QWEST Communications International Inc. Technical Publication

QWEST DIGIPAC® SERVICE INTERFACE SPECIFICATIONS FOR PUBLIC PACKET SWITCHING NETWORK

Module 5

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NOTICE

This Technical Publication describes the interface protocols necessary for:

- Asynchronous terminals and hosts (Module 1)
- X.25 terminals and hosts (Module 2)
- X.75 connections with Interexchange Carriers to communicate via the Packet Switched Public Data Network (PSPDN) (Module 3)
- Dial-up access for X.25 devices using the X.32 recommendation (Module 4) and
- Point of Sales terminal to host communications using T3POS protocol (Module 5).

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1. Introduction

1.1 Overview

This Technical Publication describes the interface protocols necessary for:

- Asynchronous terminals and hosts (Module 1)
- X.25 terminals and hosts (Module 2)
- X.75 connections with Inter-exchange Carriers to communicate via the Packet Switched Public Data Network (PSPDN) (Module 3)
- Dial-up access for X.25 devices using the X.32 recommendation (Module 4) and
- Point of Sales terminal to host communications using T3POS protocol (Module 5).

Network level signaling messages are transmitted as American Standard Code for Information Interchange (ASCII) text. The terms used herein are consistent with the text of the International Telecommunications Union (ITU), formerly International Telegraph and Telephone Consultative Committee (CCITT), Recommendations specified in this document. All reference in this Technical Publication to ITU recommendations are per the 1988 issue "blue book", unless specified otherwise.

The asynchronous interface is based on ITU Recommendation X.28 which defines the protocol between the asynchronous device and the PSPDN. The asynchronous Data Termination Equipment (DTE)/X.25 DTE interface is based on ITU Recommendation X.29 which specifies the protocol between the packet-mode DTE and the PSPDN. ITU Recommendation X.3 defines a Packet Assembly/Disassembly (PAD) facility in a PSPDN. The X.25 interface is based on ITU Recommendation X.25 which defines the protocol between the X.25 DTE and the PSPDN. The X.75 interface is based on ITU Recommendation X.75 which defines the protocol between the Inter-exchange Carriers, data service providers and the PSPDN. The X.32 interface is based on ITU Recommendation X.32 which defines the protocol and procedures for an X.25 DTE to access the PSPDN using a Dial-up connection, either to originate or terminate X.25 calls.

The T3POS interface defines the protocol, procedures, and PAD function within the PSPDN to allow Point of Sale (POS) terminals to use the Packet Network as a means to access Credit Card Association (CCA) hosts or Information Service Providers (ISP).

A table of all acronyms used in this Technical Publication can be found in Chapter 5.

All changes and reissues of this Technical Publication will be made on a QWEST wide basis.

1.2 Reason For Reissue

This document is being reissued at this time to show QWEST Communications International Inc. as the owner of this publication and the one to contact concerning the content.

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2. DIGIPAC® Support of T3POS

2.1 General

This Chapter describes the implementation of T3POS[1] protocol on the DIGIPAC® Network, if it were being offered. The T3POS Packet Assembler/Disassembler (PAD) function was provided by QWEST in support of transaction services such as Point Of Sale (POS). This module is being issued only to announce that QWEST will no longer offer access to the T3POS PAD function but that QWEST will transport X.25 Packets used to transport T3POS protocol that comes from a user on an ISDN (Integrated Services Digital Network) switch.

Where there are differences in the operation of the QWEST T3POS PAD function and the T3POS Standard it will be noted in the text as well as a compliance matrix at the end of this chapter. In addition, the phrase **Not Offered** will be used to mean the following:

- **Not Offered** indicates that either the QWEST T3POS PAD does not provide the function described or that QWEST has decided not to include the function in its service offering and therefore the function is **not offered** to subscribers of the DIGIPAC® service.

2.2 Purpose

T3POS is a transaction switching and transport protocol that has been designed to provide Point of Sale (POS) equipment already in place, as well as future POS terminals, with efficient and economical transaction switching and transport service over an X.25-based packet network. T3POS is based on de facto standard protocols in the credit card industry that were developed by VISA International and link level control procedures obtained from the International Standards Organization (ISO).

[1] The name T3POS is a pseudo-acronym derived from the term Transaction Processing Protocol for Point-Of-Sale.

Transaction switching and transport refers to X.25-based packet network support of reliable, real time receipt, routing and delivery of a transaction to and from a customer's premises and an Information Service Provider (ISP) (see Figure 2-1). Two types of transactions: credit authorization and data capture, each using a slightly different application layer protocol that is transparent to the packet network, are relevant to this discussion of T3POS. Credit authorization transactions are random events typically involving a message transmitted by a POS terminal and a response from an authorizing host system, after which the line is disconnected. Data capture transactions are events that involve a sizable amount of information transmitted from the terminal to the host and a response from the host system. Data capture typically takes place at the end of a business day. T3POS has been developed to give an X.25-based packet network, the flexibility to meet compatibility and performance requirements for both credit authorization and data capture transactions. A T3POS (PAD) permits POS terminal equipment to communicate with Information Service Providers (ISP) via Virtual Circuits (VC) supported by the X.25-based packet network. The T3POS PAD converts character-oriented frames arriving from a POS terminal to a format that is capable of being carried over a packet network VC.

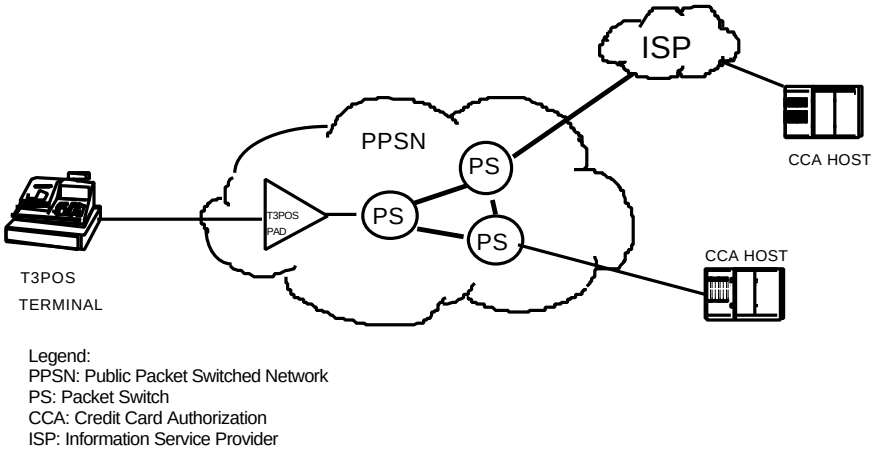


Figure 2-1 An Overview of the Transaction Switching and Transport Service Architecture

2.3 Background on T3POS

T3POS is a transaction switching and transport protocol based on VISA USA's de facto standard credit authorization and data capture protocols. T3POS is also based on the International Standards Organization's (ISO) Basic Mode Control Procedures for Data Communication Systems (ISO 1745). T3POS supports information transfer across a data link that is monitored by link control procedures, where some control characters are given a particular meaning according to the transmission phase (e.g., call establishment, data transfer, and call clearing). All necessary control information passing from the POS terminal to the PAD is carried over the link by discrete control characters selected from an internationally standardized character set. Although not internationally standardized like ISO 1745, VISA USA's authorization and data capture link level protocols are a significant factor in transaction switching and transport because of the extent of their use and the size of the embedded base of compatible equipment. For specific background information on the VISA protocols and ISO basic control procedures, refer to the following documents:

- Second Generation Authorization Terminal Link Level Protocol, Volume 3, VISA USA, September 1990.
- Information Processing -- Basic Mode Control Procedures for Data Communication Systems (ISO 1745).
- Basic Mode Control Procedures -- Conversational Information Message Transfer, ISO 2629, International Standards Organization, 1st Ed., 1973.
- Basic Mode Control Procedures -- Complements, ISO 2628, International Standards Organization, 1st Ed., 1973.

Note that the references to the VISA International documents are intended to apply to the packet network access control procedures for POS terminal transactions to any ISP or Credit Card Association (CCA), as long as the ISP or CCA conforms to the applicable interface and protocol specifications.

2.4 Support of T3POS and X.25

T3POS operates in three basic modes that provide different types of POS terminals with access to an X.25-based packet switched network that provides transaction switching and transport.

- Transparent Mode -- This mode enables the use of existing credit authorization and data capture link level protocols (e.g., VISA 2) with minimal modifications to the POS terminal and without any modifications to the ISP/CCA host system software. This mode requires that the PAD monitor the data stream to perform a limited set of link level procedures at the PAD/terminal interface. The PAD provides protocol conversion between the POS terminal and the host in a way that makes the protocol differences associated with the packet network unrecognizable to both the POS terminal and the ISP/CCA host system.

- Local Mode -- This mode eliminates the transfer of supervisory frames (e.g., ACK and NAK) across the X.25-based packet network. In this mode, the PAD assumes full responsibility for issuing supervisory frames to the POS terminal while information frames only are passed across the packet network. Modifications to the CCA host system software are required in order to function in the absence of supervisory frames.

  This is the mode in which all opening frames are processed, and the mode to which the PAD returns after the completion of each call. The default mode of operation for terminal initiated calls will be provisioned as Local Mode.

- Blind Mode -- This mode enables interworking with terminal equipment that supports unique protocols (e.g., X.28 asynchronous terminals) and proprietary message formats. When the PAD enters this mode typically upon receipt of an opening frame containing a special signal used for mode selection, it "blindly" passes all characters received from the POS terminal and the ISP without regard for the protocol or parity. Calls must be cleared by the ISP since the PAD can not interpret the user's call clear command (i.e., the DLE, EOT sequence) in the data stream. The default mode of operation for Host initiated calls will be set as Blind Mode if no other mode is requested at the time the service is ordered.

T3POS modes only apply for the duration of the virtual call. The PAD processes opening frames in Local Mode and enters the appropriate mode after the opening frame has been processed. The following is a list of benefits offered by the T3POS protocol:

- Transparent mode enables a T3POS PAD to operate with a large number of existing POS terminals and host systems requiring minimal modifications to their communications software.
- Longitudinal Redundancy Check (LRC) generation and validation is used in opening message validation and in Local mode to provide local error recovery procedures. Current asynchronous interfaces based on X.3, X.28 and X.29 do not support such reliability.
- When operating in Local mode, a T3POS PAD eliminates the need to transmit particular T3POS protocol elements (e.g., ACK, NAK, etc.) across the packet network. Operating in this mode not only reduces the number of packets that must traverse the packet network -- which may lower the cost -- but also may reduce the total transaction time.
- Blind mode provides a T3POS PAD with both data and protocol transparency to operate with X.28 or a proprietary POS terminal-to-host protocol.
- T3POS results in fewer PAD requirements than the traditional X.3 PAD. Although it must support the capabilities of the X.3 PAD that are associated with packet assembly and disassembly, a T3POS PAD is not required to support all PAD command signals and PAD service signals that are supported by an X.3 PAD.

2.5 Physical Connection of the POS TurboCharge® Service Terminal to T3POS Pad

- **Data Over Voice (Not Offered)**: The most common method of connection to the DIGIPAC, network was by way of a Data Over Voice (DOV) connection but it is no longer available under the DIGIPAC® tariff. However, a customer may chose to buy Digital Data Over Voice service from QWEST and couple that with direct asynchronous access described below. The DOV connection enabled the user to simultaneously use their telephone connection to the QWEST voice network for both voice communications as well as POS transactions. The details of that DOV interface are beyond the scope of this document but may be found in QWEST Technical Publication 77331, "Digital Data Over Voice Digital Access Arrangements, Network Interface Specifications". A pictorial representation of this method can be seen in Figure 2-2.
- **Direct Asynchronous Access (Not Offered)** only method of connection to DIGIPAC® offered at this time. The default method for this type of connection to DIGIPAC® would be using the direct access asynchronous 2400/1200 bit/s connection detailed in Chapter 4, Section 4.4.1 of this document.

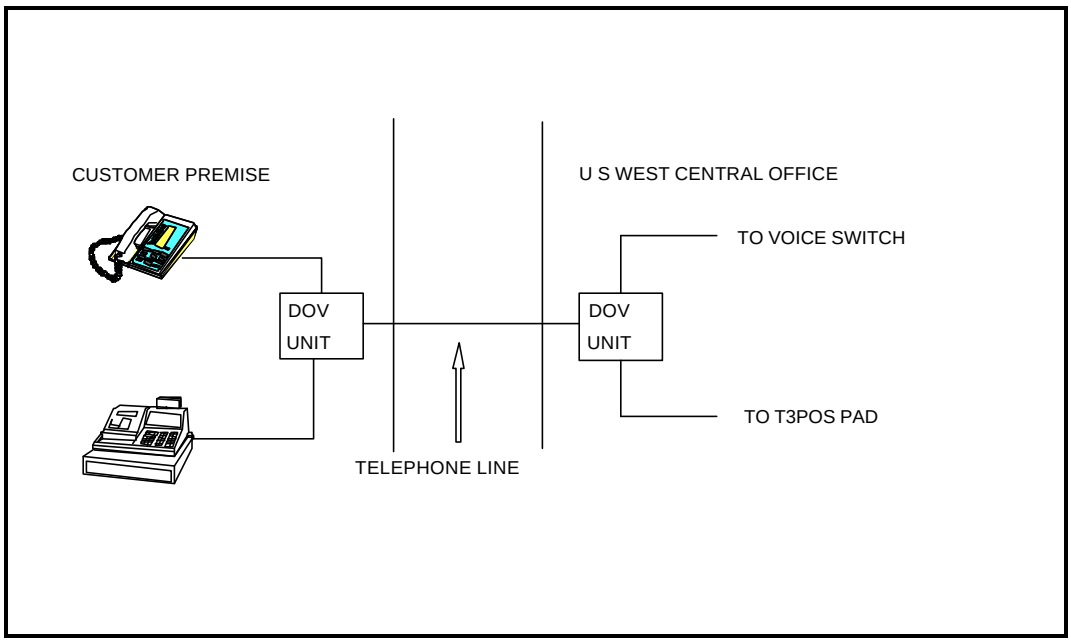


Figure 2-2 POS Terminal Connection via Data Over Voice (DOV) Unit

- **Dial Access (Not Offered)**: The third method of access, may be by a dialed access to a 950-XXXX telephone number. In this method the customer places a call to a 950-XXXX number that has been provided to them by the CCA. This call will in turn connected to the T3POS PAD in the DIGIPAC® Network or another PSPDN. This method of access may be made available on special request.

2.6 Character Exchange and Service Initialization

2.6.1 T3POS Character Set

The DIGIPAC® T3POS PAD is capable of transmitting and receiving characters in accordance with International Alphabet No. 5 (IA5) as described in CCITT Recommendation T.50, 1988, which is very similar to the character set defined by ANSI X3.4, "American National Standard Code for Information Interchange". A T3POS PAD engaged in asynchronous transmission will transmit and accept a transmission character that consists of one start bit, followed by 7 data bits, followed by a parity bit, and ending with one stop bit (see Figure 2-3). The data bit sequence is transmitted from the least significant bit to the most significant bit (i.e., the low-order bit is in the bit 1 position). The default character length and parity is set for 7 bits even parity (see Table 2-3).

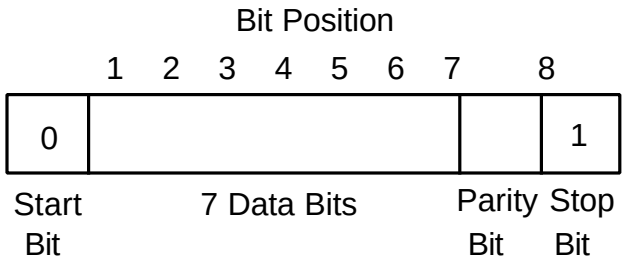


Figure 2-3 Asynchronous Character Format

The parity bit is generated in accordance with ISO 1177, Information Processing -- Character structure for start/stop and synchronous transmission, 2nd Ed., 1985, which states that the character parity sense will be odd in synchronous transmission and even in asynchronous transmission.

The parity in the Opening Frame Validation state and Local mode is settable at subscription time. The T3POS PAD will transmit and accept a transmission character that consists of one start bit, followed by 7 data bits (with an even parity bit after as shown in Figure 2-3) or 8 data bits (with no parity as shown in Figure 2-4), and ending with one stop bit. The parity of the characters transmitted by the PAD to the host will be the same as the parity received from the POS terminal. The Blind Mode and Transparent Mode character format is defined as 8 bit data with no parity bit as shown in Figure 2-4.

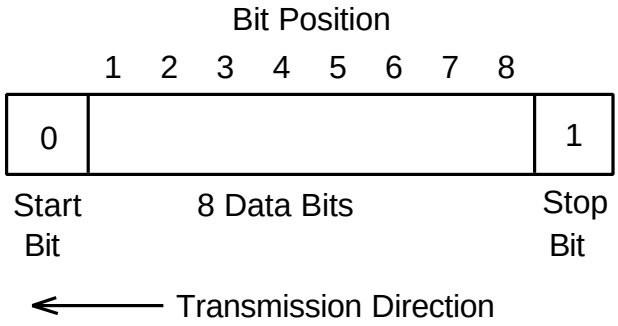


Figure 2-4 Transparent and Blind Mode Character Format

In Blind and Transparent modes, parameter 21 will be set to 0 and the PAD will accept and transmit characters that consist of one start bit, followed by 8 data bits, and ending with one stop bit (see Figure 2-4).

The parity for characters generated by the PAD in all modes of operation (e.g., DLE, EOT) will be used in the Opening Frame Validation state.

The IA5 character set contains 128 coded characters divided into both control and graphic characters as shown in Table 2-1. Control characters are derived from the first two columns of the IA5 character set. Specifically, the subset of control characters are those that appear in the 6-bit codes defined in Table 1 of ISO 646, Information Processing -- ISO 7-bit coded character set for information interchange, International Standards Organization, 2nd Ed., 1983; which are all supported by IA5. User data may consist of all characters in the third through the eighth columns of the IA5 character set, but may also include all control characters except the ETX (End of Text) control character, which is designated as a special T3POS frame delimiters. In addition, user data should NOT consist of the DLE, EOT sequence in Local and Transparent modes because it will be interpreted as a *clear request* command signal.

Table 2-1 IA5 Character Set

	Control Characters		**Displayable Characters**					
7 BIT 6 4321 5	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
0000	NUL / ^@	DLE / ^P	SP	0	@	P	`	p
0001	SOH / ^A	DC1 / ^Q	!	1	A	Q	a	q
0010	STX / ^B	DC2 / ^R	"	2	B	R	b	r
0011	ETX / ^C	DC3 / ^S	#	3	C	S	c	s
0100	EOT / ^D	DC4 / ^T	$	4	D	T	d	t
0101	ENQ / ^E	NAK / ^U	%	5	E	U	e	u
0110	ACK / ^F	SYN / ^V	&	6	F	V	f	v
0111	BEL / ^G	ETB / ^W	'	7	G	W	g	w
1000	BS / ^H	CAN / ^X	(	8	H	X	h	x
1001	HT / ^I	EM / ^Y	)	9	I	Y	i	y
1010	LF / ^J	SUB / ^Z	*	:	J	Z	j	z
1011	VT / ^K	ESC / ^[	+	;	K	[	k	{
1100	FF / ^L	FS / ^\	,	<	L	\	l	|
1101	CR / ^M	GS / ^]	-	=	M	]	m	}
1110	SO / ^N	RS / ^^	.	>	N	^	n	~
1111	SI / ^O	US / ^_	/	?	O	_	o	DEL

2.6.2 Service Initialization

Before a POS transaction may be initiated over a virtual circuit to a host system, an access information path must be established and service configuration options must be set on the access interface. This is referred to as *service initialization.* Service initialization procedures dictate what signals must be exchanged between the DTE and the PAD to set up communication and what the appropriate values for the configuration options are.

Service Configuration Options

A T3POS PAD supports interfaces that offer X.25-based packet network access to the public at large. These T3POS interfaces support a standard packet network service.

- The default mode of operation for terminal and host-initiated calls is independently settable to Local, Transparent or Blind mode.

- The PAD supports the T3POS interface service parameters and the optional values summarized in Table 2-2. The QWEST Standard default parameter value settings are summarized in Table 2-3.

Table 2-2 Service Attributes of a T3POS PAD Interface

Interface Service Parameters	Optional Values
Default PAD Aspect (Optional)	T3POS PAD X.3/X.28/X.29 PAD
Mode Selection parameters for: Host-initiated Terminal-initiated	Local, Transparent or Blind
ENQ Handling	Wait T3 sec. for ENQ Do not wait for ENQ
Maximum Block Size (Local Mode)	256 octets
Packet Size	64, 128, or 256 octets
Default Timer Values character-to-character timer SYN-to-SYN timer ENQ timer NAK Timer DLE/EOT Timer	 .01-2.55 sec. 1 - 10 sec. .5 - 5 sec. .01-2.55 sec. 4 min. fixed
Direct Call Option	ON/OFF
Direct Call Address	X.121 address E.164 address
Method of Host Notification	Call Request Packet Mode Switch Frame None
PID Selection	T3POS X.29
Opening Frame ACK Generation (Note 1)	OFF ON
Signaling Rate	300, 1200, 2400 4800, 9600, AUTO
Opening Frame/Local Mode Data format	7 bits, even parity 8 bits, no parity
Link Access Type	Dial, Dedicated
Re-try Limit (*n*) NAK or ENQ	1-15
RTS/CTS Flow Control	ON OFF

Note 1: The parameter only applies to Transparent and Blind modes.

Table 2-3 T3POS PAD Standard Default Configuration

Interface Service Parameters	Default Values
Default PAD Aspect (Optional)	T3POS
Mode Selection parameters for: Host-initiated Terminal-initiated	 Blind Local
ENQ Handling	Do not wait for ENQ
Maximum Block Size	256 octets
Packet Size	256 octets
Default Timer Values character-to-character timer SYN-to-SYN timer ENQ timer NAK timer DLE/EOT Timer	 0.04 sec. 4 sec. 1.5 sec. 4 sec. 4 min.
Direct Call Option	ON
Direct Call Address	X.121 address
Method of Host Notification	None
PID Selection	X.29
Opening Frame ACK Generation	OFF
Signaling Rate	2400
Opening Frame/Local Mode Data format	7 bits, even parity
Link Access Type	Dedicated
Re-try Limit (*n*) NAK or ENQ	3
RTS/CTS Flow Control	OFF

2.7 PAD Support of the T3POS Protocol

T3POS is a character-oriented transaction switching and transport protocol designed to provide efficient credit authorization and data capture via an X.25-based packet switched network. T3POS is used for data interchange between a POS terminal and a PSPDN Access Concentrator (AC) over a single information path. Described in terms of the Open Systems Interconnection (OSI) Reference Model, T3POS on the terminal-to-PAD interface may be viewed as a Data Link layer protocol, supporting such functions as error correction, flow control, and information delimitation. T3POS also specifies timing procedures, which reflect customer requirements that must be met to ensure consistent and reliable service operation.

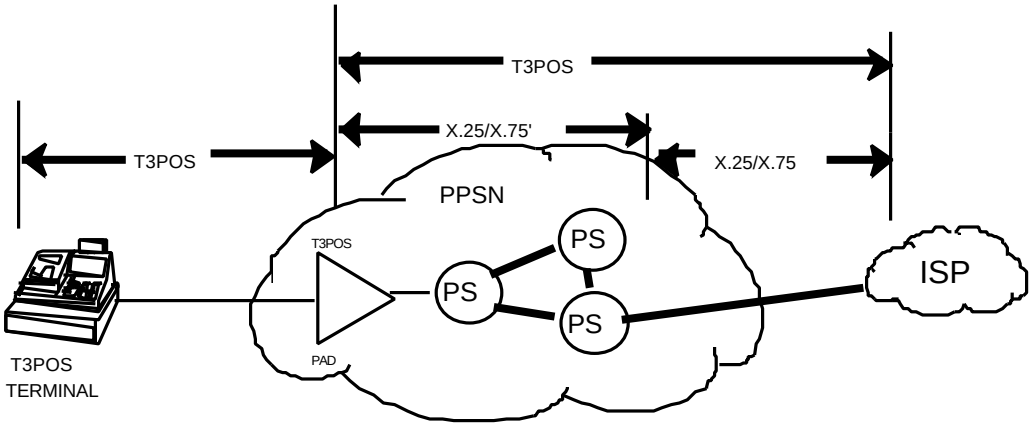


Figure 2-5 T3POS PAD Support of DIGIPAC®

Figure 2-5 illustrates a POS terminal accessing an ISP via DIGIPAC® using the T3POS protocol. The access portion -- from the POS terminal to DIGIPAC® -- shows T3POS operating over the local loop. At the PAD, a T3POS-formatted frame is encapsulated in an X.25 packet and passed to a Packet Switch (PS) over an internal protocol, X.25 or X.75' interface. The X.25 packet destined for the ISP exits DIGIPAC® over an X.25 or X.75 interface. Like most OSI Data Link layer protocols, T3POS operates independently of the Physical layer, enabling operation over several transport alternatives.

2.7.1 T3POS Frame Definitions

T3POS frames fall into two categories: information frames and supervisory frames. While supervisory frames are typically made up of a single control character, information frames are made up of a sequence of characters. The control characters are used either to define the nature of an information frame (i.e., an opening frame or a general frame) or to convey call control functions in the form of a supervisory frame. When control characters are received by a T3POS PAD, they instruct the PAD to take specific action. Some T3POS control characters must not be misconstrued as user data. In particular, the ETX control character must not be included in the Message field because the PAD will treat this as a Message field delimiter. In addition, if the sequence of DLE, EOT is in the message field, the PAD will interpret this as a disconnect signal and clear the call. The CPE must be capable of ensuring that appropriate control characters appear in the Control and Message fields of a T3POS frame.

2.7.2 Frame Structures

- Information Frames

  In Local mode, a T3POS PAD receives and transmits POS messages in information frames conforming to the General Frame format in Figure 2-6. In the General Frame format, the STX (Start of Text) character preceding the POS message is defined as the opening character. The ETX character following the Message field and preceding the LRC is defined as the Message field delimiter. In Transparent and Blind mode, the format of the customer information is unrecognized by the PAD, and the T3POS PAD receives and transmits information according to the guidelines of the particular protocol agreed to between the user (terminal end) and the ISP (host end).

Figure 2-6 General Frame Format

In the Control Frame format (Figure 2-7), the SOH (Start of Header) character preceding the Control field is defined as the *opening character.* The Control field is followed by a frame in the General format. That is, the Message field is preceded by an STX character and followed by an ETX character and an LRC character. The frames shown in Figures 2-6 and 2-7 do not include the bits that may be inserted for transmission timing (i.e., start and stop bits).

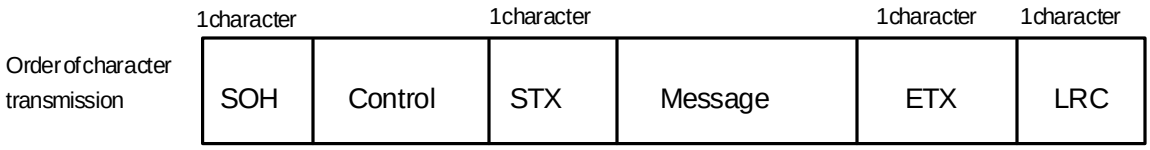


Figure 2-7 Control Frame Format

- Definition of an Opening Frame

  An **opening frame** is defined as an information frame in either the General Frame format or the Control Frame format that is received immediately after a DLE, EOT sequence has been transmitted to the POS terminal from the PAD or received from the POS terminal by the PAD (i.e., the first information frame received from the terminal or transmitted to the terminal after a VC has been cleared). An opening frame is handled in a Local Mode-like manner regardless of the default mode. The message field does need to be present in an opening frame.

  No wait period is needed between the DLE, EOT and the opening frame except if the DLE, EOT is being used to disconnect an active call in the Transparent Mode. In that case, the terminal should wait a minimum of 40 milliseconds before sending the opening frame. This will allow the PAD to transition from the Transparent Mode to the PAD waiting state.

- STX and ETX Delimiters

  The STX character is used to indicate the start of the Message field and the end of the Control field, if present. The ETX character is used to indicate the end of the Message field and the end of a T3POS frame. The ETX character is not only used to delimit a sequence of T3POS frames, but also is used in conjunction with the LRC character as data forwarding characters. When ETX is received at the end of a T3POS frame, the PAD places the frame including the LRC in an X.25 packet and forwards it.

  Following the STX, all characters in columns 0 to 7 of IA5, with the exception of the ETX control characters, will be recognized by the PAD as forming part of the Message field. The PAD will always recognize the first ETX character as the Message field delimiter. In addition, the T3POS PAD will recognize the DLE, EOT characters in the message field as a disconnect signal in the local and transparent mode and will clear the call.

- Message Field

  The Message field of an information frame follows the STX character and precedes the ETX character. The PAD assumes that the Message field is an integral multiple of 8 bits. The PAD supports opening frames and information frames, in Local Mode, of 256 octets. The DIGIPAC® network will set the default packet size to 256 octets (see Table 2-3 for all DIGIPAC® defaults).

- Control Field

  When the Control field is present in an opening frame, the SOH character is used to indicate the beginning of a frame, and the STX character appears at the end of the Control field. The Control field is intended to serve two purposes: POS terminal selection of a T3POS mode of operation and, optionally, signaling of call establishment data, such as a called address, a Fast Select facility request, or a Recognized Private Operating Agency (RPOA). The format for the Control field is as follows (information in brackets [ ] is optional):

  <Control field> ::= <Mode Selection signal>[X28 *selection PAD command signal*]

  When the Control field is present, it should contain the Mode Selection signal as a minimum. The Mode Selection signal is a single character in length and is used to signal the T3POS mode of operation. The Mode Selection signal also supports two other values used to indicate that the Control field contains network management data or that the terminal is an X.28 terminal. Table 2-4 shows the Mode Selection signal values.

Table 2-4 Mode Selection Signal Values

T3POS Mode	IA5 Character	Description
!	2/1	Request for Transparent Mode
Space	2/0	Request for Local Mode
#	2/3	Request for Blind Mode
%	2/5	Request Contains Network Management Data (Not Supported)
J	4/10	X.28 Terminal Indicator (Not Supported)

The X.28 *selection PAD command signal* is an optional part of the Control field that allows for the signaling of call establishment data. The format of the X.28 *selection PAD command signal* will be as follows:

<X.28 selection PAD command signal>::= {fax {, fax-} dna {<D/P> user data}

Fax = facility request The facility request is one or more of the following:

F = unrestricted fast select facility

T<rpoa> = RPOA transit facility

<rpoa> = Data Network Identification Code (DNIC) of the RPOA

N<nui> = NUI facility (**Not Offered**)

<nui> = NUI string

dna = X.121 network address or mnemonic name of the destination host

user data = up to 12 characters, for a regular call, or 124 characters for a fast select call. The characters are alpha-numeric separated from the network address by a P (Password) or a D (Data) character.

For details of the format(s) for the X.28 *selection PAD command signal,* refer to CCITT X.28, Section 3.5.15.

A terminal that supports the full set of CCITT X.28 commands and service signals may inform the PAD of such using the X.28 Terminal Indicator code (IA5 character 4/10). The PAD may optionally recognize this code and commence to operate in accordance with the entire CCITT X.28 capabilities. "J" mode is intended to allow the X.28 terminal the benefit of other applications (i.e., electronic mail) by modifying the X.3 parameters. DIGIPAC® does not currently support the "J" mode of operation.

The Control field may also contain network management information. The minimum length of the Control field should be at least 16 characters. Further specification of the Control field when network management information is present is under consideration. Therefore, DIGIPAC® does not support network management information in the control field.

- Supervisory Frames

With the exception of the DLE, EOT and the DLE, EOT, ENQ sequences, the supervisory frames consist of one control character from IA5 columns zero (0) and one (1). The following is a list describing the use of the IA5 control characters by the T3POS protocol:

- ACK

The ACKnowledgment character (IA5 character 0/6) is used by the PAD -- when in Local mode -- to indicate to a POS terminal that the information frame it transmitted has been received correctly. The ACK character returned to the POS terminal after the receipt of the opening frame may be delayed until the PAD is able to send the first data packet to the host. (That delay is based on whether or not the PAD is configured to wait for an ENQ character before the first data packet can be delivered to the host.)

- NAK

The Negative AcKnowledgment character (IA5 character 1/5) is used by the PAD --when in Local mode -- to indicate to the POS terminal that the command or frame was received with a LRC error or parity error.

- SYN

The SYNchronous idle character (IA5 character 1/6) is used by the PAD or the POS terminal -- in opening frame processing or Local mode -- to extend response timers applicable across the interface between POS terminal and the PAD. There is no limit on the number of SYN characters that are transmitted or received by the PAD. In Transparent and Blind modes, the PAD does not transmit SYN characters to the POS terminal after the first ACK transmitted in response to the opening frame.

- ENQ

  The ENQuiry character (IA5 character 0/5) may be used by a remote host system as an invitation to transmit or by the PAD or terminal to request retransmission. It may also be used to request retransmission of a protocol element when an expected response or a complete frame has not been received within a specified time interval. The use of the ENQ character by the host system as an invitation to transmit is optional.

- DLE, EOT

  The DLE, EOT sequence (IA5 characters 1/0 and 0/4, respectively) is used by the PAD when in all modes to indicate to the POS terminal that the virtual call has been cleared and will be transmitted in even parity or parity requested at subscription time. It is also used by the POS terminal to command that a virtual call be disconnected and must be received in the parity that is valid for the mode as well as what was set at subscription time. The DLE, EOT sequence should always appear before an opening frame is received from the POS terminal unless a DLE, EOT sequence has just been transmitted by the PAD.

- DLE, EOT, ENQ

  Otherwise known as the SELECT sequence, it is used by the PAD to indicate to a POS terminal that a host initiated call is being attempted. The SELECT sequence is intended to avoid collisions that might otherwise occur if the POS terminal were transmitting a frame while a host initiated call was in progress. In the event that such a collision has occurred, the network virtual call should be cleared and the POS terminal should be given priority. It is assumed that the terminal would restart transmission of the frame upon receipt of the SELECT sequence.

2.7.3 Information Frames in Transparent and Blind Modes

In Transparent mode, the format of the user data will be unrecognized by the T3POS PAD with the exception of the DLE, EOT sequence. The PAD will transmit and receive data without regard for the data format until the DLE, EOT sequence is received.

In Blind mode, the format of the user data will be unrecognized by the T3POS PAD, and the PAD will receive and transmit information without regard for the guidelines of the particular terminal and ISP/host protocol. Therefore, when the PAD is operating in Blind mode, it will place no restrictions on the information passed in the data stream.

2.7.4 Frame Procedures

- T3POS PAD Functions

  The T3POS PAD service performs X.25 functions on behalf of the POS terminal. A T3POS PAD extends beyond some of the capabilities of the traditional PAD and eliminates the need for others. Many of the basic functions of the traditional PAD are necessary for the operation of a T3POS PAD, such as X.25 VC control, packet assembly, and PAD/host control information exchange. The functions that extend beyond the traditional PAD are those that are associated with support of the T3POS protocol elements. The new T3POS PAD must go beyond such basic functions and support capabilities such as opening frame validation, LRC and poll stripping.

  Among the capabilities eliminated are almost the entire set of X.28 command and service signals. The T3POS PAD is not required to support any of the X.28 service signals. Also, the majority of the X.28 command signals are not required for a T3POS PAD. In addition, POS terminals with connections to a T3POS PAD typically do not require the Service Request Signal (SRS) or the network herald. In most cases, the physical connection is established and the line speed is normally set at subscription time. The default for T3POS service on DIGIPAC® will be 2400 bit/s (see Table 2-4 for all DIGIPAC® defaults).

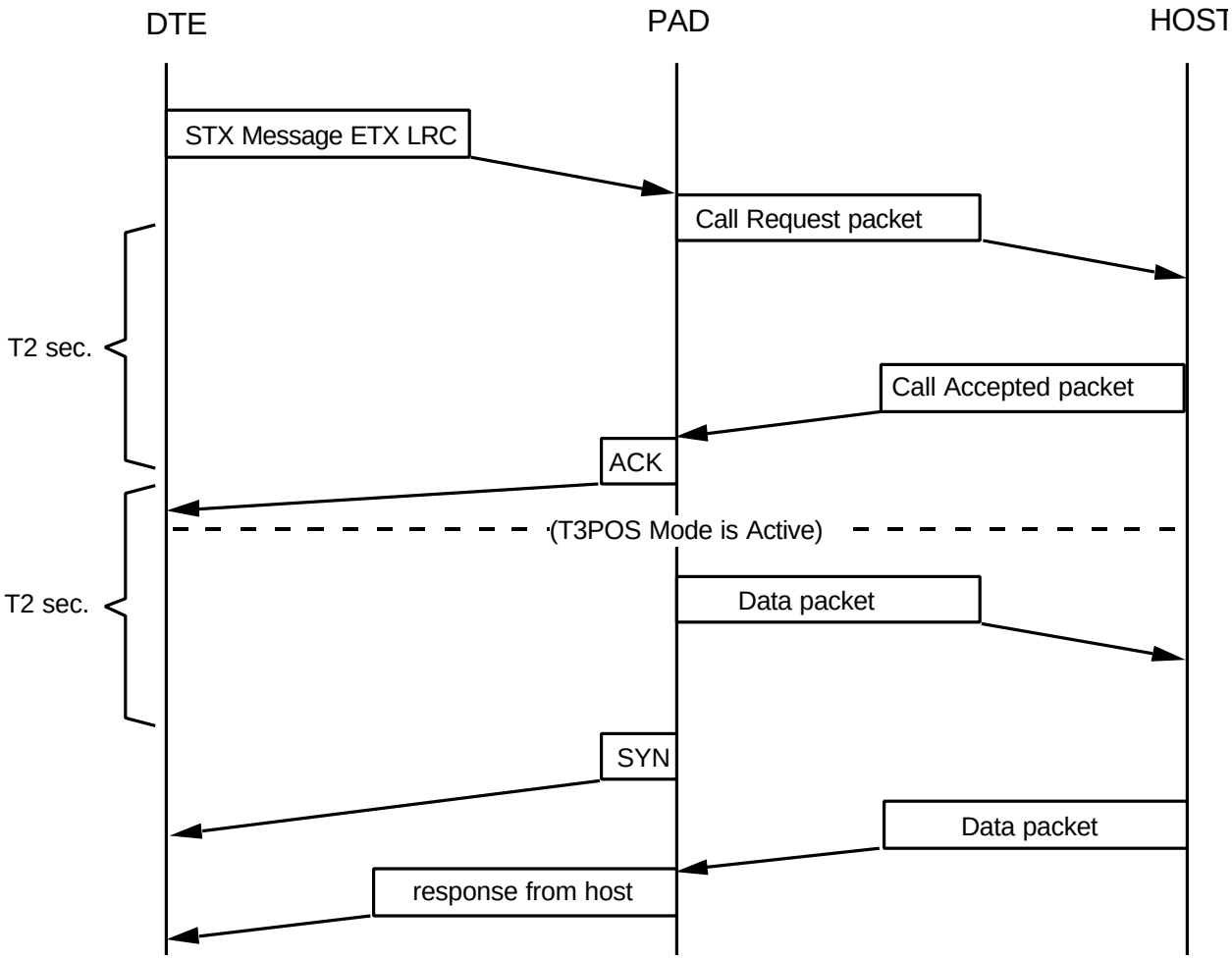
The following list contains brief explanations of the additional functions supported by a T3POS PAD:

- Opening Frame Validation -

The PAD performs a unique set of procedures when validating an opening frame received from the DTE and establishing a virtual call. These procedures are common among all three modes of operation and take place prior to activation of the mode of operation and are referred to as the *Call Establishment* or *Opening Frame Validation* state.

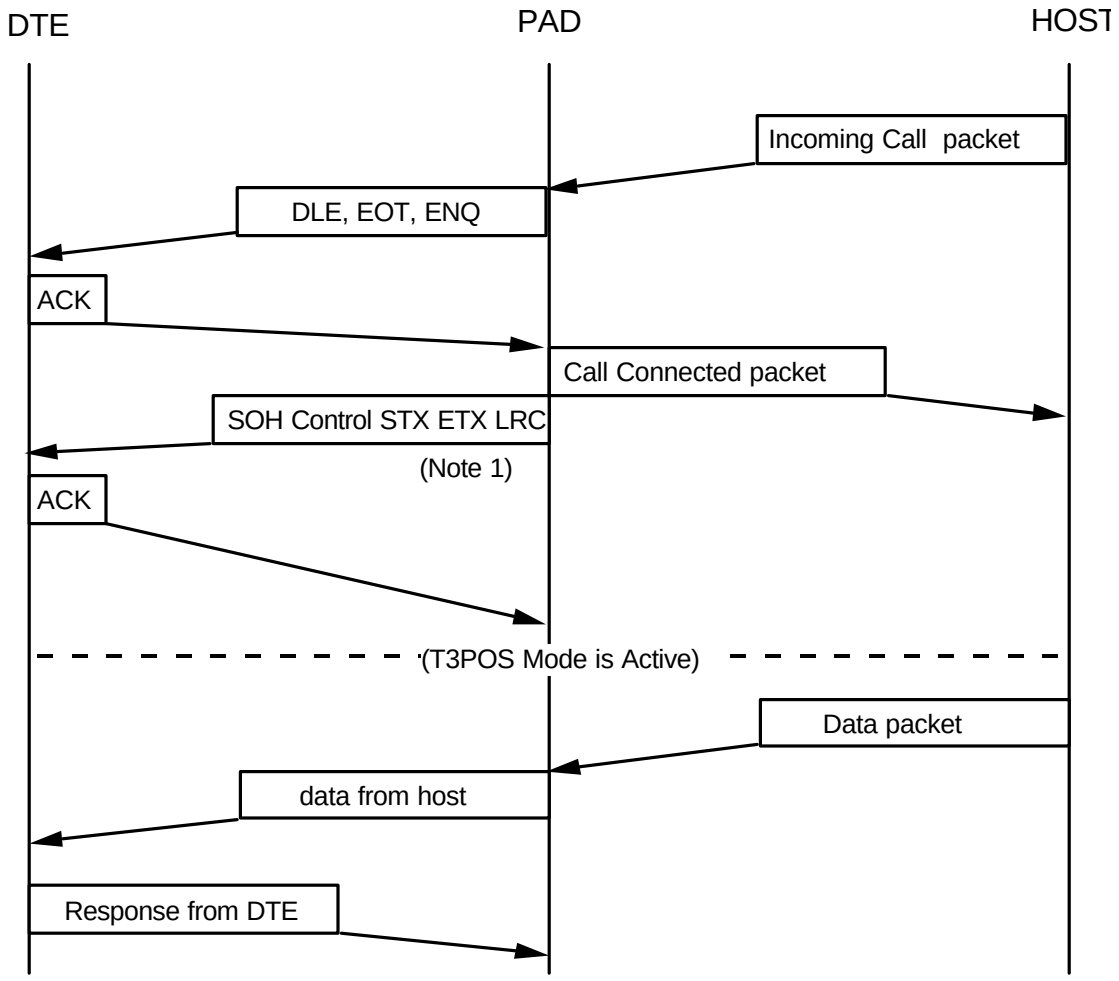
The PAD will verify that an opening frame received from a DTE is in the General or Control frame format before performing parity and Longitudinal Redundancy Checking (LRC) on the opening frame and before completing the call establishment procedures. On the DTE interface, the PAD will perform local error recovery procedures until a valid opening frame is received (see Error Recovery Procedures).

As part of the opening frame validation procedures for terminal-initiated calls, the PAD will transmit an *ACK* (IA5 character 0/6) to the DTE in response to a correctly received opening frame after the X.25 call accepted packet has been received (see Figure 2-8). This will always occur in Local mode. This will also occur if the PAD is operating in Transparent or Blind mode and the Opening Frame ACK Generation configuration option for the interface is ON. The PAD interface supports an option that suppresses the ACK to the DTE (Opening Frame ACK Generation is OFF), which is the default value. However, if the message field of an opening frame received by the PAD from the terminal, is empty and requesting a switch to transparent or Blind mode, an ACK will be transmitted to the terminal regardless of the setting of the Generate Opening Frame ACK option.



Note 1: The PAD uses the Direct Call Address to establish the virtual call and does not pass the MSS to the host.
The PAD does not acknowledge correct receipt of the opening frame until the virtual call is accepted.

Figure 2-8 Opening Frame Procedures: PAD Activated



Note 1: This frame should contain the Mode Selection Signal, but the Call User Data (CUD) field may not be present. The contents of the CUD of an incoming call packet are mapped into the Control field.

Figure 2-9 Opening Frame Procedures: Host Initiated

The PAD will transmit an ACK character to the DTE in the following cases:

- When the PAD receives a valid information frame in Local mode.
- When the PAD receives a valid frame in the Opening Frame Validation state and the Opening Frame ACK Generation parameter is set to ON.
- When the PAD receives an opening frame from the DTE in the Control frame format with no message field.

Note: An information frame in the General Format with an empty Message field will not be forwarded to the host.

The PAD will transmit an ENQ character to the DTE when the Response timer (T4) expires (see Table 2-5).

As part of the opening frame validation procedures for host-initiated calls, upon receipt of an X.25 *incoming call* packet the PAD will transmit a Select sequence to the DTE and wait to receive an ACK character from the DTE before transmitting an X.25 *call connected* packet. The PAD will then inform the DTE of the mode of operation using a Control frame and wait for an ACK from the DTE (see Figure 2-9).

- Frame Header Stripping -

The PAD removes the Control field from the T3POS frame and performs the appropriate functions based on the MSS and the selection PAD command signal. Virtual Calls (VC) are initiated based on the header information contained in the opening frame, or using the Direct Call information provided at subscription time. The header information is recognized by its starting and ending characters. The header information contains mode selection, and optionally the called address, and any X.28 facility request signals.

- Longitudinal Redundancy Checking (LRC) /Generation -

The PAD ensures accurate receipt of a T3POS opening frame by detecting an invalid LRC or a parity error. When an error is detected, the PAD responds with a NAK (IA5 character 1/5) to request retransmission. The PAD checks opening frames in the Control frame format for an LRC or parity error and generates a new LRC after stripping the Control field. The PAD checks opening frames in the General frame format but does not generate a new LRC. In Local mode, the PAD continues to check for LRC or parity errors in subsequent frames. When transparent and Blind modes are used, the PAD only checks the opening frame for an LRC or parity errors and transparently passes subsequent frames without checking for LRC or parity errors.

- Host Poll Stripping -

The DIGIPAC® T3POS PAD supports two options for ENQ (host polling) stripping:

l) Receipt of ENQ with backup timer T3 or

2) No ENQ.

If option 1 is used, after the host system accepts the incoming call packet, it may respond by polling the PAD with an ENQ (IA5 character 0/5), which the PAD must remove and not transmit to the POS terminal. Upon receipt of the first ENQ immediately following the call confirm packet, the PAD enters the Data Transfer state. If timer T3 expires before the receipt of the ENQ from the host then the PAD will enter the data transfer state and send the first data packet to the host.

If option 2 is used and no ENQ is supported, the PAD enters the data transfer state immediately after receiving the call confirm packet from the host system.

- Time-out Prevention (using SYN characters) -

The PAD transmits a SYN (IA5 character 1/6) to the POS terminal to prevent a time-out. By transmitting the SYN, the PAD is able to extend the POS terminal's delay period. Extending the delay period may be necessary for two reasons:

l) The PAD is waiting for a response from the host system or

2) The PAD's receive buffer is occupied.

When appropriate, the POS terminal issues SYN characters according to a timer that will be less than the PAD's SYN-to-SYN timer in Table 2-5.

SYN characters are not transmitted to the terminal when the PAD is receiving a long host message (i.e., Mbit is set in data packet).

- Data Transfer with Content Monitoring -

The POS terminal may clear the call by transmitting a special character sequence. In Local and Transparent modes, the PAD monitors the data stream for a DLE, EOT (IA5 characters 1/0 and 0/4) sequence from the POS terminal. When the DLE, EOT sequence is recognized, the PAD transmits a clear request packet to the host system. Content monitoring procedures do not apply when the PAD is operating in Blind mode.

- Call Clear Indication (using the DLE, EOT sequence) -

The PAD uses an DLE, EOT (IA5 characters 1/0 and 0/4) to indicate to the POS terminal that a VC has been disconnected.

- Opening Frame Processing -

As mentioned above, a T3POS Control frame contains a Control field in which optional X.28 facility request signals may be present. Some of these optional facilities allow ISP routing (based on the Recognized Private Operating Agency's Data Network Identification Code), Fast Select calls without restrictions on the response, and Network User Identification (NUI) calls.

2.7.5 Error Detection/Correction Mechanisms

- Longitudinal Redundancy Checking (LRC)

  Information frames contain a LRC character. The LRC character is attached to the end of the information frame to allow the PAD to detect errors in a frame received from a POS terminal. When the PAD examines the LRC character and an LRC error is detected, the PAD requests that the POS terminal retransmit the frame by transmitting a NAK character indicating a negative acknowledgment. The LRC character is composed of seven data bits and one parity bit and is performed in accordance with ISO 1155, Information Processing -- Use of longitudinal parity to detect errors in information messages, International Standards Organization, 2nd Ed., 1978.

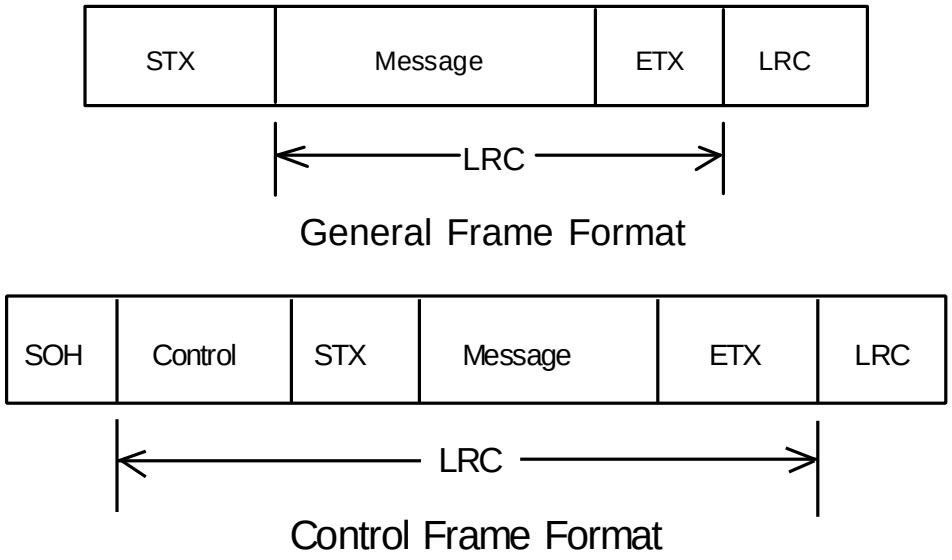


Figure 2-10 Range of the Longitudinal Redundancy Checking (LRC)

Each of the first seven bits of the LRC character shall be the modulo 2 binary sum (i.e., XOR) of every element in the same bit 1 to bit 7 column of successive characters in the transmitted T3POS frame. The longitudinal parity of each column of the T3POS frame, including the LRC character, is even. The sense of parity bit of the LRC character is the same as for the information characters (i.e., odd for synchronous transmission, even for asynchronous transmission). The summation to obtain the LRC character is initiated by the receipt of the SOH or STX character. Summation then begins with the next character and ends with an ETX character as shown in Figure 2-10. The LRC character immediately follows the ETX character in the frame. When an STX character is received after the LRC summation has begun (upon receipt of an SOH character), then the STX character is included in the LRC summation.

The PAD creates a General frame by stripping the Control field from a Control frame. The PAD then generates a new LRC character for the General frame before it is packetized and transmitted to the host.

The PAD will check an opening frame in the Control frame format for an LRC or parity error and generate a new LRC after stripping the Control field. The PAD checks the LRC of an opening frame in the General frame format but does not generate a new LRC if it is correct. If the Message field of an information frame in the General format is empty, then it will not be forwarded to the host.

In Local mode, the PAD checks the opening frame for LRC or parity errors and continues to check for LRC or parity error(s) in subsequent frames.

When an error is detected, the PAD will wait until timer T1 expires to ensure that the data stream has ended. The PAD will then respond with a *NAK* (IA5 character 1/5) to request retransmission.

To ensure correct use of a NAK and an ENQ in error recovery, the PAD will transmit a NAK to the DTE in response to a parity or LRC error. If the frame cannot be recognized, an ENQ is transmitted by the PAD to obtain retransmission.

- Parity Treatment

  The value of parameter 21 will determine the treatment of parity at a T3POS PAD during the exchange of information between the DTE and the T3POS PAD. The value of this parameter will specify whether the PAD checks the parity of characters received from the DTE and/or generate the parity type sent to the DTE in accordance with CCITT Recommendation X.3.

  Parameter 21 will be set to 3 in Local mode. In Transparent and Blind modes, parameter 21 will be set to 0.

- Transmission Considerations

  All octets of a T3POS frame shall be transmitted with the low-order bit first (for example, the first bit of the sequence number that is transmitted shall have the weight 2^0). The LRC character is transmitted and received commencing with the summation of the first column, which is found in bit position 1 of the LRC character.

- Error Recovery Procedures

  The PAD is responsible for managing all error recovery procedures in Local mode. All opening frames are processed in Local mode regardless of default mode. Several timers and counters are used to facilitate the error recovery process.

  The DIGIPAC® T3POS PAD supports two limit counters. These limit counters are called ENQ retry limit and NAK retry limit. The default value of each of these counters is 3 (see Table 2-3 for all DIGIPAC® defaults). If the PAD has to send 3 successive ENQ or NAK characters to the POS terminal the PAD will send the DLE, EOT sequence to the POS terminal. The following paragraphs describe how these counters are used during various phases of a call.

  When an opening frame or Local mode frame is received from the DTE, the PAD will examine the frame for an LRC error, parity errors, and for correct frame format. The PAD will then take the following action:

- When an LRC error is detected, the PAD will respond with a *NAK* (IA5 character 1/5) to request retransmission. This NAK will be transmitted after T1 seconds to ensure complete receipt of DTE data.
- When a parity error is detected, the PAD will transmit a NAK character to the DTE after the receipt of a complete frame or timer T1 expires.
- When an incomplete frame is detected, the PAD will transmit an ENQ character to the DTE after the expiry of the T1 timer.
- The PAD will clear the virtual call (and disconnect the dial-in physical link) if the Re-try Limit (*n*) has been reached. The Re-try Limit applies to the number of NAK/ENQs transmitted to the DTE, as well as the number of times the PAD enters the *PAD Waiting* state after unsuccessful call attempts.

  If the PAD transmits a NAK to the DTE and the terminal does not respond with re-transmission of a frame or character within T4 seconds (see Table 2-5), the PAD issues an ENQ character.

In Transparent mode, sole responsibility for link error recovery is given to the endpoints. Therefore in this mode, following the Call Establishment state, all time-out error recovery procedures are performed by the POS terminal and the host without the PAD's involvement.

- Supervisory Frame Errors

  SYNs, ACKs and other supervisory frames received by the PAD from the POS terminal may be received with errors. In Local mode, if the PAD receives an unrecognizable sequence of characters from the DTE, it will transmit an ENQ to request retransmission. If the PAD receives three (3) successive supervisory frames in error, it will clear the virtual call. In Transparent mode, all characters received after the first frame that are in error will be forwarded to the host based on the Character-to-character timer (T1).

- Timer Support

  In association with the T3POS PAD functions, the PAD must also support new timers. Table 2-5 contains the T3POS PAD timers that are recommended for all modes of operation. Currently DIGIPAC® only supports the first five (5) timers.

  Depending on the current T3POS implementation by a particular supplier, the name of the timer or the number of timers used to perform the same function of a given timer may vary. However, for discussion purposes, timers discussed in this document will be based on the timer definitions in Table 2-5.

  The factors that these timers take into account include:

1) the transmission time of the acknowledging frame
2) the propagation time over the access data link
3) the estimated processing times at the host and POS terminal and
4) the time to complete the transmission of the frame(s) in the PAD transmit queue.

Table 2-5 T3POS PAD Timers

Timer Number	Timer Name	Interface State	Started by	Terminated by	Action taken when time-out expires	Default value
T1	Character-to-character timer	PAD Command and Data Transfer	Any character received from POS terminal	Next character received from POS terminal	PAD issues an ENQ character to POS Terminal	.04 sec.
T2	SYN-to-SYN timer	Call Establishment, PAD Command, ENQ Waiting and Data Transfer	SYN transmitted to POS terminal	Response from Host is received (Note: this timer may be reset by a SYN from POS terminal)	PAD issues a SYN character to POS terminal	4 sec.
T3	ENQ timer	ENQ Waiting	X.25 Call Confirm packet is received from Host	ENQ is received from the Host	PAD continues as though ENQ was received from Host	0 sec. or 1.5 sec.
T4	NAK timer	PAD Command and Data Transfer	NAK or ENQ is transmitted to POS terminal	Retransmitted frame or character is received	PAD issues an ENQ character	4 sec.
T5	DLE, EOT timer	Data Transfer	ACK is received from POS terminal	Receipt of a frame from terminal or data packet from Host	PAD issues an DLE, EOT, clears the call, and goes to PAD waiting	4 min. (fixed)
T6 **Not Offered**	Frame Arrival timer	PAD Waiting	PAD enters the PAD Waiting state	The first character of a frame or SRS is received	PAD issues an DLE, EOT and disconnects switched connections	> 30 sec.

2.8 Terminal/PAD Control Information Exchange

2.8.1 Virtual Call (VC) Control

The state diagrams in Figures 2-9 and 2-10 represent the states of operation of a T3POS PAD that supports all three modes of operation as well as host initiated calls. These figures, along with the following text, explain the actions taken by the T3POS PAD for VC control.

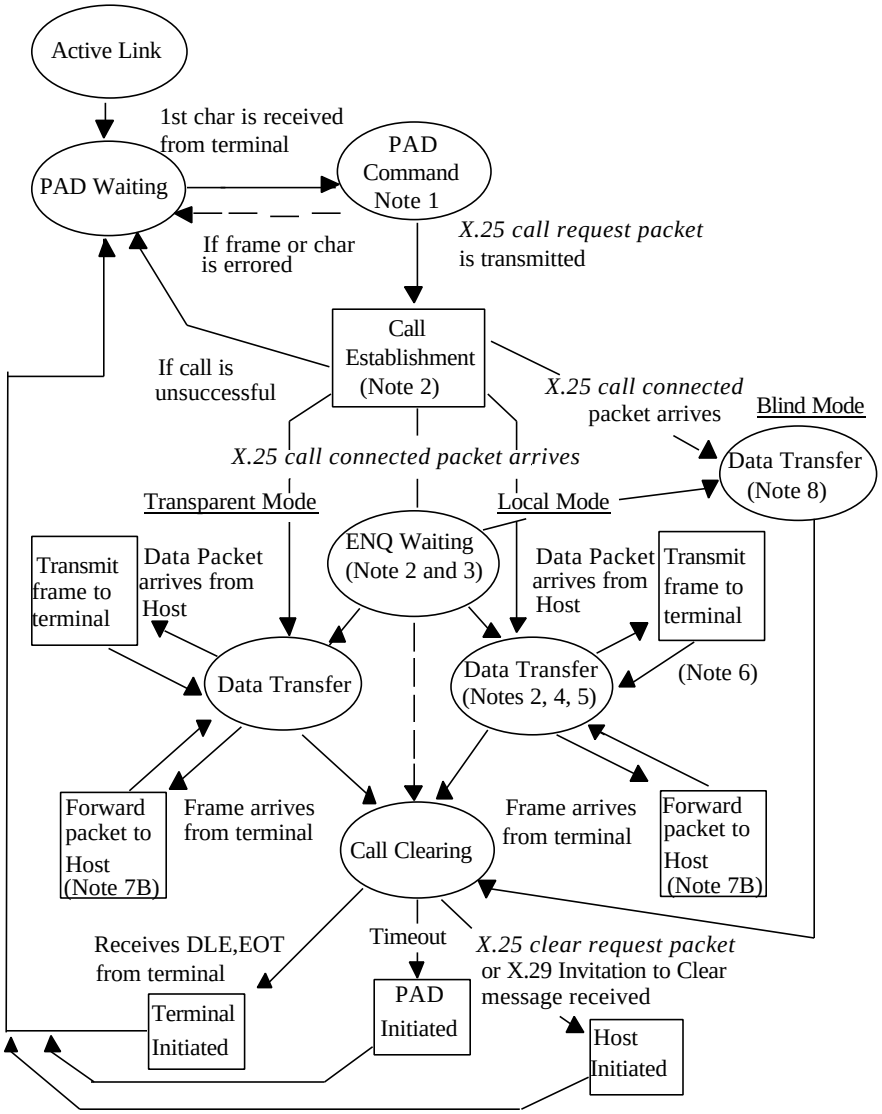
2.8.2 Active Link and PAD Waiting States

When the physical transport mechanism has established a physical connection, the POS terminal and the PAD are in the Active Link state. The physical connection may be established using a switched **(not offered)** or a lease line-type connection. The PAD will transition from the Active Link state to the PAD Waiting state when the access information path is established. Either the host or POS terminal may transmit an opening frame when the PAD is in the PAD Waiting state. The point at which the access information path is established depends on the transport mechanism used to establish the physical connection. For leased line operation the PAD is always in the PAD Waiting state when no call is in progress.

2.8.3 PAD Command State

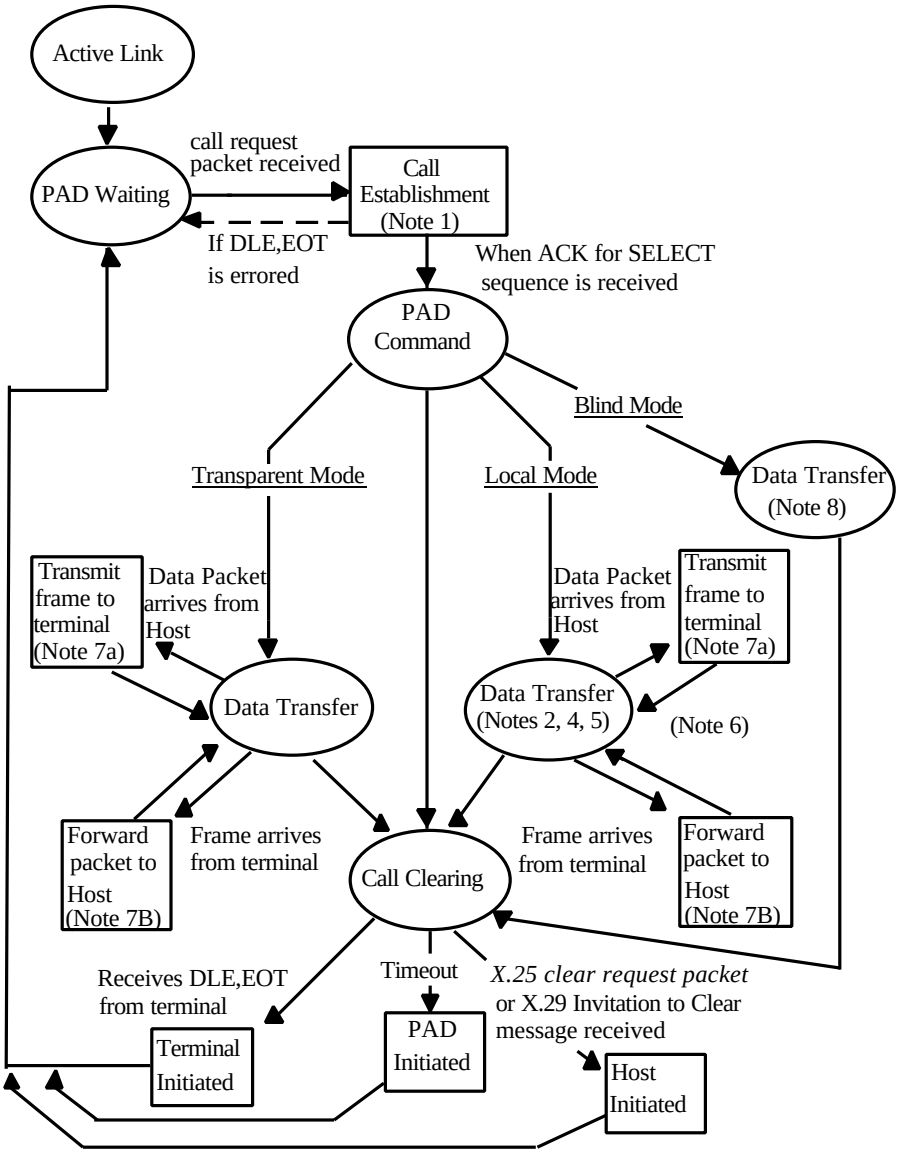
In the PAD Command state, more timers than any other state are used to detect procedural failures and to avoid excessive use of network resources. Timers T1, T2, and T4 apply when in the PAD Command state. On receipt of the first character of an opening frame, the PAD enters the PAD Command state. The PAD will remain in this state until receipt of the ETX delimiter. While in the PAD Command state, the PAD ensures correct receipt of each character and of the entire frame from the POS terminal. In addition, the PAD determines its T3POS operating mode from either the Mode Selection signal in the Control field or from its default information. The PAD may also obtain call set-up information from the Control field.

For host-initiated calls, the order of the PAD Command state and the Call Establishment state are reversed. When the PAD receives an *incoming call* packet, the PAD enters the Call Establishment state. Data from the host is not validated, but is forwarded to the DTE upon entering the *Data Transfer* state. The PAD enters the *PAD Command* state when an ACK, in response to the Select sequence, is received from the DTE. The PAD then transmits a Mode Switch Control frame to the DTE to indicate the mode of operation. When the PAD receives an ACK in response to the Mode Switch Control frame, it enters the *Data Transfer* state.



Note 1: PAD will enter this state N times before disconnecting.
Note 2: PAD may issue SYN characters to indicate that the call is still connecting.
Note 3: If ENQ is supported, PAD must wait for receipt T3 timer expiration before transitioning to *Data Transfer* state.
Note 4: PAD issues SYN characters when receive buffer is occupied.
Note 5: After forwarding data packet, ACK is immediately issued to terminal.
Note 6: Before forwarding more data to the terminal, and ACK must be received from terminal.
Note 7a: The first frame transmitted to the terminal may contain a Control field with the Mode selection facility request signal.
Note 7b: For the opening frame only, the PAD generates a new LRC before forwarding data packet to Host.
Note 8: An ACK is immediately transmitted to POS terminal following receipt of *call connected* packet, if GOA is turned on or if message field of opening frame is null.

Figure 2-11 State Diagram of Terminal Initiated Virtual Call (VC



Note 1: PAD will enter this state N times before disconnecting.
Note 2: PAD may issue SYN characters to indicate that the call is still connecting.
Note 3: If ENQ is supported, PAD must wait for receipt T3 timer expiration before transitioning to *Data Transfer* state.
Note 4: PAD issues SYN characters when receive buffer is occupied.
Note 5: After forwarding data packet, ACK is immediately issued to terminal.
Note 6: Before forwarding more data to the terminal, and ACK must be received from terminal.
Note 7a: The first frame transmitted to the terminal may contain a Control field with the Mode selection facility request signal.
Note 7b: For the opening frame only, the PAD generates a new LRC before forwarding data packet to Host.
Note 8: An ACK is immediately transmitted to POS terminal following receipt of *call connected* packet, if GOA is turned on or if message field of opening frame is null.

Figure 2-12 State Diagram of Host Initiated Virtual Call (VC)

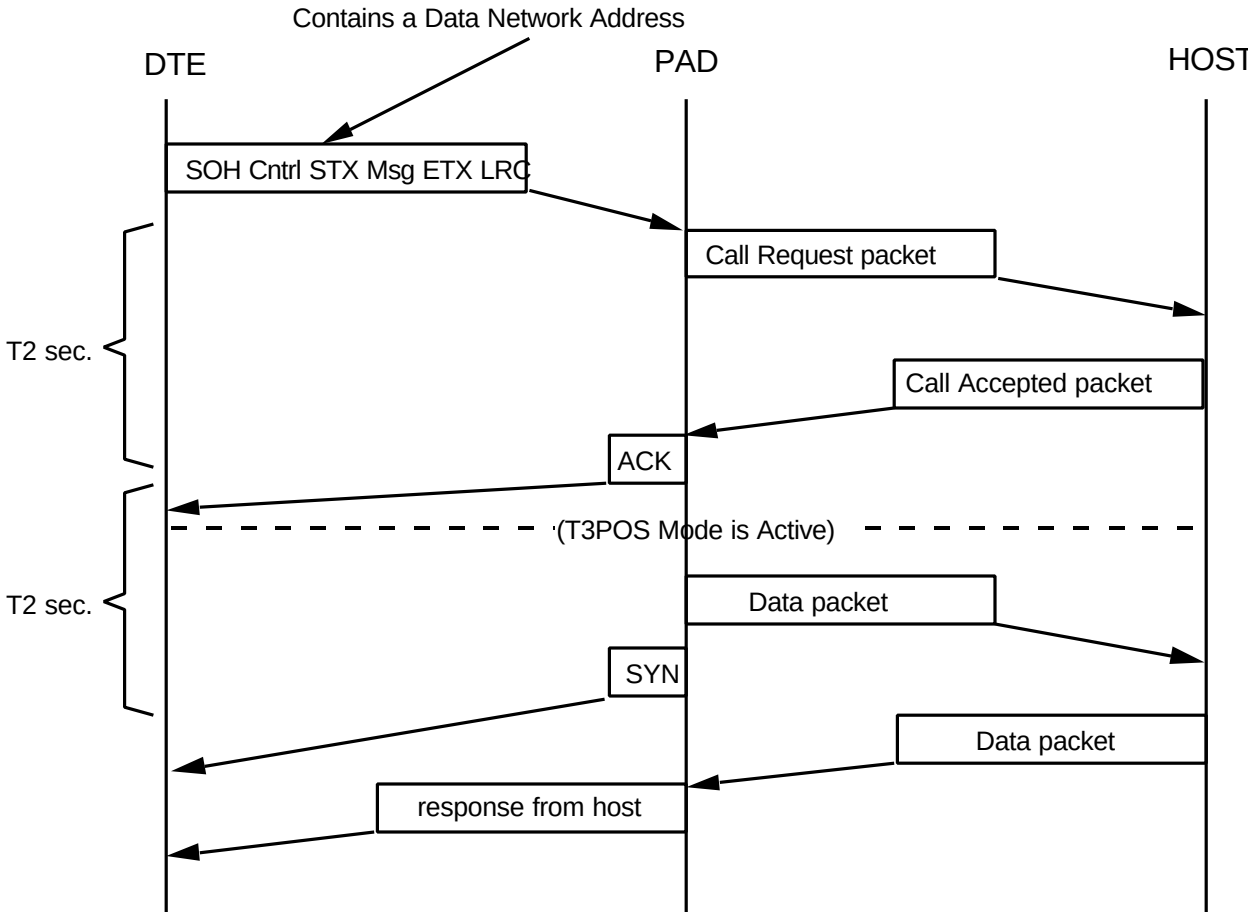
2.8.4 Call Establishment State

Upon receipt of a valid opening frame, the PAD enters the Call Establishment state. In the Call Establishment state the PAD attempts to set up a VC in accordance with the call establishment procedures in X.25, X.75' or an internal protocol. In the Call Establishment state, the PAD issues SYN characters when appropriate and a DLE, EOT if an error condition occurs. When in this state, the PAD does not accept any additional opening frames. A frame will be recognized by the PAD as an opening frame if a DLE, EOT preceded the frame (see Section 2.7.2 - Frame Structure, Definition of an Opening Frame).

When the PAD correctly receives an opening frame, the PAD starts the initial time-out prevention timer and waits T2 seconds before issuing the first SYN character. Subsequent time-out prevention timers are governed by the SYN-to-SYN timer, which starts when a SYN character is transmitted to the POS terminal. Both the initial time-out prevention timer and the SYN-to-SYN timer are terminated by PAD transmission of a supervisory or information frame to the POS terminal. The PAD will forward all information frames received before the previous frame was acknowledged. The initial time-out prevention timer and the SYN-to-SYN timer are only applicable in the PAD Command, Call Establishment, and ENQ Waiting states.

Terminal Initiated

- The Control field information in an opening frame may be used by the POS terminal to initiate VC establishment. Call set-up information may be received in the Control field along with the T3POS Mode Selection signal.

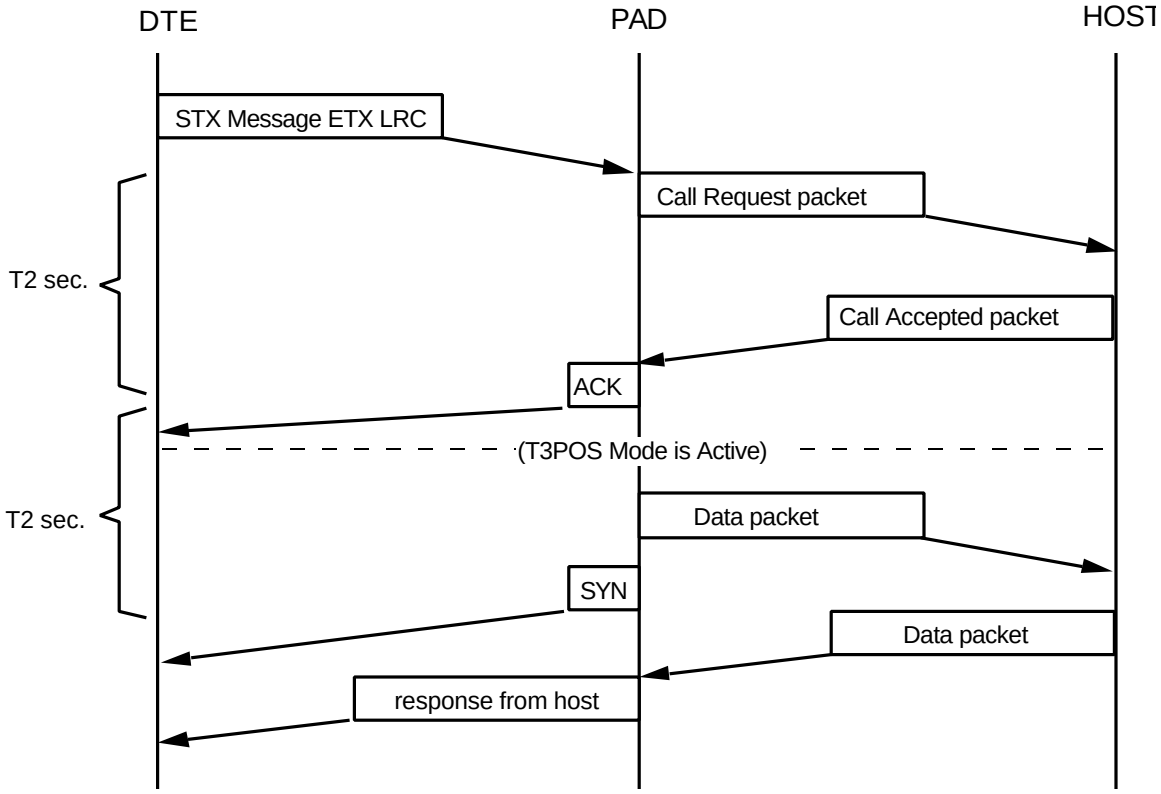


Note 1: The PAD validates the Control field and passes the MSS to the host, depending on the setting of the Method of Host Notification parameter. The PAD does not acknowledge correct receipt of the opening frame until the virtual call is accepted.

Figure 2-13 Terminal-initiated Call

PAD Initiated

- The DIGIPAC® T3POS PAD supports PAD initiated calls on interfaces with POS equipment using the Direct Call capability. The Direct Call capability is an optional subscription time service that prevents the user from having to signal the T3POS mode of operation, the called address, and the optional facilities on each call requested. At subscription time, default mode selection is obtained from the customer and the customer interface is configured accordingly. When the opening frame in the General frame format is received, the PAD automatically generates a call request packet containing call set-up information previously subscribed to by the user. If the PAD receives an opening frame that contains information other than that given at subscription time, the information contained in the Control field will override that associated with the Direct Call capability.



Note 1: The PAD uses the Direct Call address to establish the virtual call and does not pass the MSS to the host. The PAD does not acknowledge correct receipt of the opening frame until the virtual call is accepted.

Figure 2-14 PAD-activated Call

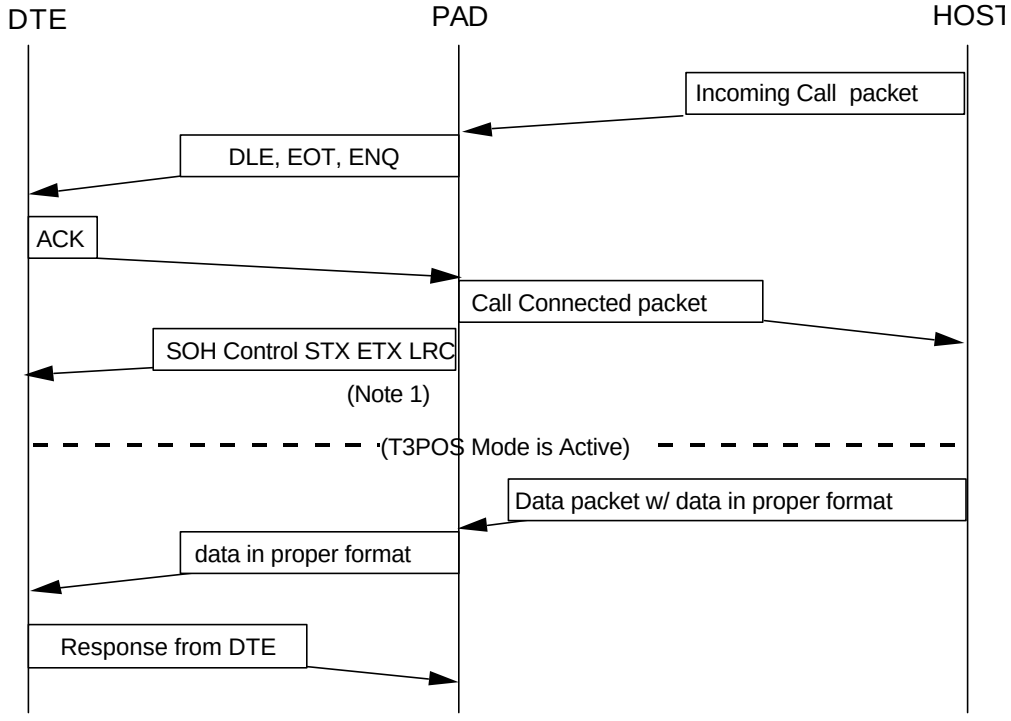
Host Initiated

- The information present in the Call User Data field received from the host in the *incoming call* packet may be used to signal the mode of operation. Upon receipt of an *incoming call* packet, the PAD will transmit the Select sequence to the DTE and wait to receive an ACK before transmitting a *call connected* packet to the host. The call is not confirmed if the PAD receives a DLE, EOT from the DTE (see Figure 2-15).

  If the Mode Selection signal is not present in the Called User Date (CUD) field of the *incoming call* packet received from the host, the PAD will operate in its default mode, which is set at subscription time.

  For host-initiated calls, if the Call User Date (CUD) of a *call request* packet contains more than the Mode Selection Signal (MSS), the PAD will pass the MSS along with the rest of the CUD contents to DTE in the Control field.

  The host can only request a change of mode if the T3POS Protocol Identification is present in the first four octets of the Call User Data (CUD) field of call request packet.



Note 1: This frame will contain the Mode Selection Signal, but the Called User Data (CUD field may not be present. The contents of the CUD of an incoming call packet are mapped into the Control field.

Figure 2-15 Illustration of a Host-initiated Call

- If a host-initiated call is attempted, the DTE may have a large number of transactions stored such that the DTE is not prepared to receive a host-initiated call. For this reason, the PAD must receive confirmation from the DTE that the host-initiated call may be completed.

  If an ACK is received from the DTE in response to a Select sequence, the PAD will transmit a Control frame with the MSS and the rest of the contents of the CUD if present (see Figure 2-15).

  If a DLE, EOT sequence is received from the DTE in response to a Select sequence, the PAD will clear the virtual call and enter the *PAD Waiting* state.

2.8.5 Call Clearing

The clearing of a VC may be initiated by either the POS terminal, the remote host system, or the PAD. The PAD commences with call clearing procedures as a result of a timer that has expired, error recovery, or a physical connection that has been lost. In addition, the PAD will recognize a clear request signal (i.e., DLE, EOT sequence) from the terminal and a clear request packet from host system and, following receipt of either, the PAD will proceed with call clearing procedures. Upon receipt of a clear request packet, the PAD transmits a clear indication signal to the POS terminal. The PAD will use the DLE, EOT sequence to indicate to the terminal that a virtual call has been cleared.

If a call attempt is unsuccessful for any reason other than a host initiated clear, the PAD indicates this to the terminal by means of a DLE, EOT sequence. After transmission of the DLE, EOT sequence, the PAD enters the PAD Waiting state.

Terminal Initiated

- A POS terminal can clear a VC by issuing a clear request command signal in the form of the DLE, EOT sequence, which is recognized by the PAD in both Transparent and Local modes. The PAD responds by transmitting a clear request packet to the host. The use of the DLE, EOT sequence as a command is only applicable in those states that are visited subsequent to the Call Establishment state.

PAD Initiated

- Clearing of a virtual call by the PAD may result from one of three conditions. The first condition depends on idle time, T5, (see Table 2-5), which a PAD must keep track of to prevent excessive inactivity.

  If the DLE, EOT (T5) timer expires, the PAD will transmit a DLE, EOT sequence to the terminal and a *clear request* packet to the host.

- In the second condition, the PAD must incorporate a means of detecting loss of the physical access link on either the terminal or network side. If the link on the terminal side has failed, the PAD transmits a *clear request* packet to the host.

  If the link on the network side fails, the PAD will issue a DLE, EOT sequence to the terminal to indicate that the call has been cleared.

  When the re-try count is exceeded, the PAD will issue a DLE, EOT sequence to the terminal to indicate that the call has been cleared.

- The third condition applies to the local mode only. If the PAD receives anything other than data frames from the host or terminal attempts to send anything other than data frames to the host (i.e., unexpected frames), the call will be cleared.

Host Initiated

- Upon receipt of an X.29 invitation to clear message or an X.25 clear request packet from the host, the PAD will commence with its VC clearing procedures in accordance with their respective CCITT Recommendations. The X.29 invitation to clear message is the desirable host initiated virtual call clearing method. The PAD will send a clear indication signal (i.e., DLE, EOT) to the terminal and respond to the host with a clear indication packet in accordance with the clearing procedures in the Bellcore PPSNGR. The PAD will issue a DLE, EOT sequence to the terminal in all modes.

For the Fault Conditions listed below the identified actions will be taken.

- Failure to Receive an Opening Frame -

  This condition only applies to non-leased line connections to the PAD and uses timer T6. DIGIPAC® does not currently offer timer T6 or non-leased line types of connections.

- Failure to Establish a Virtual Call (VC) -

  If the VC is unsuccessful for any reason the PAD transmits a DLE, EOT character to the terminal.

- Invalid Clear Request from Terminal -

  If the PAD receives a DLE, EOT sequence from the terminal while in the PAD Waiting state, no response to the terminal will be transmitted.

- Invalid Control Field -

  If the PAD receives an invalid Control field from the POS terminal, the PAD will transmit a DLE, EOT sequence to the terminal and enter the PAD Waiting state. If the call is host initiated and the MSS or PID is invalid, the PAD will clear the call.

- Maximum Packet Size Exceeded -

  If the PAD determines that the maximum packet size has been exceeded, it will transmit multiple packets in accordance with the M (more) bit procedures in CCITT X.25, Section 4.3.4. Conversely, when a data packet is received from the host with the Mbit set to 1, the PAD forwards data to terminal as it is received. The pad will suspend Timer T-2 while receiving data packets with Mbit set.

A reset may occur at any time following the completion of call establishment procedures, initiated by the PAD, host, or network, Upon receiving a reset, the PAD or host must confirm it. Upon detection of a reset, the QWEST T3POS PAD sends a clear request to the host and a DLE, EOT sequence to the terminal to terminate the session.

Additionally, the function of the interrupt packet is undefined in this protocol. However, if an interrupt packet is received by the PAD or host, it is confirmed via an interrupt confirmation packet.

2.8.6 Procedures for Changing T3POS Modes

The T3POS mode in which the PAD operates can be determined at subscription time or on a per call basis using a variety of mechanisms.

- The PAD supports two settable Mode Selection parameters that govern the PAD's default mode of operation for Terminal-initiated and Host-initiated calls.
- Both Mode Selection parameters are independently settable to Local, Transparent, or Blind mode. The default value for the Mode Selection parameter for terminal-initiated calls will be Local mode. The default value for Host-initiated calls will be Blind mode.

Different default modes for calls that are initiated by two different entities (i.e., the terminal and the host) are particularly useful in many credit/debit environments. Some users may wish to operate in Local mode for terminal-initiated calls, executing credit/debit authorizations, but other users may wish to operate in Blind mode for Host-initiated calls perhaps to download data (e.g., software or negative credit cards) to a DTE.

- The PAD is capable of changing the T3POS mode of operation from the default based on the value of the Mode Selection Signal (MSS) received in the Control field of a T3POS frame or the Called User Data (CUD) field of an *incoming call* packet.

The choice of a Mode Selection parameter value may be made on a per call basis by the DTE or the host system. A DTE or a host may not only change the T3POS PAD's mode of operation, but provide the called party with an indication of the mode in which the PAD is operating using the Control field or the CUD. Changing of the Mode Selection parameter by the host is discussed in Section 2.10.

Change mode procedures may be used in the *PAD Waiting* state before entering the *Call Establishment* state and after the *Call Clearing* state.

- A T3POS mode change is not possible while the PAD is in the *Data Transfer* or *Call Clearing* states.

The PAD responds to an opening frame containing a valid MSS by issuing a positive acknowledgment (i.e., an ACK or a response message) to the DTE.

- Regardless of the operating mode, if the MSS or selection PAD command signal in the Control field is invalid, the PAD will transmit a DLE, EOT and wait for re-transmission of the entire opening frame, valid information in the rest of the frame notwithstanding. The format of the Control field is defined in Section 2.7.2.

2.9 Terminal/PAD POS Data Exchange

The procedures described in this section apply during the Data Transfer state of the PAD interface to the POS terminal.

2.9.1 Data Transfer State

After receipt of the *call accepted* packet, the PAD will issue an ACK character to the DTE, if the ACK Generation configuration option is ON, and enter the *Data Transfer* state of either Transparent, Local, or Blind mode, depending on the Mode Selection parameter value.

- The ACK Generation configuration option only applies to Blind and Transparent modes. In Blind and Transparent modes, no ACK in response to the opening frame should be issued to the DTE if ACK Generation is OFF and the message field contains data. In Local mode, upon receipt of a valid opening frame and a *call accepted* packet, the PAD will always respond with an ACK to the DTE.

The PAD will remain in the *Data Transfer* state until the virtual call is cleared by the PAD, the terminal, or the host as described in Section 2.8.5. Characters received from an asynchronous DTE are defined as consisting of all the bits received between, but not including, the start and stop bits. Data received by the PAD for delivery to the DTE will be treated as contiguous octets.

If the PAD is in Local mode, then after the entire opening frame is received and transmitted to the host, the PAD will immediately transmit an ACK to the DTE to indicate that a virtual call has been established. In addition, in Local and Transparent mode, the PAD will monitor the data stream for a DLE, EOT sequence from the DTE and, upon receipt, the PAD will clear the call. DLE, EOT monitoring is applicable in Transparent and Local modes only. The ISP or Host is responsible for clearing all Blind mode calls.

2.9.2 Inactivity in the Data Transfer State

To avoid excessive connecting and disconnecting when switched access connections are in use, the PAD employs timers to allow enough time for a successive transaction to be conducted. The PAD must also avoid allowing so much time that an idle interface prevents other switched connections. The time that is applicable after a transaction has been conducted is called the *DLE, EOT timer* in Table 2-5. The following explains the operation of these timers.

Following receipt or transmission of an ACK or data to/from the DTE, the PAD will start the DLE, EOT timer. If the terminal or host attempts to conduct another transaction by transmitting data to the PAD within T5 minutes, the PAD will terminate the DLE, EOT timer. If data is not received from the DTE or from the host before T5 expires, the PAD will clear the virtual call, issue a DLE, EOT to the DTE, and disconnect the switched access connection if necessary. Timer T5 is fixed at a value of 4 minutes in the QWEST DIGIPAC® PAD.

2.9.3 Data Forwarding Conditions

There are two principal conditions in which the PAD commences with the forwarding of a *data* packet.

- In Local mode, the ETX and the LRC combination of characters are used to indicate to the PAD that a frame has ended and the information should be forwarded. The ETX and the LRC combination of characters are included in the data field of the packet before the packet is forwarded.
- In all modes, a full packet (i.e., the characters received from the DTE have reached the maximum packet size) or, in Blind and Transparent modes, the Character-to-character timer (T1) has expired will be the conditions that result in a data packet being forwarded to the host.

2.9.4 Hardware Flow Control Using RTS/CTS

RTS/CTS flow control is supported in Transparent and Blind modes. The configuration option for RTS/CTS Flow Control is selected at subscription time. The default value for this parameter is OFF.

2.10 Host/PAD Control Information Exchange

A T3POS PAD is responsible for informing the DTE or the host system of the mode in which it is operating, particularly when the PAD has been changed from its default MSS value. This is accomplished by using a combination of special T3POS frames and X.25 protocol elements, depending on the capabilities of the host system.

- If no control field is present in the opening frame, the PAD uses the appropriate Mode Selection default value set at subscription time.
- When a PAD receives an opening frame with a Control field from a DTE, it will ensure that a mandatory MSS is present in the first character position. If a valid MSS is not present, the PAD will issue a DLE, EOT to the DTE.

2.10.1 T3POS Protocol Identification

The Protocol IDentifier (PID) is used to uniquely identify the type of protocol conversion to take place at the PAD. A PID may be used by a PAD to inform the host of the type of PAD in use or by the host to request the use of a particular type of PAD. This may be beneficial if a host is to support access by merchants utilizing the present mode of operation and merchants utilizing the new T3POS protocol. Conversely, the PID may also be useful if a PAD is to receive host-initiated calls from host systems that support existing X.25 calls with an X.29 PID and X.25 calls with the T3POS PID present. The ability to distinguish between the traditional asynchronous protocol and the new T3POS protocol is useful for identifying different applications for billing purposes, compiling network statistics and operational efficiency in Multi-Aspect PAD environments.

- The PAD supports the Protocol IDentifier (PID) as a settable parameter that permits the subscription time selection of at least two values for the PID.
- The PAD is capable of optionally receiving and transmitting *incoming call* and *call request* packets, respectively, with the T3POS PID specified in Figure 2-16.

The PID is a specific coding of the first four octets of the Call User Data field of a *call request* packet or an *incoming call* packet. It is recognized that some hosts may not be capable of manipulating the PID.

- To accommodate host systems that are unable to transmit or receive the T3POS PID (see Figure 2-16), the PAD supports the X.29 PID specified in CCITT X.29, Section 4.2.1 as an option settable at subscription time (see Figure 2-17).
- If an *incoming call* packet is received by the PAD without an X.29 or T3POS Protocol IDentifier (PID) field or information in the Call User Data field, the T3POS PAD will operate in the default mode.

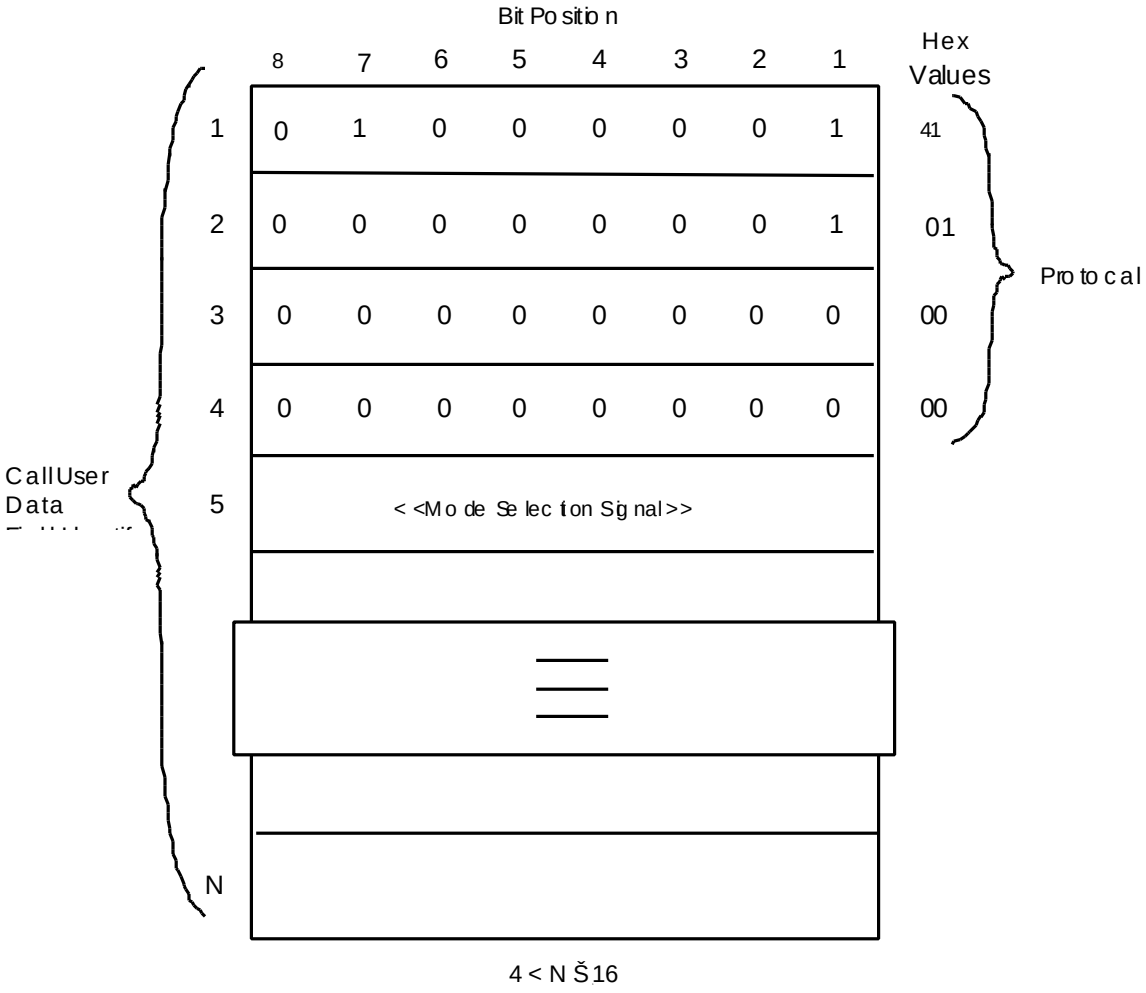


Figure 2-16 Encoding of the T3POS Protocol Identifier

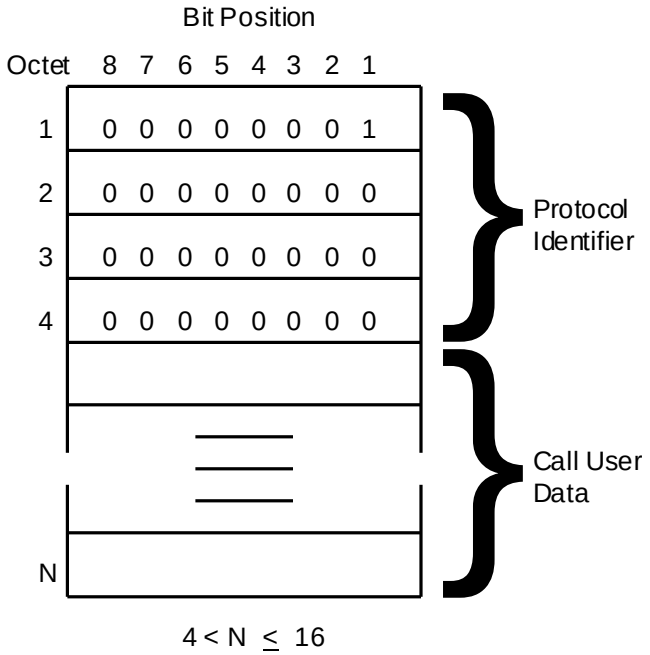


Figure 2-17 Format for the X.28 Protocol Identifier

2.10.2 Use of PID and CUD in T3POS Mode Signaling

As indicated above, the PAD's operating mode can be changed from a default mode, defined at subscription time, to another operating mode supported by the PAD. Using the Mode Selection Signal, mode switching may be performed by the DTE or the host to override the default mode on a per call basis. The called party is in some cases informed of the mode in which the call will operate, depending on the Method of Host Notification parameter (see Table 2-6).

Table 2-6 Method of Host Notification Configuration Options

Protocol Identifier (PID) Value	Call User Data Field (Octet 5) Contents	Method of Host Notification
X.29	MSS	Call Request packet
X.29	--*	Mode Switch Control frame
X.29	--	None
T3POS	MSS	Call Request packet
T3POS	--	Mode Switch Control frame
T3POS	--	None

* A dash (--) indicates that the PAD does not populate the CUD with an MSS. Information may be passed from the host system to the DTE or vice versa.

For terminal-initiated calls, the host system is conditionally informed of the mode of operation, depending on the Method of Host Notification parameter setting, but for host-initiated calls the DTE is always informed of the mode in operation. The MSS is received by the PAD to determine the mode of operation or transmitted by the PAD to indicate the mode in operation. There are two mechanisms by which the PAD may transmit or receive a host system Mode Selection Signal: 1) A special Control frame transmitted to the host with or without a Message field or 2) the Call User Data field of an *incoming call* or *call request* packet. The mechanism used by the PAD is determined by the Method of Host Notification parameter, which are settable configuration options set at subscription time.

2.10.2.1 Terminal-Initiated MSS Signaling

The following apply to terminal-initiated calls:

- When an opening frame is received in the Control frame format, the PAD will transmit a *call request* packet over the X.25 interface with the Call User Data (CUD) field containing the appropriate PID (i.e., based on the PID *Selection* parameter). Also, depending on the value of the Method of Host Notification parameter, the PAD will inform the host of the mode of operation using one of the following:
  - Populate the fifth octet of the CUD with the MSS;
  - Transmit the Mode Switch Control frame to the host after the virtual call has been established; or
  - No host notification of the mode in operation.
- The PAD also supports a No Host Notification option that at no time will inform the host of the mode of operation.
- When an Information frame is received in the General frame format, the PAD transmits a *call request* packet over the X.25 interface with the Call User Data (CUD) field containing the appropriate PID (i.e., based on the *PID Selection* parameter) but no MSS. The PAD will operate in its default mode.
- When the PAD receives an opening frame from the DTE in the General frame format, no host notification will be provided

When the virtual call is terminal-initiated and the Method of Host Notification parameter is set to use the CUD, the PAD maps the MSS into the fifth octet of the CUD field of the *call request* packet. If no MSS is present in the CUD field from the host, the PAD will operate in its default mode setting.

2.10.2.2 Host-Initiated MSS Signaling

The following apply to host-initiated calls:

- If the *PID Selection* parameter is set to T3POS and the fifth octet of the *incoming call* packet's CUD contains an MSS, the PAD transmits the Select sequence to the DTE, waits for an ACK from the DTE, transmits a Mode Switch Control frame to the DTE, and operates in the mode associated with the MSS. If the *incoming call* packet contains an X.29 PID, an MSS should not be present in the CUD.
- If the PID Selection parameter is set to T3POS or X.29 and no MSS is present in the CUD, the PAD will transmit the Select sequence to the DTE, wait for an ACK from the DTE, and operate in the mode specified by the Mode Selection Host-initiated default value.
- For host-initiated calls, the mode switching using the Mode Switch Control frame is not allowed.

Since mode signaling cannot be performed using a Mode Switch Control frame from the host, the Call User Data (CUD) field is recommended when sending the MSS to the host system or receiving the MSS from the host system. When a virtual call is initiated by either the host or the DTE and the Method of Host Notification parameter is set to use the *call request* packet, the called party is informed of the T3POS mode in operation by the CUD field of a *call request* or *incoming call* packet. The PAD transmits the MSS (for terminal-initiated and PAD-activated calls) and recognizes (for host-initiated calls) the MSS in the fifth octet of the CUD field, immediately following the Protocol Identifier (octets 1-4).

2.10.3 Illustrations of Mode Selection

Terminal-Initiated Mode Selection

The DTE selects a T3POS mode of operation by transmitting an opening frame with a Control field containing an MSS. Table 2-4 contains a list of MSS values that are available. If the DTE transmits a frame in the General format, the PAD uses the default mode set at service order time. Figures 2-18 to 2-20 illustrate terminal-initiated mode selection when the opening frame is in the General Frame format and when different values for the Method of Host Notification parameter have been selected.

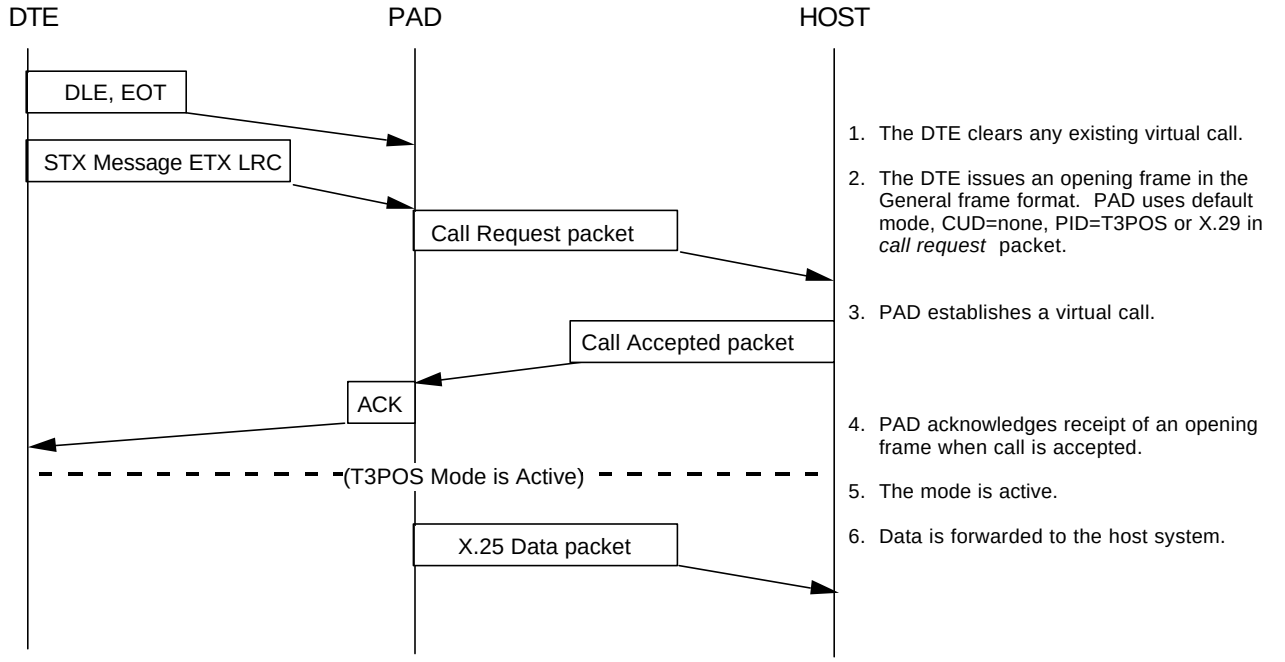


Figure 2-18 PAD-activated Call with Opening Frame in General Frame Format

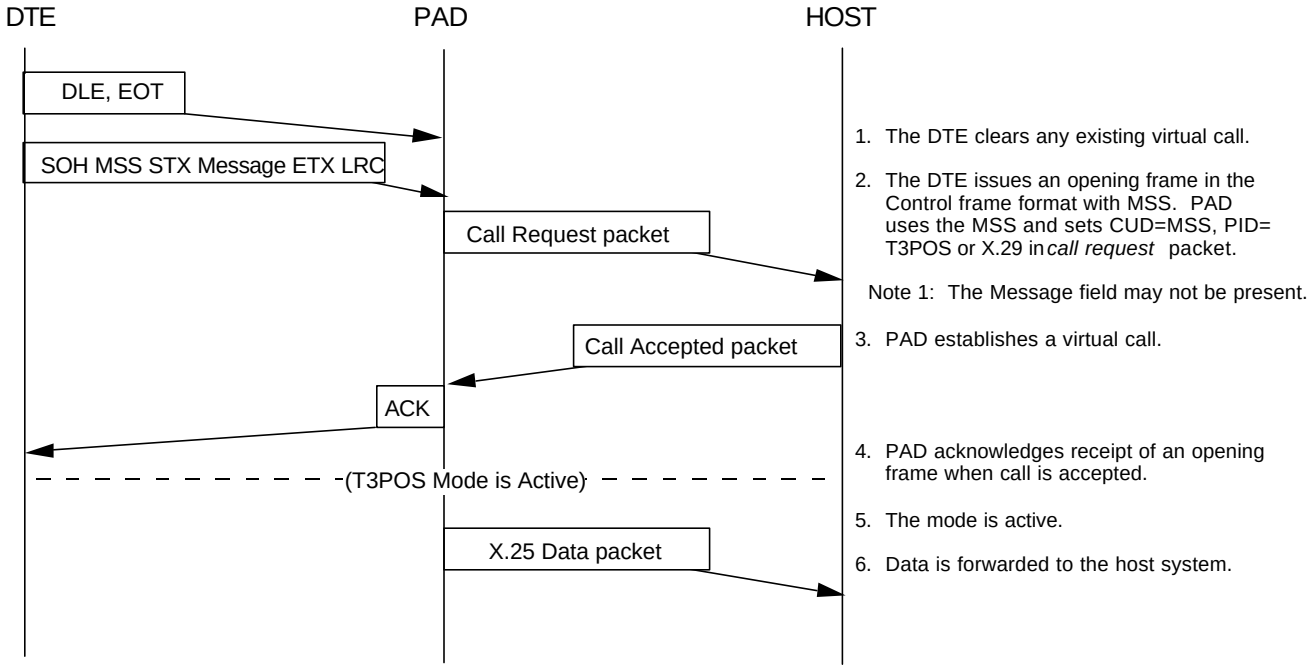


Figure 2-19 Terminal-initiated Call with Opening Frame in Control Frame Format (Method of Host Notification = CUD

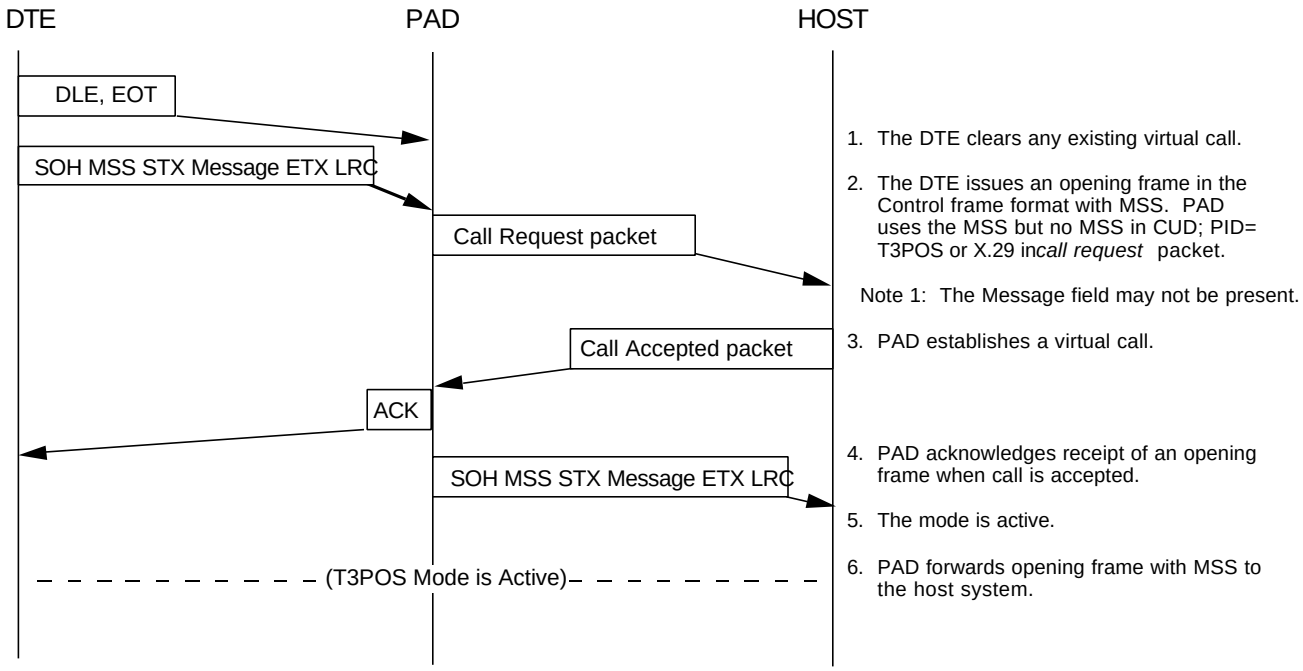
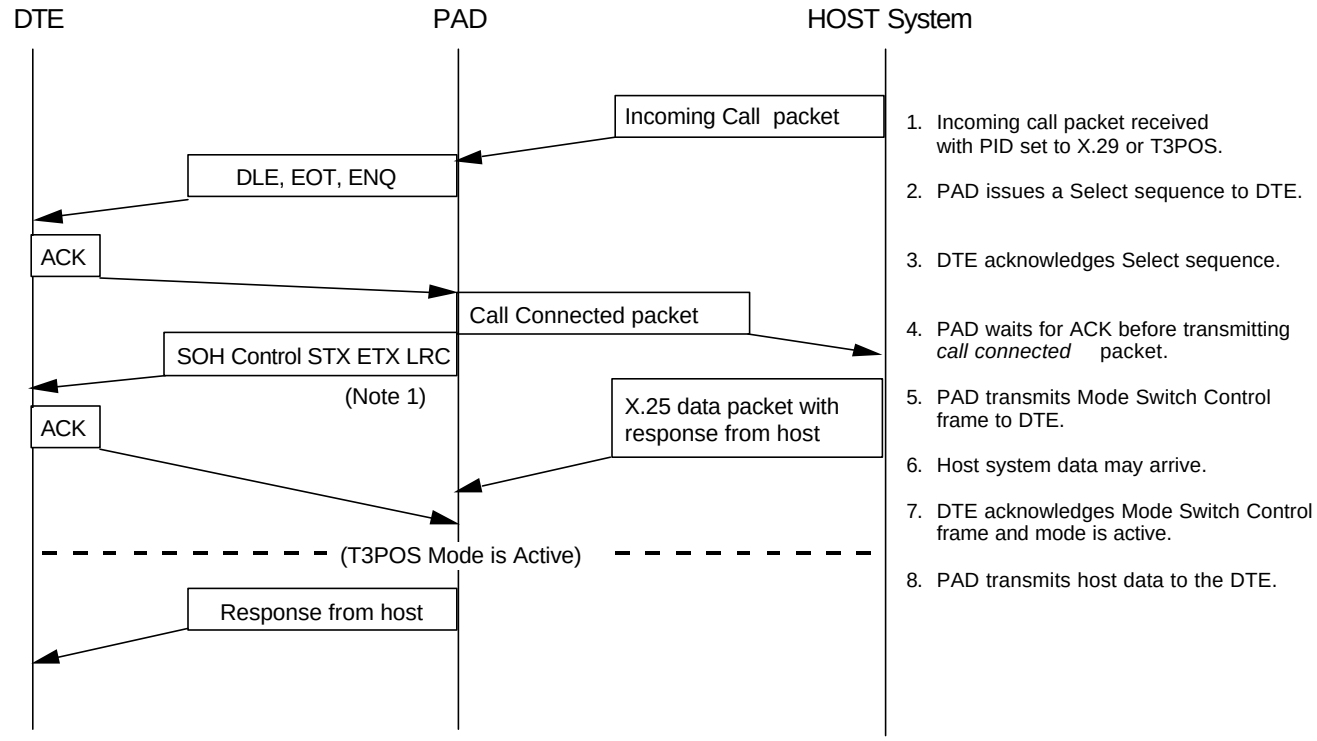


Figure 2-20 Terminal-initiated Call with Opening Frame in Control Frame Format (Method of Host Notification = Mode Switch Control Frame

Host-Initiated Mode Selection

The Host uses the MSS in the CUD to select a T3POS mode operation. The PAD provides the DTE with notification of the MSS chosen. Figure 2-21 illustrates mode selection for a host-initiated call.



Note 1: This frame will contain the Mode Selection Signal taken from the Called User Data (CUD) field. Additional data in the CUD of an incoming call packet are mapped into the Control field.

Figure 2-21 Host-initiated Call with Mode Selection

2.10.4 ENQ Character Support

The DIGIPAC® T3POS PAD supports two options for the ENQ character. With option 1, the PAD waits for receipt of an ENQ from the host system prior to transmitting the opening frame. This option makes use of the ENQ timer T3 -- will be set to a value of 1.5 seconds for this option), which transfers the PAD into the Data Transfer state if no ENQ is received within the T3 time period. With option 2, the PAD immediately transitions to the Data Transfer state upon receipt of a call connected packet from the host system without waiting for an ENQ character.

2.11 X.3 Parameter Profile for Point-of-Sale (POS) (Not Supported)

For interfaces with POS terminal equipment, there is a set of defined values of X.3 PAD parameters known as the POS Standard Profile. This profile may be assigned to the POS terminal PAD interface at subscription time. With the exception of parameters 4, 11 and 21, the value of all X.3 parameters that make up the POS Standard Profile will be set to zero. In all modes, the value of parameter 4 will be set to 1 at subscription time. In all modes, the value of parameter 11 (line speed) will be set appropriately at subscription time. In Local mode, the value of parameter 21 will be set to 3. In Transparent and Blind modes, the value of parameter 21 will be set to zero. DIGIPAC does not support this profile because in the current implementations all X.3 parameters are ignored or implied based on line configuration.

Table 2-7 T3POS PAD X.3 Parameters

Parameter #	Parameter Name	Local Mode	Transparent Mode	Blind Mode	Default
1	Escape to Command	0	0	0	0
2	Echo	0	0	0	0
3	Data Forwarding	0	0	0	0
4	Idle Timer	T1 timer	--	--	2
5	Flow Control of DTE	0	0	0	0
6	PAD Service Signals	--	--	--	Note 1
7	Break Procedure	0	0	0	0
8	Discard Output	0	0	0	0
9	Padding after <CR>	0	0	0	0
10	Line Folding	0	0	0	0
11	Port Speed	■	■	■	■
12	Flow Control of PAD	0	0	0	0
13	<LF> Insertion	0	0	0	0
14	Padding after <LF>	0	0	0	0
15	Editing Control	0	0	0	0
16	Character Delete	0	0	0	0
17	Line Delete	0	0	0	0
18	Line Display	0	0	0	0
19	Service Signal Editing	0	0	0	0
20	Echo Mask	0	0	0	0
21	Parity Treatment	3 (Note 2)	0	0	0
22	Page Wait	0	0	0	0

Note 1: The default values for parameter 6 should be set to 0 for dedicated and VPL interfaces and 1 for public dial-in interfaces.

Note 2: The value of parameter 21 is 3 for a 7 data bit, even parity setting and parameter 21 is 0 for an 8 data bit, no parity setting.

2.12 Compliance Matrix

The table below shows the compliance of the T3POS Pad in the DIGIPAC® network with the Bellcore document GR-2803-CORE, "Generic Requirements for a Packet Assembler/Disassembler Supporting T3POS", Issue 1, November 1993. The word noted indicates that no requirements were contained in the section number.

Bellcore GR-2803-CORE section number	DIGIPAC® T3POS Compliance Statement
1.0	Noted
1.1	Noted
1.2	Noted
1.3	Noted
1.4	Comply After the virtual call is cleared, the PAD operates in opening frame mode.
2.1	Comply
2.2	Noted
2.2.1	Partially Comply Maximum frame size is 256 bytes in local mode. No maximum for blind and transparent modes. Character-to-character timer range is .01-2.55 sec (default .04 sec). Frame Arrival timer is assumed to be DLE/EOT timer and is hard coded to 4 minutes. Signaling Rate defaulted to 1200 baud. Opening Frame/Local Mode Data format defaulted to 7 bits auto parity. Link Access Type defaulted to dial. Dial access is not fully supported. Separate retry limits exist for NAK and ENQ
3.0	Noted
3.1	Noted
3.1.1	Comply

Bellcore GR-2803-CORE section number	DIGIPAC® T3POS Compliance Statement
3.1.1.1	Partially Comply If the DTE wishes to terminate a transparent mode session by sending a DLE EOT sequence followed immediately by an opening frame some delay between the DLE EOT and opening frame is necessary in order to allow the PAD to re-configure with the default parity handling. If the DTE does not allow sufficient delay between these frames then it will receive an ENQ and must re-transmit the opening frame. This delay was measured by QWEST to be 40ms.
3.1.1.2	Comply
3.1.1.3	Do not Comply Opening Frame/Local Mode max. frame size is 256 bytes. No maximum for Transparent or Blind mode.
3.1.1.4	Comply Noted Network Management Data and X.28 Terminal Indicator "J" Modes are not supported.
3.1.2	Comply
3.1.3	Comply
3.2.1	Partially comply R3-16b If the PAD is optioned to wait for host ENQ then data transfer state is not entered until either an ENQ is received from the host (which is not forwarded to the DTE) or timer T3 expires. If the PAD is optioned to not wait for host ENQ then data transfer state is entered immediately. R3-17 SYN characters are not transmitted to the DTE while the PAD is receiving a long host message (i.e. M bit is set).
3.2.2.1	Comply
3.2.2.2	Comply
3.2.3	Comply
3.2.4	Partially comply R3-28 (4) - Unsuccessful call attempts are not counted in the Re-try limit since dial access is not fully supported
3.2.4.1	Comply
3.2.4.2	Partially Comply Timer T6 is not supported since it applies to dial up access.

Bellcore GR-2803-CORE section number	DIGIPAC® T3POS Compliance Statement
4.1.1	Partially Comply R4-2 The DIGIPAC® T3POS PAD does not select the default POS profile. It must be provisioned by the service provider. R4-3 The DIGIPAC® T3POS PAD does not send a T3POS-ID PAD service signal regardless of the value of P6. R4-4 Timer T6 is not fully supported. A dial connection will be disconnected if the DTE does not successfully connect a call within call setup timer value. This timer supports a range of 0-1 minute.
4.1.2	Comply
4.1.3	Comply
4.1.3.1	Comply
4.1.3.2	Comply
4.1.3.3	Comply
4.1.4	Comply The PAD does not monitor the DTE data stream for DLE EOT sequence if operating in Blind mode. After the virtual call is cleared, the PAD operates in opening frame mode.
4.1.4.1	Comply
4.1.4.2	Comply
4.1.4.3	Comply
4.1.4.4	Comply Host initiated clear is assumed to be DTE initiated clear.
4.1.4.5.1	Partially Comply Timer T6 for dial access is not supported
4.1.4.5.2	Partially Comply Unsuccessful call attempts for dial-up connection are not counted in the Re-try limit and therefore will not cause the line to be disconnected.
4.1.4.5.3	Comply
4.1.4.5.4	Comply
4.1.4.5.5	Partially Comply R4-19 Long messages received from the host (i.e. the M bit is set to 1) are forwarded to the DTE as they are received. This was initially requested in order to shorten the total transaction time.
4.2	Comply

Bellcore GR-2803-CORE section number	DIGIPAC® T3POS Compliance Statement
5.1	Partially Comply R5-1 An ACK will be sent to the DTE in transparent and blind mode even if the ACK Generation option is off if no information from the opening I-Frame is forwarded to the host.
5.1.1	Comply
5.2	Comply Data forwarding to the host on idle timer expiry in local mode is not supported since this indicates a frame error which is handled locally between the DTE and PAD. Data forwarding using X.3 parameter 4 is not supported.
5.3	Comply
6.0	Comply
6.1	Comply R6-4 T3POS PID stated as 81010000 is assumed to be 41010000.
6.2	Comply
6.2.1	Comply
6.2.2	Comply
6.3.1	Comply
6.3.2	Comply
7.0	Partially Comply P4 is not used. P6 is not supported.
7.1	Comply
8.0	Comply Multi-Aspect PAD is not supported.

Bellcore GR-2803-CORE section number	DIGIPAC® T3POS Compliance Statement
Appendix A	Partially Comply RA-1 Comply. The PAD issues ENQ if a response to a previously issued ENQ was not received within DTE response (T4) timer RA-6 Do not comply. The PAD ignores the frames received while waiting for the call to be established RA-9 Comply. The re-transmission is conditional to the predefined number of re-transmission retries. RA-l0 Do not comply. ENQ is sent if no response from the terminal The ACK to the opening frame is optional and service data configured A-16 Comply. The re-transmission is conditional to the predefined number of re-transmission retries RA-17 Do not comply. ENQ is sent if no response from the terminal

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3.1 Network Features 3-1

Table

3-1 Network Features 3-1

3. QWEST DIGIPAC® Network Features

3.1 Network Features

Please reference the following Table 3-1

KEY: S - Supported; NS - Not Supported; NA - Not Applicable

Table 3-1 Network Features
(Page 1 of 2)

FEATURE	ASYNCHRONOUS	X.25	X.75
Extended Packet Sequence Numbering Module 128	NA	S	S
Nonstandard Default Window Sizes	NA	S	S
Default throughput Classes Assignment	S	S	NA
Incoming Calls Barred	S	S	S
Outgoing Calls Barred	S	S	S
One-way Logical Channel Outgoing	S	S	NA
One-way Logical Channel Incoming	S	S	NA
Closed User Group	S	S	S
CUG with Outgoing Access	S	S	S
CUG with Incoming Access	S	S	NA
Incoming Calls Barred Within a CUG	S	S	NA
Outgoing Calls Barred Within a CUG	S	S	NA
Reverse Charging	S	S	S
Reverse Charging Acceptance	S	S	S
RPOA Selection	S	S	S
Nonstandard Default Packet Sizes	S	S	S
Multiple Circuits to the same DTE	NA	S	NA
Flow Control Parameter Negotiation	S	S	S
Throughput Class Negotiation	S	S	S
Fast Select	S	S	S
Fast Select Acceptance	S	S	NA
Closed User Group Selection	S	S	S
Local Charging Prevention	S	S	NA
Network User Identification	S	S	NS
Charging Information	S	S	NA
Multi-Line Hunt Group	S	S	NA
Call Redirection	S	S	NA
Call Line Address Modification Notification	S	S	NS
Call Redirection Notification	S	S	NA
Direct Call	S	NA	NA
Packet Retransmission	NS	NS	NS
Bilateral Closed User Group	NS	NS	NS

Table 3-1 Network Features
(Page 2 of 2)

FEATURE	ASYNCHRONOUS	X.25	X.75
Window Size Indication	NA	NA	S
Utility Marker	NA	NA	S
Bilateral CUG with Outgoing Access	NS	NS	NS
On-line Facility Registration	NS	NS	NS
Multiple Trunks with the Same Address	S	S	S
Abbreviated Address Calling	S	NA	NA
Setting Values of PAD Parameters	S	NA	NA
Reading Values of PAD Parameters	S	NA	NA
Automatic Detection of: Data Rate Code and Operational Characteristics	S	NA	NA
PAD Recall	S	NA	NA
Echo	S	NA	NA
Selection of Data Forwarding Signal	S	NA	NA
Selection of Idle Time Delay	S	NA	NA
Ancillary Device Control	S	NA	NA
Suppression of PAD Service Signals	S	NA	NA
Selection of Operation of PAD on Receipt of Break	S	NA	NA
Discard Output	S	NA	NA
Padding After Carriage Return	S	NA	NA
Line Folding	S	NA	NA
Binary Speed (Read Only)	S	NA	NA
Flow Control of PAD by Start-Stop Mode DTE	S	NA	NA
Linefeed Insertion	S	NA	NA
Linefeed Padding	S	NA	NA
Editing Functions	S	NA	NA
Parity Functions	S	S	NA
Standard Profile Selections	S	S	S
Permanent Virtual Circuits	NS	S	NS
D-bit Modification	NS	S	NS
Transmit Delay Selection and Notification	NS	NS	NS
Bilateral CUG Selection	NA	NA	S
Transit Network Identification	NA	NA	S
Call Identifier			

Note: Network features supported may change with updated tariff filings.

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4-1 Dial Access - Synchronous - 9600 bit/s CCITT Recommendation V.32 Compatible - (2-Wire) Using Trellis Coded Modulation 4-3
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4. QWEST DIGIPAC® Physical Interface

4.1 Overview

This Chapter describes the physical interface with the DIGIPAC® Network. Descriptions for the Line, Modem, Data Service Unit (DSU) and DIGIPAC® Network port are addressed. In this document, Modem is used generically to identify either an analog data Modem or a digital data DSU. Modems attached to the DIGIPAC® Network must be compatible with the description shown for each type of service. If not compatible, the customer provided modem will not be able to communicate with the associated DIGIPAC® modem located in the Central Office (CO).

Tables 4-1 specifies the options for the modem types required to accommodate the available DIGIPAC® services. These tables provide a description of each selected option and whether the option is required or recommended for the customer. The options are intended to be generic to a given modem. The customer provided modem may have different technology or text to describe each option; with fewer or more options than addressed. Tables 4-2 lists compatible Network Channel (NC) and Network Channel Interface (NCI) code combinations to assist the customer with NC and NCI selections.

A glossary section is provided Chapter 5 to assist the customer in understanding the terminology used in this section. Your QWEST Communications, Inc. Marketing Representative may be contacted for assistance with questions and for further clarification.

4.2 Dial Access

DIGIPAC® does not currently support a dial access method for T3POS.

4.3 Direct Access

DIGIPAC® supports direct access ports that provide a full duplex interface, at either 1200 or 2400 bit/s.

4.4 Physical Interface Description

4.4.1 Direct Access - Asynchronous Analog

- Direct Access - Asynchronous - 2400/1200 bit/s

  Line: 2-Wire; Two-point voice grade data channel

  Modem: CCITT V.22 bis/212A compatible; Full duplex operation

  Interface specifications and operation in accordance with CCITT Recommendation V.22 bis - 1988 "2400 Bits Per Second Duplex Modem Using The Frequency Division Technique Standardized For Use On The Leased Telephone-Type Circuits"

  Optional CCITT V.42 error correction for 2400 bit/s

  Error correction procedures in compliance with CCITT Recommendation V.42 - 1988 "Error Correction Procedures For Using Asynchronous to Synchronous Conversion" specification for LAP-M and MNP® 4

  See Table 4-1 for options

  Port: EIA RS-232-C; recommended EIA-232-D

Table 4-1 Direct Access - Asynchronous - 2400/1200 bit/s CCITT Recommendation V.22 bis/212A Compatible - (2-Wire)
(Page 1 of 2)

REQUIRED MODEM OPTIONS (DIGIPAC® AND CUSTOMER)	
1.	Communication protocol compatibility: CCITT for 2400 bit/s, 212A for 1200 bit/s
2.	Private Line operation
3.	Asynchronous operation.
4.	Data rate: 1200 or 2400 bit/s; autobaud operation.
5.	Character length: 10 bits per character including start and stop bits.
6.	Transmit signal level: -12.0 dBm. May require option: Programmable.
7.	Line impedance: 600 ohms.
8.	Constant transmit carrier - Private Line operation.
9.	Received Line Signal Detector (CF) functions normally, that is, turns on and off in response to the on and off transition of received carrier.
10.	Private Line handshake mode: CUSTOMER = Originate DIGIPAC® = Terminate
11.	Loss of carrier disconnect, enabled. Modem will terminate data connection when loss of received carrier is detected for more than approximately 350 ms.
12.	DTE control of data rate via the CH lead (pin 23), disabled. Terminal cannot control modem data rate.
13.	Send space disconnect, enabled. Transmits approximately 4 seconds of spaces at end of call to disconnect remote modem.
14.	Receive space disconnect, enabled. Modem disconnects upon receiving approximately 1.6 seconds of space signal from remote modem.
15.	Optional Error Correction Procedures per CCITT Recommendation V.42, enabled according to service requested.

Table 4-1 Direct Access - Asynchronous - 2400/1200 bit/s CCITT Recommendation V.22 bis/212A Compatible - (2-Wire)
(Page 2 of 2)

DIGIPAC® MODEM OPTIONS	
1.	Clear To Send lead (CB) forced OFF when Received Line Signal Detector (CF) goes OFF. CB lead is common to CF lead.
2.	Automatic answering, enabled. Calls are answered by modem.
3.	Data rate indicator to DTE via the CI lead (pin 12), disabled. CI lead (pin 12) not a functional DIGIPAC® port interface lead.
4.	Data Set Ready (CC lead, pin 6) forced ON during Analog Loopback test, or continuously.
5.	Data Terminal Ready (CD lead, pin 20) forced ON continuously.
6.	DTE control of Analog Loopback via the LL lead, enabled and assigned to pin 18.
7.	Modem goes off-hook (busy) when an Analog Loopback test is invoked.
8.	DTE control of Remote Digital Loopback via (pin 21), enabled.
9.	Enable modem's ability to respond to Remote Digital Loopback (RDL) signal from remote modem. The modem responds to a digital loopback signal generated by the far end modem.
	Test mode indication to DTE via TM lead (pin 25), enabled.
10.	Signal quality abort, disabled. Modem dies not disconnect when the received signal quality deteriorates.
11.	Frame and signal grounds separated by 100 ohms.
12.	

Table 4-2 NC and NCI Code Combinations - Voice Grade Analog Channel

SPEED (bit/s)	SERVICE	MODEM OPERATION	NC CODE			NCI CODE CKL 1-PS	NCI CODE CKL 2-CS
			VG6	VG10	VG36		
1200	Async	212A	N/A	LN1-	UG- -	02DM2.2P.PT	02DA..PX
2400	Async	CCITT V.22 bis	N/A	LN1-	UG- -	02DM2.8PA.PT	02DA..PX

See appropriate QWEST Technical Publication for additional information on Digital Channel Interface Codes.

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5. Definitions

5.1 Acronyms

AC	Access Concentrator
AMA	Automatic Message Accounting
ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
BCD	Binary Coded Decimal
BOC	Bell Operating Company
bps	Bits per Second
CCA	Credit Card Association (CCA)
CCITT	International Telegraph and Telephone Consultative Committee
CO	Central Office
CPE	Customer Provided Equipment
CSU	Channel Service Unit
CUD	Call User Data
CUG	Closed User Group
DCE	Data Circuit-Terminating Equipment
DDD	Direct Distance Dialing
DDS	Digital Data System
DISC	Disconnect
DM	Disconnect Mode
DNIC	Data Network Identification Code
DNPA	Data Numbering Plan Area
DOV	Data Over Voice
DSU	Data Service Unit
DSP	Display System Protocol
DTE	Data Terminal Equipment
DVM	Data/Voice Multiplexer
EIA	Electronic Industries Association
F	Final bit

FCS	Frame Checking Sequence
FRMR	Frame Reject
HDLC	High Level Data Link Control
I	Information
IA5	International Alphabet No. 5
IC	Interexchange Carrier
INIC	ISDN Network Identifier Code
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ISP	Information Service Provider
Kbps	Kilobits per second
LAPB	Link Access Procedure Balanced
LATA	Local Access and Transport Area
LC	Logical Channel
LCN	Logical Channel Number
LRC	Logical Channel Number
MLHG	Multi-line Hunt Group
MNP®	Microcom Networking Protocol
MTCE	Maintenance
NPA	Numbering Plan Area
N(R)	Receive Sequence Number
N(S)	Send Sequence Number
NTN	Network Terminal Number
NUI	Network User Identification
OOS	Out of Service
OSI	Open Systems Interconnection
OTC	Operating Telephone Company
P	Poll
PAD	Packet Assembler/Disassembler
PDN	Public Data Network
PHF	Packet Handler Function

POS	Point-Of-Sale
PPSN	Public Packet Switching Network
PPSNGR	Public Packet Switching Network Generic Requirement
PS	Packet Switch
PSDN	Packet Switched Data Network
PSPDN	Packet Switched Public Data Network
PSTN	Public Switched Telephone Network
PVC	Permanent Virtual Circuit
RC	Recent Change
RCVS	Recent Change and Verify Subsystem
REJ	Reject
RES	Reset
RNR	Receive Not Ready
RPOA	Recognized Private Operating Agency
RR	Receive Ready (packets or frames)
SABM	Set Asynchronous Balanced Mode
SABME	Set Asynchronous Balanced Mode Extended
STE	Signaling Terminal Equipment
SVC	Switched Virtual Calls
UA	Unnumbered Acknowledgment
USTA	United States Telephone Association
VC	Virtual Call
V(R)	Receive State Variable
V(S)	Send State Variable
XID	Exchange Identification

5.2 Glossary

Asynchronous Transmission

Data transmission in which the time of occurrence of a specified significant instant in each byte, character, word, block or other unit of data (usually the leading edge of a start signal) is arbitrary, and occurs without necessarily being dependent on preceding signals on the channel.

Baud

Denotes a unit of signaling speed. It is the reciprocal of the time duration in seconds of the shortest signal element (mark or space) within a code signal. The rates specified are the number of signal elements per second.

Bit

An abbreviation of binary digit; one of the members of a set of two in the binary numeration system, e.g., either of the digits 0 or 1. Also, a unit of information; one bit of information is sufficient to specify one of two equally like possibilities, usually meaning yes or no.

Bits Per Second (BPS)

Unit of data transmission rate (see baud).

Carrier Detect (DCD)

See Received Line Signal Detector.

Character

Letter, numeral, punctuation, control figure or any other symbol contained in a message.

Clear To Send (CTS)

An EIA-232 interface control signal that indicates to the DTE whether or not the modem is ready to transmit data.

Conditioning

Denotes an enhancement to the transmission performance of a voiceband channel. Parameter(s) affected are attenuation distortion, envelope delay, distortion and noise.

Consultative Committee International Telephone and Telegraph (CCITT)

An international association that sets international telecommunications standards.

Data Communications Equipment (DCE)

The equipment that provides the functions required to establish, maintain and terminate data transmission connection; e.g., a modem, as well as the signal conversion, and coding required for communications between data terminal equipment and data circuit.

Data Set Ready (DSR)

An EIA-232 interface control signal that indicates to the DTE the status of the local modem; e.g., modem is connected to communications channel and is not in the test or dial mode.

Data Terminal Equipment (DTE)

Customer owned equipment used to transmit and receive data.

Data Terminal Ready (DTR)

An EIA-232 interface control signal that indicates to the modem the DTE is ready to transmit or receive data.

Dial Access

Access to the packet switch is via the voice Public Switched Network.

Digital Service Unit (DSU)

A DCE device that converts EIA-232-D or CCITT V.35 signals (from the packet switch) to baseband bipolar line signals suitable for transmission over a telephone channel.

Direct Access

Access to the packet switch is via a dedicated channel between the End-User and the packet switch.

Full Duplex

Simultaneous transmission in both directions between two points.

Half Duplex

Data transmission in either direction, but not simultaneously.

Line

The transport facility (cable pair or carrier) between the Central Office and Network Channel Interface.

Link Access Procedure For Modems (LAP-M)

An error correction procedure defined in CCITT Recommendation V.42-1988.

Loopback

A test procedure that causes a received signal to be returned to the source.

Modem

A DCE device that converts EIA-232-D or CCITT V.35 signals (from the packet switch) to voiceband signals suitable for transmission over a telephone channel.

Port

An EIA-232 or CCITT V.35 I/O interface of a packet switch, computer or modem.

Received Line Signal Detector

An EIA-232 interface control signal that indicates to an attached DTE device that the modem is receiving a signal from a remote modem.

Request to Send (RTS)

An EIA-232 interface control signal that indicates the DTE has data to transmit and conditions the modem for data transmission.

Ring Indicator

An EIA-232 control interface signal which indicates to the DTE that a ringing signal is being received on the communications channel.

Start Bit

In asynchronous transmission, the first bit in each character, normally a space, which prepares the receiving equipment for the reception and registration of the character.

Stop Bit

In asynchronous transmission, the last bit, used to indicate the end of a character, normally a mark condition, which serves to return the line to its idle or rest state.

Switch Network

Data transmission and access to DIGIPAC® is via the voice Public Switched Network.

Synchronous Transmission

Transmission in which the occurrence of a specified event (e.g., byte, character, word, block or other unit of data, such as the leading edge of a start signal), occurs in a specified time relationship with a preceding signal in the channel, in accordance with a specified timing pulse, or in accordance with a specified time frame.

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6.5 Electronic Industries Association 6-3
6.6 Pre-Divestiture Publication 6-3
6.7 United States Telephone Association 6-3
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6. References

6.1 American National Standards Institute

ANSI X3.4 Denotes the code character set to be used for the general interchange of information among information-processing systems, communications systems and associated equipment.

6.2 AT&T Publication

PUB 62310 *"Digital Data System Channel Interface Specification"*, September 1983.

6.3 Bellcore Publications

TR-NPL-000011 Bellcore, *Asynchronous Terminal and Host Interface Reference,* Issue 1

TR-TSY-000301 Bellcore, *Public Packet Switched Network Generic Requirements,* Issue 2

TR-TSY-000448 Bellcore, *ISDN Routing and Digit Analysis,* Issue 1, Revision 1

6.4 Consultative Committee International Telephone And Telegraph

CCITT Recommendation V.3 International Alphabet No. 5

CCITT Recommendation V.22*bis* 2400 Bits per second duplex modem using the frequency division technique standardized for use on the general switched telephone network and on point-to-point 2-Wire leased telephone-type circuits.

CCITT Recommendation V.24 Defines physical and electrical connection between data terminal equipment and data communications equipment.

CCITT Recommendation V.26 2400 BPS modem standardized for use on 4-Wire leased telephone-type circuits.

CCITT Recommendation V.27 4800 BPS with manual equalizer standardized for use on leased telephone-type circuits.

CCITT Recommendation V.29 9600 BPS modem standardized for use on leased telephone-type circuits.

CCITT Recommendation V.32	A family of 2-Wire duplex modems operating at data signaling rates of up to 9600 bit/s for use on the general switched telephone network and on leased telephone-type circuits.
CCITT Recommendation V.32*bis*	A family of 2-Wire duplex modems operating at data signaling rates of up to 14400 bit/s for use on the general switched telephone network and on leased telephone-type circuits.
CCITT Recommendation V.34	A family of 2-Wire duplex modems operating at data signaling rates of up to 28800 bit/s for use on the general switched telephone network and on leased telephone-type circuits.
CCITT Recommendation V.35	Modems for Synchronous Data Transmission using 60-108 KHz Group Band Circuits (Replaced by V.36)
CCITT Recommendation V.36	Data Transmission at 48 Kilobits per second using 60-108 KHz Group Band Circuits
CCITT Recommendation V.42	Error-correction procedures for DCEs using Asynchronous-Synchronous conversion.
CCITT Recommendation V.54	Loop back interface option associated with V.24.
CCITT Recommendation X.1	International user classes of service in Public Data Networks.
CCITT Recommendation X.2	International user services and facilities in Public Data Networks.
CCITT Recommendation X.3	Packet Assembly/Disassembly (PAD) facility in a Public Data Network.
CCITT Recommendation X.4	General Structure of Signals of International Alphabet. 5 Code for data transmission over Public Data Networks.
CCITT Recommendation X.21	Use on Public Data Networks of DTEs which are designed for interfacing to synchronous CCITT series V. recommendation modems.
CCITT Recommendation X.25	Interface between DTE and DCE for terminals operating in the packet mode on Public Data Networks.
CCITT Recommendation X.28	DTE/DEC Interface for start-stop mode data terminal equipment accessing the PAD facility in a Public Data Network situated in the same country.

CCITT Recommendation X.29	Procedures for the exchange of control information and user data between a PAD facility and a packet mode DTE or another PAD.
CCITT Recommendation X.32	Interface between data terminal equipment and data circuit terminating equipment for terminals operating in the Packet mode and accessing a packet switch Public Data Network through a public switched telephone network or an Integrated Services Digital Network or a circuit switch Public Data Network.
CCITT Recommendation X.75	Terminal and transit call control procedures and data transfer system on international circuits between packet switched data networks.
CCITT Recommendation X.87	Principles and procedures for realization of international facilities and network utilities in Public Data Networks.
CCITT Recommendation X.92	Hypothetical reference connections for public synchronous data networks.
CCITT Recommendation X.96	Call progress signals in Public Data Networks
CCITT Recommendation X.110	Routing principles for international public data services through Switched Public Data Networks of the same type.
CCITT Recommendation X.121	International numbering plan for Public Data Networks.

6.5 Electronic Industries Association

EIA RS-232-C	Defines physical and electrical connection between data terminal equipment and data communications equipment.

6.6 Pre-Divestiture Publication

PUB 41021	*"Digital Data System - Channel Interface Specifications"*, March 1973 and Addendum, October 1981

6.7 United States Telephone Association

USTA document TA20	*Compatibility Criteria for Data Set 212A,* September 1977

6.8 QWEST Communications, Inc. Technical Publications

PUB 77331 *"Digital Data Over Voice Digital Access Arrangements, Network Interface Specifications"*, Issue E, September 2001

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