a character in the outbound data stream that is an extended double-byte character and the definition of the bit matrix is required at the workstation.
- The workstation operator requests an extended double-byte character by typing in an input field.

## LOAD MATRIX Command Definition

The LOAD MATRIX command loads the bit matrix into the RAM of an ideographic workstation or identifies the RAM location that already contains the bit matrix for a double-byte character. The command format is shown in Table A-3.

*Table A-3. Load Matrix Command Format*

| Byte | Value (Hex) | Description |
|---|---|---|
| 0 | 04 | Escape character |
| 1 | 31 | LOAD MATRIX command |
| 2–3 | YYYY | Extension character whose bit matrix is being loaded, or is already loaded |
| 4–5 | AAAA | Display RAM address |
| 6 | nn | Length of the bit matrix data included with this command. The length does not include this byte. |
| 7–n | DDDD | Bit matrix data (optional) |

Valid decimal values for byte 6 are:

- 0 – No bit matrix is included, the display RAM address contains the bit matrix pattern
- 72 – 24 x 24 bit matrix is included
- 116 – 116-byte 26 x 29 bit matrix is included.

If the length value is not valid (0, 72, or 116), the data stream is rejected with a parameter error SNA negative response X'1005012E'.

Valid extension character RAM addresses are:

- X'F040' through X'F0FF'
- X'F140' through X'F1FF'
- X'F240' through X'F2BF'.

If the workstation does not support the RAM address, the data stream is rejected with a parameter error SNA negative response X'1005012E'.

## LOAD MATRIX Command Processing

The AS/400 system searches all data streams for extension characters before sending the data streams to the 5494. Each extension character code point is replaced by a RAM address assigned by the AS/400 system, which contains the bit matrix. The AS/400 system issues the LOAD MATRIX command to the 5494 to load the bit matrix for each assigned RAM address.

The AS/400 system maintains a RAM content list as the data streams are searched for extension characters. The AS/400 system issues a LOAD MATRIX command for each extension character in the data stream. At the end of the data stream, the RAM content list matches the contents of the extension character RAM in the workstation.

LOAD MATRIX commands can be included with any data stream that is sent to the workstation. It is recommended that the LOAD MATRIX command precede the

WRITE-TO-DISPLAY command so that the extension characters are immediately displayed when the RAM addresses are written into the workstation buffer.

If a workstation operator enters an alternate or user-defined character that is not in the character-generating ROS in the workstation, the 5494 sends an extension character request to the AS/400 system.

The 5494 waits for a LOAD MATRIX command with a matching ideographic code point. The extension character request is satisfied when the 5494 receives the matching LOAD MATRIX command from the AS/400 system. The keyboard is locked and the cursor stays in the same position while the AS/400 system processes the extension character request.

The extension character request can be cleared and the keyboard unlocked by one of the following commands:

- CLEAR FORMAT TABLE
- CLEAR UNIT
- WRITE ERROR CODE
- WRITE-TO-DISPLAY.

The following sequence is used to process the LOAD MATRIX command:

1. When the 5494 receives a LOAD MATRIX command, the length byte is tested to make sure that the command is valid. If the length byte is valid and is not 0, the 5494 loads the bit matrix into the extension character RAM at the assigned address. If the length is 0 (meaning that the bit matrix is already loaded), the RAM is not loaded.
2. The 5494 tests for a locked keyboard while processing the extension character request.

   When the keyboard is locked, an extension character request LUSTAT has been sent to the AS/400 system and the workstation is waiting for the AS/400 system to respond. The 5494 compares the double-byte ideographic code from the AS/400 system to the extension character code sent to the AS/400 system. If the two codes match, the 5494 writes the RAM address on the screen at the current cursor position and unlocks the keyboard. If the two codes do not match, the 5494 does not write the RAM address on the screen and the keyboard stays locked while waiting for the correct LOAD MATRIX command.

   If the 5494 receives a LOAD MATRIX command when it did not send an extension character request, it loads the bit matrix into the extension character RAM, but does not write the RAM address on the screen.

After the LOAD MATRIX command is completed, the 5494 starts on the next command in the data stream, if there is another command.

## Keyboard Functions

The Ideographic support modifies the following key functions. For more information on key functions, see Chapter 13, “Keyboard Functions.”

The AID-generating keys generate AID codes that go in the display data stream to the AS/400 system in response to the READ commands. The AID-generating keys that alert the AS/400 system that the 5494 requires some action are the command keys and the record backspace key.

## Command Keys

The command keys do special functions such as program function (PF). All keyboard modes use the same PF keys.

## Record Backspace Key

On the Ideographic keyboard, the record backspace function is the lower-shift function of the Erase Input/Home key.

Normally, the 5494 recognizes only the designated home position. If the cursor is not at the home position when the Home key is pressed, the cursor is moved to the designated home position without any AID code sent to the AS/400 system. If the cursor is already at the home position when the Home key is pressed, the 5494 sends a record backspace AID code to the AS/400 system without moving the cursor.

The home position is usually the first position of an input field. However, the first character for an ideographic input field may or may not contain a shift-out character. If the home position falls under a leading shift-out character, the 5494 assumes a home position at the first character position of the input field.

For more information on character entry, refer to your workstation documentation.

# Glossary

## A

**A**. Address (A).

**ABM**. Asynchronous balanced mode.

**ACTLU**. Activate logical unit.

| **ACTPU**. Activate physical unit.

**adjacent link station (ALS)**. A link station that directly connects a given node by a link connection, over which network traffic can be carried.

**ADM**. Asynchronous disconnected mode.

**AID**. Attention identifier.

**alert**. For LAN management-based products, a notification indicating a possible security violation, a persistent error condition, or an interruption or potential interruption in the flow of data around the network.

**ALS**. Adjacent link station.

**analog network**. A type of communications network that carries analog signals.

| **API**. Application program interface.

**ARM**. Asynchronous response mode.

**AS/400 system**. In a communications system, the computer that provides end-users with services such as computation and databases, and that usually does network control functions.

**AS/400 system operator**. A person who uses the workstation that is designated as the system console to activate certain system functions, and to control and monitor system operation.

**ASCII**. American National Standard Code for Information Interchange.

| **ASM**. Address space manager.

**asynchronous balanced mode (ABM)**. An operational mode of a balanced data link in which either combined station can send commands at any time and can initiate transmission of response frames without explicit asynchronous response permission from the other combined station.

**asynchronous data transfer**. A physical transfer of data that occurs without a regular or predictable time relationship. Start and stop bits are required to indicate transmission boundaries.

**asynchronous response mode (ARM)**. An operational mode of an unbalanced data link in which a secondary station may initiate transmission without explicit permission from the primary station.

**attention identifier (AID)**. A character in the identification string indicating that the user has pressed a key, such as the Enter key, that requests an action by the system.

**Attn**. Attention.

**AWG**. American Wire Gauge.

## B

**B' '**. Binary number in single quotes.

**basic information unit (BIU)**. In SNA, the unit of data and control information passed between half-sessions. It consists of a request/response header (RH) followed by a request/response unit (RU).

**basic link unit (BLU)**. In SNA, the unit of data and control information transmitted over a link by data link control.

| **BBI**. Begin bracket indicator.

**beacon**. In the Token-Ring network, a frame sent by an adapter indicating a serious network problem, such as a broken cable.

**beaconing**. Sending beacon frames continuously.

**BEL**. The bell character.

**BIDI**. Bidirectional.

**BIS**. Bracket initiation stop.

**BIU**. Basic information unit.

**BLU**. Basic link unit.

**bps**. Bits per second.

| **BTU**. Basic transmission unit.

**buffer**. A temporary storage location, especially one that accepts information at one rate and delivers it at another rate.

## C

**CAT**. Request/response unit category.

**C**. Control field.

**cable-through**. A method of cabling that allows multiple workstations to be attached to a single cable path.

**cabling system**. A system of communications wiring installed in a building to connect computers and communications equipment.

**CC**. Control character.

**CCITT**. International Telephone and Telegraph Consultative Committee.

**CD**. Change of direction.

**CDI**. Change direction indicator.

**CDSTL**. Connect data set to line.

**CGCS**. Character graphics code set.

**CI**. Calling indicator.

**closed user group**. A group of locations that can communicate themselves, but cannot call, or receive calls from, any location outside the group. This facility allows a limited number of users to communicate with either the 5494 or the AS/400 system, and thus increases security. You can usually obtain this service at a nominal fee, or it may be provided as a basic service with your subscription. On some networks, you can specify different closed user groups for different applications, if your subscription includes more than one group and a closed user group index is included in the connection setup instructions. Variations that allow calls to or from a device outside the group may be available depending on the network.

**Cmd**. Command.

**CNM**. Communication network management.

**CNOS**. Change number of sessions.

**CNR**. Controlled-not-ready.

**common carrier**. In the U.S.A., a government-regulated private company (such as a telephone or telegraph company) that furnishes the general public with telecommunications service facilities.

**copy and paste**. An operation using a mouse that copies text from one area of a screen to another.

**cpi**. Characters per inch.

**CPS**. Call progress signal.

**CR**. Carriage return.

**CRC**. Cyclic redundancy check.

**CRD**. Call request command with double dial-up required.

**CRI**. Call request command with number and identification provided.

**CRN**. Call request command with number provided.

**CRS**. Call request command with memory address provided.

**CSI**. Code selection indicator.

**CSU**. Customer setup.

**CTS**. Clear to send.

**CU**. Clear unit.

**customer setup (CSU)**. The unpacking, assembly, connecting, and checkout of IBM CSU-designated machines by user personnel according to a sequence of instructions provided by IBM. CSU is done without the use of tools and without help from IBM personnel.

**cyclic redundancy check (CRC)**. A mathematical process that determines the accuracy of a specific field or fields of data in an SDLC frame.

## D

**DACTLU**. Deactivate logical unit.

**DAF**. Destination address field.

**data circuit-terminating equipment (DCE)**. The equipment that provides the signal conversion and coding between the data terminal equipment (DTE) and the line.

**data coupler**. An electrical isolation device usually required by a common carrier to attach to the carrier's switched telephone lines. This is also referred to as a data access arrangement or protective coupler.

**data packet**. The type of data grouping used to send information from one DTE to another DTE attached to an X.25 packet switched network.

**data terminal equipment (DTE)**. A term for any machine, such as the 5494 or the AS/400 system, that is connected to a network.

**Db**. Decibel.

**DBCS**. Double-byte character set.

**DCD**. Data carrier detect.

**DCE**. Data circuit-terminating equipment.

**definite response**. In SNA, a value in the form-of-response-requested field of the request header. The value directs the receiver of the request to return a response unconditionally, whether positive or negative, to that request.

**Del**. Delete.

**dependent workstation (DWS)**. See *nonprogrammable workstation (NWS).*

**DFC**. Data flow control.

**Diacritic**. A mark added to a letter to indicate a special phonetic value.

**direct attachment**. Attachment of workstations to an AS/400 system without intermediate control units.

**diacritic**. A mark added to a letter to indicate a special phonetic value.

**DISC**. Disconnect command.

**display screen**. The presentation surface of a cathode ray tube used to display graphics or alphanumeric information.

**display station**. An input/output device containing a display screen and an attached keyboard.

**DLC**. Data link control.

**DM**. Disconnect mode.

**DMA**. Direct memory access.

**DP**. Data processing.

**DR**. Data ring.

**DR1I**. Definite response 1 indicator.

**DR2I**. Definite response 2 indicator.

**DRAM**. Dynamic random access memory.

**DSP**. Data stream profile.

**DSR**. Data set ready.

**DSRS**. Data signal rate select.

**DSU**. Digital service unit.

**DTE**. Data terminal equipment.

**DTR**. Data terminal ready.

**dual connection**. An SVC and a PVC operating on the same physical X.25 DTE/DCE interface.

**Dup**. Duplicate.

**duplex**. A method of data transmission in which the data can be transmitted in both directions simultaneously. (Also known as full-duplex.)

**DWS**. Dependent workstation. See *nonprogrammable workstation(NWS).*

**DXE**. Data transmit enable.

# E

**EA**. Erase to address.

**EAB**. Extended attribute buffer.

**EB**. End bracket.

**EBCDIC**. Extended binary-coded decimal interchange code.

**EBI**. End bracket indicator.

**ECB**. Extended character buffer.

**EDI**. Enciphered data indicator

**EIA**. Electronics Industries Association.

**ELLC**. Enhanced logical link control.

**emulation**. The imitation of all or part of one system by another (primarily by hardware) so that the imitating system accepts the same data, runs the same programs, and achieves the same results as the imitated system.

**enhanced logical link control**. A type of logical link control used in X.25 communications.

**EOC**. End of chain.

**EOF**. End of field.

**EOM**. End of message.

**EOQ**. End-of-command queue.

**EOT**. End-of-tape marker.

**ERAP**. Error recording analysis procedure.

**ERI**. Exception response indicator.

**ERP**. Error recovery procedure.

**ESC**. Escape character.

**exception response (EXR)**. In SNA, a value in the form-of-response-requested field of a request header. The receiver is requested to return a response only if the request is unacceptable as received or cannot be processed (that is, a negative response can be returned).

**EXR**. Exception response

## F

**F**. Flag.

**FCS**. Frame check sequence.

**FCW**. Field control word.

**FER**. Field exit required.

**FF**. Form feed indicator.

**FFW**. Field format word.

**FI**. Format indicator.

**FIC**. First in chain.

**FID**. Format identification.

**field replaceable unit (FRU)**. An assembly that is replaced in its entirety when any one of its components fails.

**flag**. A logical tool used to differentiate between two different states.

**flow control negotiation**. The ability to alter the packet size and packet window size. These may be changed from call to call if the network subscription allows flow control negotiation.

**FM**. Function management.

**FMD**. Function management data.

| **FMDS**. Functional management data services.

**FMH**. Function management header.

**format identification (FID)**. In SNA, a field in each transmission header (TH) that indicates the format of the transmission header (that is, the presence or absence of certain fields).

**frame**. A single transmission of variable length (32-bit minimum format) that SDLC uses for transmission of data over a communications network.

**frequency shift keying (FSK)**. The frequency modulation of a carrier by a digital modulating signal.

**FRMR**. Frame reject.

**FRU**. Field replaceable unit.

**FSK**. Frequency shift keying.

## G

**GDDM**. Graphical data display manager.

**GFI**. General format identifier.

| **GUI**. Graphical user interface. Displays with graphical user interface support include the 3486, 3487, and 3488. They have special characters to draw boxes, menus, and scroll bars.

## H

**half-duplex**. A method of data transmission in which data can be transmitted in both directions, but not at the same time.

**hard error (HE)**. An error condition on a network that requires the network be reconfigured or that the source of the error be removed before the network can resume reliable operation.

**HDLC**. High-level data link control.

**HDX-FF**. Half-duplex flip-flop.

**HE**. Hard error.

**header**. A prefix or preface that describes the type of information, and sometimes the quantity of information, that follows. The control field of the SDLC frame contains 5 bytes of SNA header information.

**help line**. A line on a workstation screen that provides messages to the operator in symbols. For example, a clock indicates the operator must wait.

**hexadecimal**. A number system with a base of 16. (Valid digits range from 0 through F.)

| **hot spots**. Screen data that is interpreted by the 5494 to represent certain activities when a mouse cursor is positioned on the data and a button is clicked, or double clicked. For example, if you position the mouse cursor on the text F3 (Exit) and press the left mouse button, the 5494 translates that activity into the F3 key being pressed and sends the appropriate AID information to the AS/400.

**Hz**. Hertz.

## I

**I**. Information.

**IA5**. International Alphabet No.5.

**IBM Cabling System**. A system of IBM-manufactured communication wiring that provides a common cable and connector type for a wide variety or wire types (such as coaxial, twinaxial, and telephone twisted-pair). Compare with *twinaxial cable* and *telephone twisted-pair (TTP) cable*. Note: It is used to pass information between devices separated by up to 1524 m (5000 ft.)

**IC**. Insert cursor.

**ID**. Identifier.

| **ideographic**. Used to identify processing performed by languages that require both single bytes and double bytes to represent their character sets.

| **independent workstation (IWS)**. See *programmable workstation (PWS).*

**initialization**. A process that prepares for the beginning of another process.

**initialization mode**. A nonoperational mode of a balanced or unbalanced data link in which a remote secondary or combined station data link control program can be initialized or regenerated by the local primary or combined station, or in which other parameters to be used in the operational mode can be exchanged.

**interface**. A shared boundary between two functional units, defined by functional characteristics, common physical interconnections, and signal characteristics.

**International Telegraph and Telephone Consultative Committee (CCITT)**. An organization of common carriers and other interested parties who meet periodically to define standards that they will mutually adopt.

**I/O**. Input/output.

**IPDS**. Intelligent printer data stream.

**IPDU**. Information protocol data unit.

| **IPL**. Initial program load.

**ISO**. International Organization for Standardization.

| **IWS**. See *programmable workstation.*

## K

**KB**. Kilobyte.

**KTT**. Keyboard Translation Table.

**keyboard translation table (KTT)**. A translate table downloaded from an AS/400 system during the power-on process of a device. The new table replaces the default keyboard translate table of the device. See translate table.

## L

**LAC**. Load alternate characters.

**LAPB**. Link access protocol-balanced.

**LCI**. Logical channel identifier.

**leased line**. A communication line that is permanently connected, always available, and does not require dialing to establish communication. Synonymous with *nonswitched line.*

| **LEN**. Low-entry networking.

**LF**. Line feed character.

| **LFSID**. Local form session identifiers.

**LIC**. Last in chain.

**line turnaround**. Time required to change the direction of transmission (from send to receive) a half-duplex circuit.

**link access protocol-balanced (LAPB)**. A protocol used for accessing an X.25 network at the link level. LAPB is a duplex, asynchronous, symmetric protocol used in point-to-point communication.

**link window size**. The maximum number of I-frames that can be sent from the 5494 without receiving an acknowledgment from the network. Valid values are 1 through 7.

| **LL**. Local loopback.

**LLC**. Logical link control.

**lobe**. In a Token-Ring network, the section of cable (which may consist of several cable segments) that connects an attaching device to an access unit.

**local loopback**. A test procedure done to verify the operation of the local modem.

**logical link control**. Information included in data packets for X.25 that provides end-to-end link-level type functions to the SNA layers in the AS/400 system and the 5494.

**logical unit (LU)**. In SNA, a port through which an end-user accesses the SNA network in order to communicate with another end-user, and through which the end-user accesses the functions provided by system services control points (SSCPs).

| **LP**. Licensed program.

| **LPDU**. Logical protocol data unit.

**lpi**. Lines per inch.

**LSID**. Local session identifier.

**LU**. Logical unit.

**LU 6.2**. Logical unit 6.2.

**LUSTAT**. Logical unit status.

# M

**maintenance analysis procedure (MAP)**. A maintenance document that gives an IBM service representative a step-by-step procedure for tracing a symptom to the cause of failure.

**mandatory enter (ME) field**. A field in which a user must enter at least 1 character.

**mandatory fill (MF) field**. A field a user must fill completely or leave blank.

**MAP**. Maintenance analysis procedure.

**MC**. Move cursor.

**MDT**. Modified data tag.

**ME**. Mandatory enter.

**MF**. Mandatory fill.

**MI**. Mode indicate.

**MIC**. Mode indicate common.

**code**. A set of instructions for a processing unit located in memory.

**migration**. The process of changing to a new operating environment, usually to a new release or version of a system.

**modem (modulator-demodulator)**. A device that converts digital data from a computer to an analog signal that can be transmitted on a telecommunication line and converts the analog signal received to data for the computer.

**modulo**. In a sequence of numbers, the modulo number indicates the point at which the sequence returns to 0. For example, modulo 8=012345670123...

| **mouse**. A type of pointer device attached to a display.

**MPL**. Maximum print line.

**MPP**. Maximum print position.

**MPU**. Microprocessing unit.

**MSR**. Magnetic stripe reader.

**multipoint line**. A data link that connects three or more data stations. A multipoint line is always leased.

# N

**NAU**. Network addressable unit.

| **NC**. Network control.

**NCI**. Network control information.

**NCP**. Network control point.

**NDM**. Normal Disconnected mode.

**NEMA**. National Electrical Manufacturer's Association.

**network addressable unit (NAU)**. In SNA, a logical unit, a physical unit, or a system services control point. The NAU is the origin or the destination of information transmitted by the path control network.

**network architecture**. A set of design principles, including the organization of functions and the description of data formats and procedures, for the purpose of allowing multiple computers to communicate so that they can share software and hardware.

**NL**. New line character.

**NLS**. National language support.

| **NMVT**. Network Management Vector Transport.

| **nonprogrammable workstation (NWS)**. A workstation
| that is incapable of operating independently of the 5494
| or the AS/400 system. A PC or PS/2 computer running
| a 5250 emulation program is also considered a DWS by
| the 5494.

**nonreturn to zero**. A data encoding method.

**nonreturn to zero inverted**. A data encoding method.

**nonswitched line.** See *leased line.*

**no response.** In SNA, a value in the form-of-response-requested field of the request header (RH) indicating that the no response is to be returned to the request, whether or not the request is received and processed successfully.

**Nr.** Receive count.

**NRM.** Normal Response mode.

**NRZ.** Non-return-to-zero.

**NRZI.** Non-return-to-zero inverted.

| **NS.** No network services.

| **NSMV.** Network services major vector.

**Ns.** Send count.

**NUI.** Network user identification

**Nul.** Null character.

| **NWS.** Nonprogrammable workstation.

| **N2.** Retry count.

| **N3.** Maximum in.

# O

| **OAF.** Origin address field.

| **ODAI.** Origin/destination address field assignor
| indicator.

**OIC.** Only in chain.

**OR.** A logic operator having the property that if P is a statement, Q is a statement, R is a statement,...then the OR of R, Q, R,..., is true if at least one statement is true, false if all statements are false. P OR Q is often represented by P + Q, *PvQ.*

# P

**P/F.** Poll final (bit).

**PA.** Program access.

**pacing.** A method by which a receiving station controls the rate of transmissions of a sending station. If a transmission is sent faster than it can be handled, a portion of the transmission would be lost. This is called overrun.

**packet.** Information transmitted through a packet switched network is divided up and inserted into packets. These usually consist of control information field giving destination, sequence number, optional facilities, and often a user data area. Various kinds of packets are used to transmit error codes and supervise the virtual circuit.

**packet size.** 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.** 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.

**packet window size.** Maximum number of packets that can be sent without receiving an acknowledgment.

**parity.** A system to ensure that a byte was received as it was transmitted. In a system that uses "even" parity, with 7 bits plus a parity, if the sum of the first 7 bits is an odd number, a 1 would be put in the eighth bit to make sure the sum of all bits an even number. In "odd" parity, a 0 would be put in the eighth bit so that the sum of all bits would be an odd number.

**PC.** Path control.

**PDI.** Padded data indicator.

**PDN.** Public data network.

**PDT.** Printer definition table.

| **PF.** Program function.

**permanent virtual circuit (PVC).** The packet switched equivalent of a leased line. The 5494 and the AS/400 system appear to the user to be permanently connected.

**physical services header (PSH).** A type of logical link control used in X.25 communications.

**PI.** Pacing indicator.

**PIU.** Path information unit.

**planar.** The planar is a printed-circuit electronic board that contains the logic that directs the 5494.

| **PLU.** Primary logical unit.

**point-to-point line**. A data link that interconnects two DTEs. It can be either switched or leased.

**polling**. The method the AS/400 system or 5494 uses to ask a workstation if it wishes to transmit.

| **POR**. Power-on reset.

**port**. The hardware coupling used to attach workstations to the 5494.

**Post Telephone and Telegraph Administration (PTT)**. A name used to describe a World Trade operating agency that controls the transportation of information (postal, voice, and/or data).

**power cord**. A cord that plugs into a wall outlet supplying electrical power.

| **Printer definition table (PDT)**. A translate table downloaded from an AS/400 system during the power-on process of a 3477, 3486, 3487 or 3488 device if the 3477, 3486, 3487 or 3488 device is attached to an ASCII printer. The new translate table replaces the 3477, 3486, 3487 or 3488 existing translate table used for printers. See *translate table*.

| **programmable workstation (PWS)**. A workstation that can operate independently of an AS/400 system but can also communicate with an AS/400 system, for example a PC or PS/2 computer running PC Support/400.

**protocol**. A set of instructions, requests, and responses providing a means of controlling the transfer of data between devices.

| **PSID**. NSMV Product Set ID.

**PSDN**. Packet switched data network.

**PTI**. Packet-type identifier.

**PTT**. Post Telephone and Telegraph Administration.

**PU**. Physical unit.

**public switched network (PSN)**. A communications facility owned by a telephone company through which subscribers can be connected by dialing the unique access number of another subscriber.

**PVC**. Permanent virtual circuit.

| **PWS**. Programmable workstation.

# Q

**QLLC**. Qualified logical link control.

**QRI**. Queued response indicator.

**qualified logical link control**. A type of logical link control used in X.25 communications.

| **QPSID**. Query Product Set ID.

# R

**RA**. Repeat to address.

| **RAM**. Random access memory.

| **RD**. Request disconnect or received data.

**Rec ADV**. Record advance key.

**Rec Bs**. Record backspace key.

**RECFMS**. Record formatted maintenance statistics.

**Recommendation V.24**. A recommendation for interfaces set by the CCITT and amended periodically. V.24 is a specification that defines the list of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE).

**Recommendation V.25 bis**. A recommendation for interfaces set by the CCITT and amended periodically. V series defines standards for interfaces and voice board modems. V.25 bis defines automatic calling and answering for the general switched telephone network using the 100-series interchange circuits.

**Recommendation V.28**. A recommendation for interfaces set by the CCITT and amended periodically. Electrical characteristics for unbalanced double-current interchange circuits. (These characteristics are identical to those defined in EIA-232D.)

**Recommendation V.35**. A recommendation for interfaces set by the CCITT and amended periodically. V.35 defines a communications interface composed of five single-ended interchange lines and separate differential lines for transmit data, transmit clock, receive data, and receive clock signals.

**Recommendation X.21**. A recommendation for interfaces set by the CCITT and amended periodically. The X series of recommendations defines standards for data transmission interfaces. X.21, specifically, defines the interface between data terminal equipment and public data networks for digital leased and circuit-switched synchronous services.

**Recommendation X.25**. A recommendation for interfaces set by the CCITT and amended periodically. The X series of recommendations defines standards for data transmission interfaces. X.25, specifically, defines the interface between data terminal equipment and packet switched networks.

**remote attachment**. Attachment of workstations to an AS/400 system through communication lines, and usually through an intermediate 5494.

**remote data communications system**. A computer system that communicates with one or more of its devices by means of a communications system such as a telephone line, satellite system, or microwave device.

**remote loopback**. A test procedure that verifies the operation of the local modem, the remote modem, and the communication lines between them.

**remote workstation**. A workstation that is attached to the AS/400 system through communication lines.

**REQMS**. Record maintenance status.

| **REQTEST**. Request test.

**reversed charging acceptance**. This facility allows virtual calls to be billed to the DTE receiving the call.

**RFS**. Ready-for-sending.

**RH**. Request/response header.

| **RI**. Ring indicator.

**RIM**. Request initialization mode.

**RJE**. Remote job entry terminal.

**RLSD**. Received line signal detected.

**RNR**. Receive not ready.

**ROM**. Read-only memory.

| **ROS**. Read-only storage.

**RPOA**. Recognized Private Operating Agency.

| **RPQ**. Request for price quotation.

**RQD**. Request definite response.

**RQE**. Request exception response.

**RQN**. Request no response.

**RQR**. Recovery.

**RR**. Receive ready.

**RRI**. Request/response indicator.

| **RSP**. Required space character.

**RSET**. Received signal element timing.

**RSHUTD**. Request shutdown.

**RTI**. Response type indicator.

| **RTM**. Response time monitor.

**RTS**. Request to send.

| **RTR**. Ready to receive.

**RU**. Request/response unit.

| **RX**. Receive data.

# S

**SABM**. Set asynchronous balanced mode.

**SAP**. Service access point.

**SARM**. Set asynchronous response mode.

**SBA**. Set buffer address.

| **SC**. Session control.

**SCD**. Set character density.

**SCL**. Set CGCS through local ID.

| **scroll bar drag and drop**. An operation using a mouse that scrolls a list to view items not currently displayed, by moving the mouse cursor over the scroll bar beside the list.

**SCS**. SNA character string.

**SDI**. Sense data included indicator.

**SDLC**. Synchronous Data Link Control.

| **SDT**. Start data traffic.

**sense data**. The data sent with an SNA negative response or provided with an SRC, indicating the reason for the problem.

**service access point**. A logical point made available by an adapter where information can be received and transmitted.

**session control (SC)**. (1) In SNA, one of the components of transmission control. Session control is used to purge data flowing in a session after an unrecoverable error occurs, resynchronize the data flow after such an error, and perform cryptographic verification. (2) In SNA, an RU category used for requests and responses exchanged between the session control components of a session, and for session activation/deactivation requests and responses.

**SET.** Signal element timing.

**SF.** Start of field.

**SG.** Signal ground.

**SGEA.** Set graphic error action.

**SHF.** Set horizontal format.

| **Shift-in character (SI)..** Ends double-byte character representation and returns to single-byte character representation on a screen.

| **Shift-out character (SO)..** Starts double-byte character representation on the screen.

**SHM.** Short Hold mode.

**SIM.** Set initialization mode.

**SLD.** Set line density.

**SLP.** Selector light pen.

| **SLU.** Secondary logical unit.

**SNA.** Systems Network Architecture.

**SNBU.** Systems network backup.

**SNRM.** Set Normal Response mode.

**SOH.** Start of header.

**SRC.** System reference code.

**SS.** System services.

**SSCP.** System services control point.

**station protector.** A device used on the system cable to offer protection against lightning for attachments made in different buildings.

**STSN.** Set and test sequence numbers.

**subscription.** An agreement between a user and a PTT/network supplier for the use of certain network services and optional facilities.

**SVC.** Switched virtual circuit.

**SVF.** Set vertical format.

**switched line.** A connection between computers or devices that is established by dialing.

**switched virtual circuit (SVC).** A switched virtual circuit is the packet switched service equivalent of a switched line. It allows communication between the 5494 and one of several possible AS/400 systems.

**SYN.** Synchronous idle character.

**synchronization character.** The bit pattern used to identify the beginning of a message in character-oriented and byte-count-oriented protocols; also called synchronizing character and abbreviated SYN.

**Synchronous Data Link Control (SDLC).** A form of communication line control used to transfer data over a communication line.

**synchronous operation.** An operation that occurs regularly or predictably with respect to the occurrence of a specified event in another process.

**system configuration.** A process that determines the devices, programs, and methods that form a data processing system.

**system generation.** A procedure used to configure the AS/400 system for the particular options and functions chosen.

**system reference code (SRC).** A code that contains information, such as a failing field replaceable unit, for a service representative.

**Systems Network Architecture (SNA).** A set of rules for controlling the transfer of information in a data communications network.

# T

**TAC.** Transmit activity check.

| **TC.** Transmission control.

**TD.** Transmitted data or transparent data.

**telecommunications.** The transmission of data between locations by telephone line, telegraph, radio, satellite, television, or microwave media.

**telephone twisted-pair (TTP) cable.** An unshielded cable with two or more pairs of insulated copper wire twisted together at a minimum of two twists per foot. This type of cable is commonly used in telephone installations for voice transmission. It can also be used for data transmission. However, twisted-pair cable is subject to interference and line loss, and therefore is limited to lengths of 305.8 m (1000 ft) when used to interconnect workstations to the 5494. Compare with *twinaxial cable* and *IBM Cabling System.*

**terminal multiconnector**. A device used to connect up to seven workstations to a single port on the 5494. The IBM 5299 Terminal Multiconnector can be used when cable-thru is inappropriate or unavailable.

**TH**. Transmission header.

| **Ti**. Inactivity timer.

**Token-Ring network**. A network using a ring topology to pass data transmission authority (called a *token*) in a unidirectional circuit from one workstation to another so that transmitted data not only reaches the addressed station but also returns to the transmitting station.

**translate table**. A table that defines the translation of EBCDIC to ASCII and that allows the use of special characters and nonstandard codes. For KTT, it defines what EBCDIC character is displayed for a particular key.

**transmission header (TH)**. In SNA, control information optionally followed by a basic information unit (BIU) or by a BIU segment, that is created and used by path control to route message units and to control their flow within the network.

**TRN**. Transparent.

**TS**. Transmission subsystem.

**TSET**. Transmitted signal element timing.

**TTP**. Telephone twisted-pair (cable).

| **TW**. Maximum out value.

**twinaxial cable**. A shielded cable with two conductors surrounded by insulating material and a conductive sleeve. It is used to pass information between devices separated by up to 1524 m (5000 ft). Compare with *telephone twisted-pair (TTP) cable* and *IBM Cabling System*.

| **T1**. Response timer.

| **T2**. Acknowledgment timer.

| **T2.1**. Type 2.1 connection.

| **TX**. Transmit data.

# U

**UA**. Unnumbered acknowledgment.

**unit address**. The address used to define each remote workstation. This address is determined for the remote configuration (customer setup) and must be obtained for use by the AS/400 system.

**UI**. Unnumbered information.

# V

**vertical redundancy check character**. A character code used for error sensing and correction.

**virtual call**. A call placed on a switched virtual circuit.

**virtual circuit**. A logical connection between two DTEs, which enables them to exchange information according to a standard communication procedure with the sequence of information preserved. A virtual circuit occupies transmission capacity only when the data is actually being transmitted.

**V.24**. See *Recommendation V.24.*

**V.28**. See *Recommendation V.28*

**V.25 bis**. See *Recommendation V.25 bis.*

**V.35**. See *Recommendation V.35.*

# W

**WCC**. Write-to-display control character.

**WDSF**. Write-to-Display-Structured-Field.

**WEA**. Write extended attribute.

| **window communications**. 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 to queue them. A default window size, usually 2, is assigned at subscription time. In some networks, this can be altered for a given virtual call.

| **window graphics**. An area on the screen that generally has borders and that overlays other areas of a screen.

**workstation**. An input/output device that allows either the transmission of data and the reception of data (or both) from the 5494 or AS/400 system, as needed to do a job. A workstation is either a display station or a printer.

**workstation address**. The address set by the operator during setup of the workstations. This address may be set on rocker switches, by keyboard entry, or by control panel entry.

**World Trade**. Any of the countries in Europe, Asia, Africa, and South America served by IBM.

**WP**. Word processing.

| **WSC**. Workstation customization support.

**WSF**. Write structured field.

**WSSF**. Write single structured field.

**WTD**. Write-to-display.

# X

**X' '**. Hexadecimal number in single quotes.

**X.21**. See *Recommendation X.21*.

**X.21 bis DCE**. A type of data circuit-terminating equipment that converts signals between EIA signal lines and those associated with an X.21 interface.

**X.25**. See *Recommendation X.25*.

**XID**. Exchange station identification.

**XMIT**. Transmit.

# Z

**zero-bit**. A bit with a voltage that represents a value of 0.

**zero-bit insertion/deletion**. A communications plan which prevents more than six 1-bits from being transmitted (including the flag), by inserting a 0 after each sixth 1-bit.

# Special Characters

**+rsp**. Positive response.

**-rsp**. Negative response.

# Index

## Numerics



## A



## B



## C

# D

# E



# F

# X



# Z

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