U S WEST Communications, Inc. Technical Publication

U S WEST DIGIPAC® SERVICE INTERFACE SPECIFICATIONS FOR PUBLIC PACKET SWITCHING NETWORK

Module 2

77359, Module 2
Issue H
July 1996

U S WEST
Communications, Inc.
Technical Publication

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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 U S WEST wide basis.

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2. X.25 Interface (Multichannel-Direct Access)

2.1 Overview

This Chapter describes the service provided by the X.25 Interface of the Packet Switched Public Data Network (PSPDN). The interface (based on the 1988 International Telegraph and Telephone Consultative Committee (CCITT) Recommendation X.25) defines the interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for terminals or hosts operating in the packet mode on a PSPDN. Where there are differences in the operation of the U S WEST X.25 Interface function and the 1988 X.25 Recommendation it will be noted in the text as well as a compliance matrix at the end of this chapter. The X.25 interface supports Switched Virtual Calls (SVC) and Permanent Virtual Circuits (PVC). The interface also supports Reverse Charging and Closed User Groups. The interface specifications for communications between an X.25 host and an asynchronous DTE is specified in Module 1, Chapter 2, Section titled “Interface Procedures (Asynchronous DTE to X.25 DTE)”. These specifications are based on CCITT Recommendation X.29.

2.2 Physical Level

The X.25 interface is available at data rates of 2400 bit/s to 9600 bit/s using a voice grade data channel or digital data channel; and at 56 kbit/s using a digital data channel (see Table 2-3). Details on the physical interfaces available on DIGIPAC® are found in Chapter 4.

Note: The following link and packet level specification items refer to parts of the 1980, 1984 and 1988 CCITT Recommendation X.25. Information is also provided on system parameter options (see Tables 2-1, 2-2 and 2-3).

2.3 Link Level

The link level access protocol controls data transmission across the access link. Both information and control are transferred across the access link in transmission units called frames. Frame structure and procedures are in accordance with Link Access Procedures Balanced (LAPB) described in section 2 of the 1988 CCITT Recommendation X.25

2.3.1 System Parameters (see Table 2-3)

Timer 1

Timer T1, commonly referred to as the frame response timer, is used to retransmit frames if no frame acknowledgment is received within the timed interval. The period of Timer T1, at the end of which re-transmission of a frame may be initiated, will take into account whether T1 is started at the beginning or the end of the transmission of a frame. The period of Timer T1 is agreed to at subscription time with U S WEST, and may be set in increments of .01 Seconds.

The value of DCE Timer T1 for the DIGIPAC® network may be between 0 and 655 seconds and the default value equals 3 seconds.

Proper operation of link procedure requires that transmitter's (DTE or DCE) Timer T1 be greater than the maximum time between transmission of frames (Set Asynchronous Balanced Mode (SABM), Disconnect (DISC), Information (I) or supervisory command, or Disconnect Mode (DM) or Frame Reject (FRMR) response) and the reception of the corresponding frame returned as an answer to that frame (Unnumbered Acknowledgment (UA), DM or acknowledging frame). Therefore, the DTE or DCE receiver should not delay the response or acknowledging frame returned to one of the above frames by more than a value T2, where T2 is a system parameter.

Parameter T2

Parameter or Timer T2 is used to delay the acknowledgment of incoming I-frames to enforce frame level piggybacking of acknowledgment frames to I-frames. The DCE or DTE will not delay the response or acknowledging frame returned to a command by more than value of T2. The value T2 should always be less than the value of T1. When setting this value, the round trip propagation delay of the access line should be added to the value of T2 and the result should be less than the value of T1. The value of T2 for DIGIPAC® has a range of 100-1000 milliseconds and OFF and is set to a default value of 400 milliseconds

Parameter N2

Parameter N2, commonly called the retransmit limit, is used to specify the number of times a frame is retransmitted before other recovery action is taken. The range of values for the number (N2) of attempts made by the DTE to complete the successful transmission of a frame to the PSPDN is from 1 to 15. The default value of this parameter is set to 10 unless the subscriber requests otherwise.

Parameter N1

This field specifies the maximum number of bits (excluding flags and bits inserted for transparency) that can be contained in each I-frame. The highest value that can be used is 16440. The default value of this field is set to 2120 bits in order to accommodate a packet of 256 octets.

Parameter k

This field specifies the maximum number of sequentially numbered I-frames that can be outstanding (unacknowledged) at any given time. This is nominally set to 7 if module 8 service is specified, or 127 if module 128 service is specified. The default value of k in the DIGIPAC® network is 7.

2.3.2 Timer Recovery

DIGIPAC® supports timer recovery procedures specified in 1988 CCITT X.25 Paragraph 2.4.5.9.

2.3.3 Link Disconnection

During the information transfer phase, the frame reject condition or the disconnected phase, the DTE shall indicate disconnecting of the link by transmitting a DISC command to the PSPDN. When receiving a DISC command during the information transfer phase or the frame reject condition, the PSPDN will return a UA response to the DTE and enter the disconnected phase.

When the PSPDN wishes to disconnect the link, it will send the DISC command with the P bit set to 1 and start Timer T1. Upon reception of the UA or DM response, with Final bit (F) set to 1, from the DTE, the PSPDN will stop its Timer T1. Should Timer T1 expire before reception of the UA or DM responses from the DTE, the PSPDN will retransmit the DISC command and restart Timer T1. After transmission of the DISC command N2 times by the PSPDN, recovery action will be initiated.

2.3.4 Timer T3 (Idle Channel State)

Timer T3 is used to indicated to the packet layer that there has been an excessively long idle time. Timer T3 (Idle Channel State) is supported on the DIGIPAC® network and is started when no level two activity is detected (no flags sent or received). If the timer expires it will start link recovery actions. The range of values for this timer is from 1-655 seconds and OFF in increments of 1 second. The default value of Timer T3 is set to 15 seconds.

In addition, an idle probe timer is available. This timer is started when there is no activity on the link (valid frames sent or received.). When the timer expires a command level Receive Ready/Receive Not Ready (RR/RNR) with the poll bit set will be sent to check the conditions of the link. The range of values for this timer is from 1-655 seconds and OFF in increments of 1 second. The default value of this timer is set to OFF.

2.3.5 Link Level Addressing

The address field identifies a frame as either a command or a response. A command frame contains the address of the DCE or DTE to which the command is being sent. A response frame contains the address of the DCE or DTE sending the frame.

Frames containing commands transferred from the DCE to the DTE will contain the address "A" for the single link operation. Frames containing responses transferred from the DTE to the DCE shall contain the address "A" for the single link operation.

Frames containing commands transferred from the DTE to the DCE shall contain the address "B" for the single link operation. Frames containing responses transferred from the DCE to the DTE will contain the address B for the single link operation.

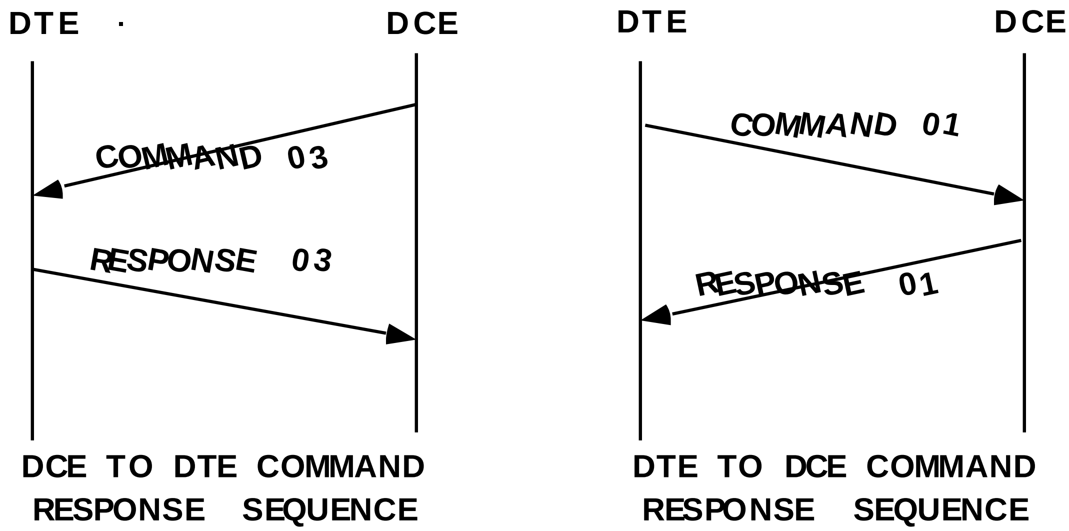

Figure 2-1 An Overview Of The Transaction Switching

These addresses are coded as follows:

	Address	1	2	3	4	5	6	7	8	
Single link operation	A	1	1	0	0	0	0	0	0	DCE
	B	1	0	0	0	0	0	0	0	DTE

Note: The DCE will discard all frames received with an address other than A or B.

The default link level-addressing mode for DIGIPAC® will have DIGIPAC® as the DCE.

2.4 Packet Level

2.4.1 Packet Level Access

The packet level access protocol provides the interface procedures required to set up, maintain and clear SVCs and maintain PVCs between DTEs. The packet types, formats and procedures are those given in X.25 for Switched Virtual Call and Permanent Virtual Circuit services (see Tables 2-A, 2-B and 2-C for explanation and values of packet timers and parameters).

2.4.2 Standard Packet Level Attributes

Packet level interface attributes specified in X.25 include:

- User data field length of 128 octets (optionally 256 octets)
- Packet sequence numbering module 8
- Packet level window size of 2

2.4.3 Logical Channels

Logical channels are identified by a four bit logical channel group number and an eight bit logical channel number. This allows a maximum of 4096 logical channels. The recommend maximum number of logical channels for an interface based on its speed are listed below:

Speed	Max #
2.4 kbit/s	127
4.8 kbit/s	255
9.6 kbit/s	511
56.0 kbit/s	1023

DIGIPAC® Logical channels will be assigned per Annex A of 1988 CCITT Recommendation X.25. For each range of logical channels applying to a VC interface, the user must specify the logical channel number. If either the incoming/outgoing calls barred facility applies to an interface, the user must specify the logical channel number range (beginning and end). For permanent virtual circuits, the user much specify the logical channel number for each permanent virtual circuit applying to an interface.

2.4.4 User Data Field Length of Data Packets

The standard User Data Field Length is 128 octets. However, the User Data field of data packets transmitted by a DTE may contain any number of bits up to the agreed maximum. If the User Data field in a data packet exceeds the locally permitted maximum User Data Field length, then the PSPDN will reset the virtual call or permanent virtual circuit with the resetting cause "local procedure error". Octet aligned (any integral number of octets up to 128 or optional 256) User Data fields are supported.

2.4.5 More Data Mark

The More Data Mark (M-bit) may only be set to 1 in a full data packet. When it is set to 1 in a full data packet, it indicates that more data is to follow. The network does not perform fragmentation or recombination of packets since the maximum packet length is the same at both ends and equal to 128 octets. The network checks if a data packet with the M-bit set is a full data packet. If not, the PSPDN considers this as a "local procedure error" and will reset the call. A sequence of data packets with every M-bit set to 1 except for the last one will be delivered as a sequence of data packets with the M-bit set to 1 except for the last one, when the original packets have M=1 are full.

2.4.6 Qualifier Bit

The Q-bit is handled transparently on the X.25 interface.

2.4.7 Delivery Confirmation

The delivery confirmation (D-bit) procedures are supported as specified in X.25. The DTE indicates whether it wishes to receive, by means of the packet receive sequence number P (R), and end-to-end acknowledgment (indicated by D = 1).

2.4.8 Significance of DCE (PSPDN) Clear, Reset, and Restart Confirmation Packets

DCE (PSPDN) Clear, Reset, and Restart Confirmation packets have local significance. Local significance permits a confirmation packet to be sent as soon as the network has cleared or reset the logical channel, rather than after the remote DTE has confirmed the reset or clear indication.

2.4.9 Flow Control Principles

The network follows the standard flow control principles specified in Section 4.4.1, 1988 CCITT X.25.

2.4.10 Diagnostic Packet

Diagnostic packets are generated whenever specified according to the recommendation, and only if the user has elected to receive these packets when they negotiate service with U S WEST. A special feature of DIGIPAC®, not within the recommendation, is a subscription option to allow DTE the right to send diagnostic packets. These diagnostic packets do not impact the state of any logical channel and will not be carried across the network even if a virtual circuit is in place.

2.4.11 Packet Format

See CCITT Recommendation X.25.

2.5 Addresses

The network numbering plan for Virtual Call services complies with CCITT Recommendation X.121. Network addresses consist of 10 digits. All 10 digits must be present whenever an address is given in the address field of a packet. It is expected that inter network calls will utilize 14 digits which consist of the network address preceded by a 4 digit DNIC.

For packet calls to and from Integrated Services Digital Networks (ISDN) the address of the ISDN subscribers will be in a format that conforms to TR-TSY-000448, Issue 1, Revision 1, July 1989. For calls to and from ISDNs within the United States the format will be as follows:

1+0+CC+N(S)N
Where
1 = Prefix Digit
0 = Escape Code to non-native numbering plan
CC = Country Code for North America
N(S)N = National Significant Number (NPA+NXX+XXXX for North America)

2.5.1 Address Screening

Address screening will be performed by the network on the calling address field of the call request packet from the calling DTE. The access port for a user will always have the Ignore Local Address option turned of in order to ensure that the address in the calling address field of the Call Request Packet going forward will contain a valid network address.

For access lines with a Single Data Network Address (DNA):

- If there is no address present in the calling address field of the call request packet from the calling DTE, the DNA assigned to the access port will be placed in the calling address field and the call will proceed.
- If there is an address in the calling address field of the call request packet from the calling DTE, and that address matches the DNA assigned to the access port the call will proceed.
- If there is an address in the calling address field of the call request packet from the calling DTE, and that address does not match the DNA assigned to the access port the call will be rejected.

For access lines with Multiple Sequential DNAs:

- If there is no address present in the calling address field of the call request packet from the calling DTE, the lead DNA assigned to the access port will be placed in the calling address field and the call will proceed.
- If there is an address in the calling address field of the call request packet from the calling DTE, and that address matches the lead DNA assigned to the access port the call will proceed.
- If there is an address in the calling address field of the call request packet from the calling DTE, and that address does not match the lead DNA assigned to the access port the call will be rejected.

For access lines with Multiple Non-Sequential DNAs:

- If there is no address present in the calling address field of the call request packet from the calling DTE, the call will not be rejected.
- If there is an address in the calling address field of the call request packet from the calling DTE, and that address matches any DNA assigned to the access port the call will proceed.
- If there is an address in the calling address field of the call request packet from the calling DTE, and that address does not match any DNA assigned to the access port the call will be rejected.

2.5.2 Multiple Address

DIGIPAC® offers the ability to assign multiple addresses to a single interface in one of two ways.

The first method is the assignment of multiple DNAs in a sequential block of either ten (10) or 100 numbers. When this method is used the user is able to use the last digit or the last two digits of the address for sub-addressing. An example of how sub-addressing can be used may be to direct an incoming call to a specific application based on the last one or two digits of the called address.

The second method allows the user to have multiple non-sequential address assigned to a single interface. This method does not allow the user the ability to use sub-addressing and is probably used less frequently than the first method.

2.6 Access Line Takedown

2.6.1 General

These capabilities apply to individual access lines, including access lines which are part of a hunt group.

2.6.2 Unconditional Access Line Takedown

A user may place a call to repair and request an unconditional take down of an access line. The line is then taken out of service until the user requests that it be returned to service. The network will take the line out of service by clearing all SVCs and resetting all permanent virtual circuits toward the remote DTEs and by initiating the link level disconnect procedure on the local interface. For SVCs, a Clear Indication packet will be transmitted to each remote DTE with a cause code of "out of order". For permanent virtual circuits, a Reset Indication packet will be transmitted to each remote DTE with a cause code of "out of order". A DISC command frame will be transmitted to the local DTE.

2.6.3 Conditional Access Line Takedown

This feature allows a user to take an access line gracefully out of service. The user calls, by standard voice telephone, to request a conditional take down of an access line. Based on the user request, action is taken to prevent any new Virtual Calls (VCs) from being set up on the designated access line. Existing virtual call and permanent virtual circuits are unaffected. When the network detects that all SVCs have been terminated, the network will take the line out of service by initiating the restart procedure at the interface and then initiating the link level disconnect procedure. The network will transmit a Restart Indication packet to the local DTE with a cause code of "network congestion". For each permanent virtual circuit, the restart procedure results in a Reset Indication packet being sent to the remote DTE with a cause code of "out of order". The line will remain out of service until the user calls and requests its return to service.

2.7 X.25 User Optional Facilities

2.7.1 Permanent Virtual Connections

The virtual circuit corresponding to the virtual call is a switched connection and the association only lasts for the duration of the call, whereas in a permanent virtual connection, the association is, by definition, a permanent one. To the subscribers who are connected, it resembles a point-to-point leased line and it is therefore unnecessary to go through the call establishment procedure. The permanent virtual connections are set up in the Network Control Center by the operator.

The procedures for the control of packets between the DTE and the PSPDN conform with the virtual call service in the data transfer state. In error conditions the PSPDN indicates a reset with "local procedure error"; the distant DTE is also informed of the reset by a Reset Indication packet with "remote procedure error". If the link level fails, the PVC is set in the "out-of-order" state. After recovery of the link level the PVC is set automatically in the operational state. The operator of the Network Control Center can establish or release a permanent virtual connection by an operator command.

2.7.2 Closed User Group Related Facilities

Closed User Groups (CUGs) provide a mechanism for creating private networks that restrict communication among group members and non-members in various ways. Ordinary CUGs permit members to communicate with each other but preclude communication with non-members. CUGs with outgoing access permit members to communicate with each other and to originate calls to subscribers who do not belong to any CUGs or to subscribers who belong to other CUGs with incoming access. Closed User Groups with incoming access permit members to communicate with one another and to receive calls from subscribers who do not belong to any CUG, or from subscribers who belong to other CUGs with outgoing access capability. The Closed User Group facility is designated as essential (E) in 1988 CCITT Recommendation X.2, “International Data Transmission Services and Optional User Facilities in Public Data Networks and ISDNs”. The Closed User Group with outgoing access facility and the Closed User Group with Incoming Access facility are designated as additional (A) in Recommendation X.2.

2.7.3 Fast Select

This facility is requested by the DTE on a per call basis in the Call Request packet. It allows the calling DTE to send up to 124 octets of user data in the Call Request packet and receive up to 124 octets of user data from the called DTE in a Call Connected packet or a Clear Indication packet, if issued in direct response to the Call Request packet.

The abilities to either originate or to receive Fast Select calls are subscription options. The option for originating Fast Select calls supports two options: restricted and unrestricted. A fast select call with the unrestricted option is turned into a normal virtual circuit when it is accepted by the destination DTE. A fast select call with the restricted option will not be permitted to achieve data transfer state.

2.7.4 Multiple Line Hunt Group

A multiple line hunt group is a grouping of access lines which can be called by DTEs using a single network address. The incoming calls are distributed across the available lines of the hunt group so that the number of VCs on each line are approximately equal. Hunt group sizes of up to sixteen access lines are supported. The hunt group performs an access line selection for an incoming call if there is at least one idle logical channel available for SVCs (excluding one-way outgoing logical channels). The hunt group is considered busy when VCs are established on all logical channels available for VCs on all lines in the group.

Once a virtual call is assigned to a particular access line, it is treated as a regular call (e.g., if the access line fails, the virtual call is disconnected). All packets associated with an individual virtual call are routed over the same access line. All access lines in a hunt group are treated as a single administrative unit when virtual call facilities are selected at service order time.

2.7.5 Reverse Charging

Reverse charging allows a user to request that the call be charged to the called party.

2.7.6 Reverse Charging Acceptance

Reverse charging acceptance allows the user to accept charges for all terminating calls to their access line.

2.7.7 Throughput, Packet, and Window Size Negotiations

DIGIPAC® provides for DTE negotiation of window size, packet size, and throughput class. The ability to negotiate is a subscriber option. The defaults for window size, normal and priority class packet size, and throughput class are provided at the time service is ordered. Any value offered by a DTE must be a legal value according to the X.25 negotiation rules.

Packet Size Negotiation

Packet sizes for PVC are not negotiated, they are specified in service data. If the two ends of a PVC disagree on their specified packet size, they will both be reset with cause Incompatible Destination. No data transfer will be permitted.

Calls initiated DTEs not subscribing to negotiation will be cleared with cause Invalid Facility if they attempt to negotiate by providing the packet size flow control parameter negotiation facility. In situations where a non-negotiating DTE is called with a packet size unequal to its subscribed packet size, the network will negotiate for the DTE if this is possible. X.25 puts constraints on the negotiating process which may make it impossible for the call to be set up. If the call cannot be set up for this reason, the DTE will not be made aware of the call arrival and the calling party will be cleared with cause Incompatible Destination. If the remote DCE/DTE negotiates a packet size different from the subscribed packet size of a non-negotiating DTE, the call will be cleared at both ends with Incompatible Destination.

While in the process of establishing a virtual call between two DTEs, the DIGIPAC® network may support different packet sizes at the two local interfaces. In the data transfer state of the call, the DIGIPAC® network may have to segment or recombine the received data packets from one end before sending them to the remote end. The segmentation and recombination are performed in such a way as to preserve the complete packet sequence as it was before the segmentation or recombination took place. This process is known as local packet size negotiation.

In the course of establishing the virtual circuit between the two DTEs, the packet size is locally negotiated at the interface which has subscribed to the local packet size option.

For backwards compatibility reasons, if neither end of the virtual call have subscribed to this option, the packet sizes are negotiated end-to-end and are not changed by this feature.

Local Window Size Negotiation

Local windows for PVCs are not negotiated; they are specified in service data.

Local window negotiation for SVC will be a local affair between the DCE and DTE. If a non-subscriber to negotiations attempts to negotiate by providing the window size flow control parameter facility, the call will be cleared with cause Invalid Facility. Local window sizes will not necessarily be the same at both ends of a call, or for both directions on a given end. The final negotiated window sizes will be equal to, or closer to two, than either the subscribed default or the window sizes in the initial call request. The initial window size in a call request may be larger or smaller than the range offered by the network. If so, the value will be negotiated to an offered value, if possible.

Throughput Class Negotiation

Throughput class negotiation will be only a concern of SVCs. A DTE, subscribing to negotiations, will be able to provide a throughput class higher than the subscribed default. PVCs will each have an individual throughput class which must be the same in both ends service data.

2.7.8 Network User Identification (NUI) (Not Offered)

The NUI is used to provide secure access to the network. Network User Identification, if subscribed to, will be a unique sequence of numbers that identifies the user for billing and access purposes. The network user address is forwarded to the called party on the calling DT. The network user address is used for billing. The NUI is assigned at subscription time by U S WEST. Currently there is no way to validate NUIs of users that subscribe to services in another network and U S WEST has decided not to issue network specific NUIs to its customers.

2.7.9 Recognized Private Operating Agency (RPOA)

Recognized Private Operating Agency (RPOA) selection is per virtual call facility. This facility is the signaling mechanism that allows X.25 subscribers to select, at call setup, the transit network through which an inter network call is routed. Only the basic format of the RPOA facility, CCITT 1988, is supported on DIGIPAC®.

Inter-exchange Carrier (IC) Preselection. A user may select a preferred IC at subscription time. If the user does not select an IC during call setup using the RPOA selection facility, this preferred or preselected IC will be used.

Table 2-1 DCE Time-Outs
(Page 1 of 2)

Time-out number	Time-out value	State of the logical channel	Start when	Normally terminated when	Actions to be taken when the time-out expires (See Note 1)	
					Local side	Remote side
T10	60s	r3	DCE issues a restart indication	DCE leaves the r3 state (i.e., the restart confirmation or restart request is received)	DCE remains in state r3 and signals a restart indication (local procedure error #52) again, and restarts time-out T10 (see Note 2)	For permanent virtual circuits, DCE may enter the d3 state signaling a reset indication (remote procedure error #52)
T11	180s	p3	DCE issues an incoming call	DCE leaves the p3 state (e.g. the call accepted, clear request or call request is received)	DCE enters the p7 state signaling a clear indication (local procedure error #49)	DCE enters the p7 state signaling a clear indication (remote procedure error #49)
T12	60s	d3	DCE issues a reset indication	DCE leaves the d3 state (i.e., the reset confirmation or reset request is received)	DCE re transmits the restart indication (local procedure error #51) and remains in state d3 and restarts time-out T12 (see Note 3)	DCE may enter the d3 state signaling a reset indication (remote procedure error #51)
T13	60s	p7	DCE issues a clear indication	DCE leaves the p7 state (e.g., the clear confirmation or clear request is received)	DCE remains in p7, signals a clear indication (local procedure error #50) again, and restarts the time-out T13 (see Note 4)	

Table 2-1 DCE Time-Outs
(Page 2 of 2)

Notes (continued) :

1. The following Notes 2, 3, and 4 describe alternative DCE actions on time-out.
2. Upon a second T10 time-out, the DCE enters the r1 state and may issue (service data option) a diagnostic packet #52.
3. Upon a second T12 time-out for virtual calls, a Clear Indication packet is transmitted (local procedure error, diagnostic #51).

   or

   Upon a second T12 time-out for PVCs, the DCE enters the state d1 and may issue (service data option) a diagnostic packet #51.
4. Upon a second T13 time-out, the DCE enters the p1 state and may issue (service data option) a diagnostic packet #50.

Table 2-2 DTE Time-Outs

Time-out number	Time-out value	State of the logical channel	Started when	Normally terminated when	Preferred action to be taken when time limit expires
T20	180s	r2	DTE issues a restart	DCE leaves the r2 state (i.e., the restart request confirmation or indication is received)	To re transmits the restart (Note 1)
T21	200s	p2	DTE issues a call request	DTE leaves the p2 state (e.g. the call connected, clear indication, or incoming call is received)	To transmit a clear request
T22	180s	d2	DTE issues a reset request	DTE leaves the d2 state (e.g., the reset confirmation or reset indication is received)	For virtual calls, to re transmit the reset request or to transmit a clear request For permanent virtual circuits to transmit the reset request (Note 2)
T23	180s	p6	DTE issues a clear indication	DTE leaves the p6 state (e.g., the clear confirmation or clear indication is received)	To re transmit the clear request (Note 2)

Notes:

1. After unsuccessful retries, recovery decisions should be taken at higher levels.
2. After unsuccessful retries, the logical channel should be considered out-of-order. The restart procedure should only be invoked for recovery if re initialization of all logical channels is acceptable.

Table 2-3 Summary of X.25 PDN Standard (Default) Interface Attributes

PHYSICAL LEVEL

Transmission Rates	2.4 to 56 kbit/s		
Interface	EIA-232 Recommendation for 2.4 to 9.6 kbit/s CCITT Recommendation V.35 for 56 kbit/s		

LINK LEVEL

Procedure	LAPB/SLP		
Parameter K	K =7 (Module 8) K=127 (module 128)		
Parameter N1	2120 bit (256 octets)		
Parameter N2	10		
Timer T1	3 Seconds		
Parameter T2	0.4 seconds		
Time T3	15 Seconds		
Frame Address Field Convention			
Command	03	from DCE to DTE	
Response	01	from DCE to DTE	

PACKET LEVEL

Packet Types	All basic packets		
Number of logical channels per link (2 way)	Default = 2		
Packet Size	128 octets		
Packet Window Size	W = 2		
Packet Sequence Numbering	Module 8		
Address Format	Inter network:	4 digit DNIC + 10 digit NTN	
	Intra-network:	10 digit NTN	
	ISDN Addresses:	1+0+CC+N(S)N	
	CC	= Country Code (1 for North America)	
	N(S)N	= National Significant Number	
Addresses per Line	1000 maximum		
Lines per Address (Hunt Group)		16 maximum	
Access Line Take Down	Unconditional and Conditional		
Timer T10	60 Seconds		
Timer T11	180 Seconds		
Timer T12	60 Seconds		
Timer T 13	60 Seconds		

2.8 X.25 Gateway Service

The X.25 gateway service is an alternative service for connecting packet networks that are unable or unwilling to use the X.75 service. The X.25 gateway feature enhances the X.25 service to facilitate interworking of packet networks by means of the X.25 protocol.

2.8.1 Applications

The X.25 gateway service is fully supported on all DIGIPAC® modules and may be used for interconnection of:

- A private network to a public network.
- A private network to a private network via a public network.
- A public network to another public network; where circumstances do not permit the use of X.75

2.8.2 Address Numbering Plans

The X.25 gateway supports two numbering plans, E.164 and X.121 for interworking. The gateway address itself, can only be X.121. The addresses supported comply with both the CCITT Recommendation X.121 and the CCITT Recommendation E.164. The Private Network Identification Code (PNIC) and the subaddressing address schemes are supported. CCITT Recommendation X.121 defines the PNIC scheme as follows:

- A group of private data networks in a country is identified by a specific Data Network Identifier Code (DNIC).
- Each private network is assigned a PNIC (up to 6 digits). It occupies the first digits of the Network Terminal Number (NTN).
- Multiple PNICs can be allocated to a single private network, if more numbers for the Data Communications Equipment (DCE)/Data Terminal Equipment (DTE) interfaces on the private network are needed.
- Assignment of the PNICs are administered nationally.

The subaddressing scheme is similar to the PNIC scheme, except that the DNIC is the same for the public and private networks. The public network allocates a block (continuous range) of its own addresses to each attached private network.

2.8.3 X.25 Gateway Features

The X.25 gateway service is based on the LAPB/X.25 service. Consequently, in general the X.25 gateway service provides the same features as the LAPB/ X.25 service. In addition, there are a number of additional features specific to the X.25 gateway service to facilitate interworking capabilities. A few LAPB/ X.25 service features not appropriate to X.25 gateways are not supported by the X.25 gateway service.

This section gives a general description of the X.25 gateway specific features and lists areas where the X.25 gateway service differs from the X.25 service.

2.8.3.1 Address Translation

Address translation allows X.25 to be used for connecting networks which use different addressing schemes. The address translation capability may translate either the called, calling or both addresses given in call setup packets. Depending on which addresses are to be translated, one or two address translation tables are configured per X.25 gateway. The address translations defined in the table(s) are independent of numbering plans, translating digit string to digit string. This permits the translation of:

- routing prefixes (including prefix digits, DCC/DNIC, etc.);
- full addresses;
- addresses including subaddress digits.

2.8.3.2 Address Validation

Address validation uses the address translation tables described in the “Address Translation” section to provide a form of access control to and from the network containing the X.25 gateway. Address validation can be enabled for calling and/or called addresses for call requests sent to and/or received from the link by the X.25 gateway service. If address validation fails, the action taken by the X.25 gateway can be either to clear the call attempt or allow it to continue.

2.8.3.3 Facility Manipulation

Special handling of the following facilities is provided to facilitate internetworking with the X.25 gateway service:

- Network User Identification (NUI)
- Address Extension Facilities (calling and called AEF)
- Recognized Private Operating Agencies (RPOA)

The following facilities may be suppressed by both the X.25 and X.25 gateway services:

- Transit Delay Selection And Indication (TDSAI)
- Call Redirection Notification (CRN)
- Called Line Address Modified Notification (CLAMN)
- DTE facilities

The following features which are available to the X.25 service are not supported by the X.25 gateway service:

- Direct call (X.25 gateways can not initiate direct calls)
- Hunt group (X.25 gateways can not be members of an hunt group)

2.8.3.4 Cause Signaling

Both the X.25 and X.25 gateway services can optionally signal “DTE originated causes” in clear, reset and restart packets sent to the link (that is, with bit 8 of the cause set to 1). Similarly, clear and reset causes received from the link can optionally be converted to “DTE originated causes” at both gateway and non-gateway X.25 ports.

The X.25 gateway service also permits the translation of restart causes received from the link into clear/reset causes according to ISO 8208 - table A.2.

2.8.4 Advantages Of The X.25 Gateway

Some advantages of the X.25 gateway service are as follows:

- It provides a cost-effective means to interconnect packet networks by using the X.25 protocol as an alternative to the X.75 protocol.
- It provides public network access to private network users.
- It provides private network access to public network users.
- It permits the interconnection of networks with different numbering plans through the use of the address translation feature.
- It enhances DIGIPAC® security capabilities by providing address validation.
- It facilitates interworking by providing flexible facility handling options.
- It permits the removal of “black boxes” currently used at many X.25 gateways.

2.9 Compliance Matrixes for X.25

This section describes the compliance of the DIGIPAC® Implementation of X.25 LAPB with the CCITT Recommendation. This compliance is based on the 1988 version of the CCITT recommendations. In this section, individual paragraphs of the recommendation and any specific deviations to those paragraphs are noted in point form.

The CCITT Recommendation for X.25 is divided into seven sections which cover the following subjects:

1. DTE/DCE interface characteristics
2. Link access procedures across the DTE/DCE interface
3. Description of the packet layer DTE/DCE interface
4. Procedures for virtual circuit service
5. Packet formats
6. Procedures for optional user facilities (packet layer)
7. Formats for facility fields and registration fields

The compliance characteristics of the different paragraphs in each section are described as follows:

- Implemented as specified
- Implemented as specified with the following interpretation
- Implemented as specified as the section heading, with a subheading "Implementation Note(s)" when some additional relevant information is included, for example , the range of timer values,
- Not implemented.
- Not offered. This means that the equipment used by U S WEST may be capable of providing what is specified but is not part of the service offering from U S WEST.

2.9.1 Physical Interface Compliance

This section describes the DIGIPAC® compliance to the CCITT X.25 Recommendation for physical interface characteristics between the DTE and DCE. The inter face standards described are:

1.1 X.21 Not offered

1.2 X.21bis

1.3 V-Series

1.4 X.31 Not offered

Table 2-4 DTE/DCE Interface Characteristics (Physical Layer)
(Page 1 of 2)

CCITT Part	**Description**	**Implementation**
1,1	X.21 interface	Not offered
1.1.1	DTE/DCE PHYSICAL INTERFACE	Not offered
1.1.2	Procedures for entering operational phases	Not offered
1.1.3	Failure detection and test loops	Not offered
1.1.4	Signal element timing	Not offered
1.2	X.21 bis interface	Noted
1.2.1	DTE/DCE physical interface elements	Implemented as specified Implementation notes: In accordance with section 1.2 of Recommendation X.21 bis
1.2.2	Operational phases	Implemented as specified Implementation Notes: The implementation is per V.24 and V.35 specification.
1.2.3	Operational phases	Implemented as specified with the following interpretation: Implementation notes: In accordance with sections 3.1 through 3.3 of Recommendation x.21 bis.
1.2.4	Signal element timing	Implemented as specified Implementation notes: In accordance with section 3.4 of Recommendation X.21. bis
1.3	V-Series Interfaces	Implemented as specified with the following interpretation: Implementation notes: General operation with V-Series modems is as specified in 1.2 above. However, for specific details, particularly related to the use of circuits 107, 109, 113, and 114 refer to 241-1001-182, External Interface Specification. The DIGIPAC® service is supported on the V.24 interface at speeds up to 9.6 kbit/s, and on the V.35 interface at speeds up to 56 kbit/s.

Table 2-4 DTE/DCE Interface Characteristics (Physical Layer)
(Page 2 of 2)

CCITT Part	Description	Implementation
1.4	X.31	Not offered
1.4.1	DTE//DCE physical interface	Not offered
1.4.2	Operational phases	Not offered
1.4.3	Maintenance	Not offered
1.4.4	Synchronization	Not offered

2.9.2 Link Layer Compliance

This section describes the DIGIPAC® compliance to the X.25 link layer procedures across the DTE/DCE interface.

2.1 Scope and field of application

2.2 Frame structure

2.3 LAPB elements of procedures

2.4 Description of the LAPB procedure

2.5 Multilink Procedure (MLP)

2.6 LAP elements of procedure

2.7 Description of the LAP procedure

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
(Page 1 of 14)

CCITT Part	Description	Implementation
2.1	Scope and field of application	Implemented as specified Implementation notes: The DIGIPAC® level 2 protocol implements link access procedure LAPB only.
2.1.1	Link access procedures	Implemented as specified Implementation notes: Link Access Procedures (LAPB) are described as the Data Link layer Element and are used for data interchange between a DCE and DTE over a single physical circuits, operating in user classes of service 8 to 11 as indicated in Recommendation X.1. The Single Link Procedures (SLP) described in sections 2.2, 2.3, and 2.4 (LAPB) are used for data interchange over a single physical circuit, conforming to the description given in section 1, between a DTE and a DCE. When the optional multilink operation is employed, a single link procedure is used independently on each physical circuit, and the Multilink Procedure (MLP) described in section 2.5 used for data interchange over these multiple parallel LAPB data links,. In addition, when only a single physical circuit is employed with LAPB, agreements may be made with the Administration to use this optional multilink procedure over the one LAPB data ink.
2.1.2	Single link procedures	Implemented as specified Implementation notes: The high-level link control procedures used in the DIGIPAC® are specified in ISO 3309-1986 (E), ISO IS4335-DAD1
2.1.3	Duplex transmission facility	Implemented as specified

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
(Page 2 of 14)

CCITT Part	**Description**	**Implementation**
2.1.4	DCE compatibility of operation with the ISO balanced classes of procedure	Implemented as specified Implementation notes: The DIGIPAC® level 2 link access procedure is compatible with ISO balanced class of procedure Class BA with options 2 and 8 (also known as LAPB module 8) and Class BA with options 2, 8, and 10 (also known as LAPB module 128). The DIGIPAC® level 2 protocol may act as wither Data Circuit terminating Equipment (DCE) or Data Terminating Equipment (DTE) at the link layer.
2.1.5	Basic and extended LAPB sequence numbering	Implemented as specified
2.1.6	Internal mode variable B	Implemented as specified
2.2	Frame formats	Implemented as specified
2.2.2	Flag sequence	Implemented as specified
2.2.3	Address field	Implemented as specified
2.2.4	Control field	Implemented as specified
2.2.5	Information field	Implemented as specified
2.2.6	Transparency	Implemented as specified
2.2.7	Frame Check Sequence (FCS) field	Implemented as specified
2.2.8	Order of bit transmission	Implemented as specified
2.2.9	Invalid frames	Implemented as specified
2.2.10	Frame abortion	Implemented as specified
2.2.11	Interframe till fill	Implemented as specified
2.2.12	Link channel states	Implemented as specified
2.2.12.1	Active channel state	Implemented as specified
2.2.12.2	Idle channel state	Implemented as specified
2.3	LAPB elements of procedures	Noted
2.3.1	Definitions	Noted
2.3.2	LAPB control field formats and parameters	Noted
2.3.2.1.	Control field formats	Implemented as specified
2.3.2.1.1	Information transfer format	Implemented as specified
2.3.2.1.2	Supervisory format–S	Implemented as specified
2.3.2.1.3	Unnumbered format – U	Implemented as specified

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
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CCITT Part	Description	Implementation
2.3.2.2	Control field parameters	Implemented as specified
2.3.2.2.1	Modules	Implemented as specified
2.3.2.2.2	Send state variable V(S)	Implemented as specified
2.3.2.2.3	send sequence number N(S)	Implemented as specified
2.3.2.2.4	Receive state variable V(R)	Implemented as specified
2.3.2.2.5	Receive sequence number N(R)	Implemented as specified
2.3.2.2.6	Poll/final bit P/F	Implemented as specified
2.3.3	Functions of the Poll/Final bit	Implemented as specified
2.3.4	Commands and responses	Implemented as specified
2.3.4.1	Information (I) command	Implemented as specified
2.3.4.2	Receive Ready (RR) command and response	Implemented as specified Implementation notes: The level 2 protocol will automatically issue a responding receive ready command if: –Layer 2 protocol is in an information transfer phase (see 2.4.4.2) or –Layer 2 protocol issued a Receive Not Ready (RNR) signal to indicate a busy condition and there is sufficient local memory available to start receiving I frames In addition to indicating the DCE or DTE status, the RR command with the P-bit set to 1 may be used by the DCE or DTE to ask for the status of the DTE OR DCE respectively. DIGIPAC® also implements an optional frame level " idle probe timer" which will trigger the sending of and RR/RNR to the link if there is no link activity for the time interval. NAME: idle probe timer RANGE: 1-655 seconds and OFF INTERVAL: 1 seconds DEFAULT: OFF

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
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CCITT Part	**Description**	**Implementation**
2.3.4.3	Received Not Ready (RNR) command and response	Implemented as specified Implementation notes: The DIGIPAC® level 2 will issue an RNR command to the remote if insufficient local memory is available to buffer an incoming l-frame. If the busy condition is forced clear by the far end (SABM/UA, FRMR//SABM/ UA), the DIGIPAC® level 2 responds with an RNR to the next received I-frame. I frames numbered up to and including N(R) - 1 are acknowledged. I frame N(R) and any subsequent frames received, if any, are not acknowledged. The acceptance status of these I frames will be indicated in subsequent exchanges. In addition to indicating the DCE or DTE status,, the RNR command with the P-bit set to 1 may be used by the DCE or DTE to ask for the status of the DTE or DCE respectively. See 2,3,4,2 regarding the DIGIPAC® "idle probe timer"
2,3.4.4	Reject (REJ) command and response	Implemented as specified
2.3.4.5	Set Asynchronous Balanced Modes (SABM) command/ Set Asynchronous Balanced Extended (SABME) command (subscription time option)	Implemented as specified

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
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CCITT Part	Description	Implementation
2.3.4.6	Disconnect (DISC) command	Implemented as specified Implementation notes: If an Unnumbered Acknowledgment (UA) command is not received by the end of time-out T1, another DISC command is sent. The DISC unnumbered command is used to terminate the mode previously set. It is used to inform the DCE or DTE receiving the DISC command that the DTE or DCE sending the DISC command is suspending operation. Prior to acting on the DISC command, the DCE receiving the DISC command confirms the acceptance of the DISC command by the transmission of a UA response. The DTE or DCE sending the DISC command enters the disconnected phase when it receives the acknowledged UA response. Previously transmitted I frames that are unacknowledged when this command is invoked remain unacknowledged. It is the responsibility of a higher layer to recover from the possible loss of the contents of such I frames..
2.3.4.7	Unnumbered Acknowledge (UA) response	Implemented as specified
2.3.4.8	Disconnected Mode (DM)	Implemented as specified

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
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CCITT Part	Description	Implementation
2.3.4.9	Frame Reject (FRMR) response	Implemented as specified Implementation notes: The DIGIPAC® generates an FRMR command on receipt of frame that has an information field that is not permitted or on receipt of an S- or U-frame of incorrect length. The FRMR unnumbered response is used by the DCE or DTE to report an error condition not recoverable by retransmission of the identical frame, that is, at least one of the following conditions which results from the receipt of a valid frame: 1) the receipt of a command or response control field that is undetermined or not implemented 2) the receipt of an frame with an information field which extends the maximum established length 3) the receipt of an invalid N(R) field 4) the receipt of a frame with an information field which is not permitted or the receipt of a supervisory or unnumbered frame with incorrect length. A valid N(R) much be within the range from the lowest send sequence number N(S) of the still unacknowledged frames to the current DCE send state variable inclusive (or to the current internal variable x if the DCE is in the timer recovery condition as described in section 2.4.5.9. An information field which immediately follows the control field and consists of 3 or 5 octets (module 8 (basic) operation or module 128 (extended) operation respectively), is returned with this response and provided the reason for the FRMR response. DIGIPAC® does not generate a FRMR command on receipt of N(S) equal to both V(R) and N(R)+k since CCITT 2.4.6.1 places the onus on the DTE to enforce its own security by not extending its window beyond 7.

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
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CCITT Part	Description	Implementation
2.3.5	Exception condition reporting	Implemented as specified
2.3.5.1	Busy condition	Implemented as specified
2.3.5.2	N(S) sequence error condition`	Implemented as specified
2.3.5.2.1	REJ recovery	Implemented as specified
2.3.5.2.2	Time-out recovery	Implemented as specified Implementation notes: The first unacknowledged I-frame is retransmitted after an I-frame acknowledgment timeout. The retransmitted frames may continue an N(R) and a p bit that is updated from, and therefore different from, the ones contained in the originally transmitted frames.
2.3.5.3	Invalid frame condition	Implemented as specified
2.3.5.4	Frame rejection condition	Implemented as specified
2.3.5.5	Excessive idle channel state condition on incoming channel	Implemented as specified
2.4	Description of the LAPB procedure	Noted
2.4.1	LAPB basic and extended modes of operation	Implemented as specified
2.4.2	LAPB procedure for addressing	Implemented as specified
2.4.3	LAPB procedure for the use of the P/F Bit	Implemented as specified
2.4.4	LAPB procedure for data link setup and disconnection	Implemented as specified
2.4.4.1	Data link set-up	Implemented as specified Implementation notes: If the DIGIPAC® level 2 protocol sends a SABM command but does not receive a SABM or a UA reply within N2 T1 rime intervals, it informs the level 3 protocol and enters the disconnected state.

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
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CCITT Part	Description	Implementation
2.4.4.3	Data link disconnection	Implemented as specified Implementation notes: The DIGIPAC® level 2 protocol after sending a DISC command N2 times, informs level 3, and enters the disconnect state.
2.4.4.4	Disconnected phase	Implemented as specified Implementation notes: DIGIPAC® is always able to set up the link if the port hardware is enabled When the level 2 protocol enters the disconnected phase, it transmits a DM response and starts timer T1. If a SABM command is not received within the time setting of T1, the process is repeated. After transmission of the DM response N2 times, the Level 2 protocol enters the link set-up phase and starts the link set-up process. While in disconnected phase, the level 2 protocol responds as follows: -if it receives a DISC command it issues a DM signal -If it receives a SABM command it issues a UA response and enters information transfer phase -If it receives any other command with the P bit set to 1, it responds with a DM response (with F bit set to 1)
2.4.4.5 includes 2.4.4.5.1 and 2.4.4.5.2	Collision of unnumbered commands	Implemented as specified
2.4.4.6.	Collision of DM response with SABM/SABME or DISC commands	Implemented as specified

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
(Page 9 of 14)

CCITT Part	**Description**	**Implementation**
2.2.4.7	Collision of DM responses	Implemented as specified
2.4.5	LAPB procedures for information transfer	Noted
2.4.5.1	Sending I frames	Implemented as specified
2.4.5.2	Receiving an I-frame	Noted
2.4.5.2.1	DCE not busy (i)	Implemented as specified
	(ii)	Implementation notes: If no I frame is available for transmission by the DCE and its response delay timer (T2) is not running , the level 2 protocol starts the timer. If a timeout occurs before a frame becomes available for transmission, the level 2 protocol starts the timer. If a timeout occurs before a frame becomes available for transmission, the level 2 protocol transmits an RR/RNR command with the N(R) equal to the value of its received state variable V(R) If a frame becomes available for transmission or an S-frame is sent before the response delay timer times out, the response delay timer is stopped and no further action is required. (That is the I-frame or S-frame has acknowledged the incoming frame.)
2.4.5.2.2	Receiving an I frame when DCE is busy	Implemented as specified Implementation notes: The level 2 protocol will ignore the information field in as I-frame if there is insufficient local memory to buffer the data. Level 2 informs the packet level procedures of a zero--length information field.
2,4,5,3	Reception of invalid frames	Implemented as specified
2.4.5.4	Reception of out-of-sequence I frames	Implemented as specified
2.4.5.5	Receiving acknowledgment	Implemented as specified
2.4.5.6	Receiving an REJ frame (i)	Implemented as specified
	(ii)	Implemented as specified

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
(Page 10 of 14)

CCITT Part	**Description**	**Implementation**
	(iii)	Implemented as specified with the following interpretation The level 2 protocol completes the transmission of a currently transmitting I-frame before commencing transmission of the requested I-frame.
	(iv)	Implemented as specified
2.4.5.8	DCE busy condition	Implemented as specified
2.4.5.9	Waiting acknowledgment	Implemented as specified Implementation notes: If , while in timer recovery condition, the level 2 protocol correctly receives a frame that acknowledges all unacknowledged sent frames but does not clear the timer recovery condition, the level 2 protocol remains in timer recovery condition and continues to poll with a command level RR/RNR.
2.4.6	LAPB conditions for data link resetting or data link re-initialization (data Link set-up)	Noted
2.4.6.1	Invalid frame reception	Implemented as specified
2.4.6.2	FRMR response from DTE	Implemented as specified Implementation notes; When the DCE receives, during the information transfer phase, an FRMR response from the DTE, the DCE will either initiate the data link resetting procedures itself as described in section 2.4.7.2, or return a DM response to ask the DTE to initiate the data link setup (initialization) procedure as described in 2.4.4.1. After transmitting a DM response, the DCE will enter the disconnected phase as described on section 2.4.4.4.2

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
(Page 11 of 14)

CCITT Part	Description	Implementation
2.4.6.3	UA response from DTE	Implemented as specified Implementation notes; When the DCE receives, during the information transfer phase, a UA response, or an unsolicited response with the F-bit set to 1, the DCE may either initiated the data link set-up (initialization) procedure as described in section 2.4.4.1. After transmitting a DM response, the DCE will enter the disconnected phase as described in section 2.4.4.4.2.
2.4.7	LAPB procedure for data link resetting	Implemented as specified
2.4.7.1		Implemented as specified The data link resetting procedure is used to initialize both directions of information transfer according to the procedure described below. The data link resetting procedure only applies during information transfer phase.
2.4.7.2	Reset procedure	Implemented as specified
2.4.7.3	Clearing the frame rejection	Implemented as specified
2.4.8.	List of LAPB system parameters	Noted
2.4.8.1	Timer T1	Implemented as specified Implementation notes; Timer T1 is used to retransmit frames if no frame acknowledgment is received within the timed interval. DIGIPAC® implementation: NAME : Response timeout RANGE: 0.01-655 seconds INTERVAL: 0.01 seconds DEFAULT: 3 seconds

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
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CCITT Part	Description	Implementation
2.4.8.	Parameter T2	Implemented as specified Implantation notes: Timer T2 is used to delay the acknowledgments of incoming I-frames to enforce frame level piggybacking of acknowledgment frames to I-frames. DIGIPAC® implementation: NAME : Response delay timer RANGE: 100-1000 milliseconds and off INTERVAL: 100 milliseconds and OFF; DEFAULT: 400 milliseconds
2.4.8.3	Parameter T3	Implemented as specified Implementation notes: Timer T3 is used to indicated to the packet layer that there has been an excessively long idle time. DIGIPAC® implementation: NAME : Idle channel timer RANGE 1-655 seconds and OFF INTERVAL: 1 seconds DEFAULT: 15
2.4.8.4	Maximum number of attempts to complete a transmission (N2)	Implemented as specified Implementation notes: This field specifies the number of times a frame is retansmitted before other recovery action is taken. DIGIPAC® implementation Name: Retransmit limit RANGE; 1-15 DEFAULT; 10

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
(Page 13 of 14)

CCITT Part	Description	Implementation
2.4.8.5	Maximum number of bits in an I-frame (N1)	Implemented as specified Implementation notes: This field specifies the maximum number of bits (excluding flags and bits inserted for transparency) that can be contained in each I-frame. The highest value that can be used is 16440. DIGIPAC® implementation NAME: Maximum bits in frame (N1) RANGE: up to 16440 (for 2048 octet packet)
2.4.8.6	Maximum number of outstanding I-frames (k)	Implemented as specified Implementation notes: This field specifies the maximum number of sequentially numbered I-frames that can be outstanding (unacknowledged) at any given time. This is nominally set to 7 if module 8 service is specified, or 127 if module 128 service is specified. DIGIPAC® implementation: NAME : Response timeout RANGES: 1-7,1-127 (if LAPB with "extended sequence numbering" is provisioned) DEFAULT: 7
2.5	Multilink Procedure (MLP) (Subscription-time selectable option)	Not offered
2.5.1	Field of application	Not offered
2.5.2	Multilink frame structure	Not offered
2.5.2.1	Multilink control field	Not offered
2.5.2.2	Multilink information field	Not offered
2.5.3	Multilink control field format and parameters	Noted
2.5.3.1	Multilink control field format	Not offered
2.5.3.2	Multilink control field parameters	Not offered
2.5.3.2.1	Void sequencing bit (V)	Not offered
2.5.3.2.2	Sequencing check option bit	Not offered
2.5.3.2.3	MLP reset request bit (R)	Not offered

Table 2-5 Link Access Procedures Across The DTE/DCE Interface
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CCITT Part	Description	Implementation
2.5.3.2.4	MLP RESET CONFIRMATION BIT (C)	Not offered
2.5.3.2.5	Multilink send state variable MV(S)	Not offered
2.5.3.2.6	Multilink sequence number MN(S)	Not offered
2.5.3.2.7	Transmitted multilink frame acknowledged state variable MV(T)	Not offered
2.5.3.2.8	Multilink receive state variable MV(R)	Not offered
2.5.3.2.9	Multilink window size MW	Not offered
2.5.3.2.10	Receive MLP window guard region MX	Not offered
2.5.4	Description of Multilink Procedure (MLP)	Not offered
2.5.4.1	Initialization	Not offered
2.5.4.2	Multilink resetting procedure	Not offered
2.5.4.3	Transmitting multilink frames	Noted
2.5.4.3.1	General	Not offered
2.5.4.3.2	Transmission of multilink frames	Not offered
2.5.4.4	Receiving multilink frames	Not offered
2.5.4.5	Taking an SLP out of service	Not offered
2.5.5	List of multilink system parameters	Noted
2.5.5.1	Lost-frame timer MTI (multilink)	Not offered
2.5.5.2	Group busy timer MT2 (multilink)	Not offered
2.5.5.3	MLP reset confirmation timer MT3 (multilink)	Not offered
2.6 through 2.7	LAP elements of procedure Description of the LAP procedure	LAP data link procedure is not implemented

2.9.3 Packet Layer Procedures

This section describes the DIGIPAC® compliance to packet layer procedures, and covers the following topics:

3.1 Logical channels

3.2 Basic structure of packets

3.3 Procedure for restart

3.4 Error handling

Table 2-6 Description of the Packet Layer DTE/DCE Interface
(Page 1 of 4)

CCITT Part	**Description**	**Implementation**
3	Description of the packet level DTE/DCE interface	Implemented as specified Implementation notes: This and subsequent sections of the Recommendation relate to the transfer of packets at the DTE/DCE interface. The procedures apply to packets that are successfully transferred across the DTE/DCE interface. Each packet to be transferred across the DTE/DCE interface is contained within the data link layer information field which will delimit its length, and only one packet is contained in the information field. Octet alignment - DIGIPAC® supports both non-octet alignment and octet alignment of user data. DIGIPAC® can pad DTE user data with zeros to ensure octet alignment if this option is subscribed by the DTE. DIGIPAC® can also ensure delivery of only octet aligned user data to the DTE if this option is also subscribed by the DTE. If this last option is subscribed, then Incoming Calls and Call Connects sent to the DTE from the network are checked for octet alignment of any attached user data and cleared "Incompatible Destination" (diag hex/dec 52/82); data packets to be sent to the DTE by the network with non-octet aligned user data trigger a Reset with cause "Incompatible Destination" (diag hex/dec 52/82).
3.1	Logical channels	Implemented as specified Implementation notes: Due to memory constraints, 4095 logical channels are not supported on any single DTE/DCE interface. The number of logical channels is restricted by engineering considerations for the Processing Element on which the X.25 Service is being supported.
3.2	Basic structure of packets	Implemented as specified

Table 2-6 Description of the Packet Layer DTE/DCE Interface
(Page 2 of 4)

CCITT Part	**Description**	**Implementation**
3.3	Procedure for restart	Implemented as specified Implementation notes: Permanent virtual circuit When the DTE issues a RESTART REQUEST over a PVC, the network transmits a RESET INDICATION (Cause: DTE reset) to the remote end; the local end of the PVC is reset later (Cause: remote DTE operational). During a restart procedure, incoming data for the PVC circuit is queued within the network. When e restart procedure has been completed, the DCE transmits data to the DTE. If the DTE transmits data before the remote end of the permanent virtual circuit has confirmed the reset, the network queues the data received. The data is transmitted to the remote DTE once it has confirmed the reset. If the DTE transmits any packets over a PVC during the restart request state, a procedure error results, and the network transmits a RESET INDICATION (Cause: local procedure error) on the PVC when the restart condition has been terminated. Switched Virtual circuit When the DTE issues a RESTART REQUEST over a virtual circuit, a CLEAR INDICATION is transmitted (Cause: DTE clear), to the remote end of the call. On termination of the restart condition, all logical channel numbers of virtual calls are in the ready state. During a restart, all incoming calls are queued within the network and transmitted to the DTE when it leaves the restart state. If the DTE transmits packets over a logical channel subscribed for virtual calls while in the restart request state, a CLEAR INDICATION (Cause: local procedure error) is sent to the DTE on the same logical channel when the restart condition is terminated.

Table 2-6 Description of the Packet Layer DTE/DCE Interface
(Page 3 of 4)

CCITT Part	Description	Implementation
3.3.1	Restart by the DTE	Implemented as specified Implementation notes: Timer T20 is specified in the X.25 Recommendation. This is the period of time within which the DCE is expected to complete a restart after a DTE-initiated restart request. The restart confirmation will be sent as soon as all logical channels are idle. All logical channels for switched virtual call are therefore then in the READY (P1) state. If a PVC has been successfully reset, the PVC is in the FLOW CONTROL READY (D1) state; a RESET INDICATION (Cause: remote DTE operational) is sent to the DTE. If the reset has not been completed, the network queues data packets and interrupts until the reset has been completed. If the PVC is not operational, DIGIPAC® transmits a RESET INDICATION (Cause: network congestion or out of order). Any calls in the network destined for a DTE during RESTART REQUEST state at the DCE are queued by the network. After the RESTART CONFIRMATION has been sent to the DTE by the DCE, the Incoming Calls queued are transmitted to the DTE.
3.3.2	Restart by the DCE	Implemented as specified Implementation notes: A RESTART INDICATION is issued whenever Level 2 is reinitialized (Cause: network congestion). The DCE waits for a period, repeats the RESTART INDICATION (T10) time-out, and issues a diagnostic packet. When the frame level is initialized, the DIGIPAC® sends a RESTART INDICATION. All switched virtual call logical channels should be free and all PVCs should be in the process of being established. For PVCs, when the local DTE sends a RESTART CONFIRM, a RESET (Cause: remote DTE operational) is sent to the local DTE.

Table 2-6 Description of the Packet Layer DTE/DCE Interface
(Page 4 of 4)

CCITT Part	Description	Implementation
3.3.3	Restart collision	Implemented as specified
3.4	Error Handling	Implemented as specified
3.4.1	Diagnostic packet	Implemented as specified with the following interpretation: Two additional subscriber options are provided. One option blocks the issuing of diagnostic packets. The other permits the network to receive diagnostic packets.

2.9.4 Virtual Circuit Services

This section covers the procedures for virtual circuits services, and deals with the following aspects of data transmission:

4.1 Procedures for virtual call service

4.2 Procedures for permanent virtual circuit service

4.3 Procedures for data and interrupt transfer

4.4 Procedures for flow control

4.5 Effects if clear, reset and restart procedures on the transfer of packets

4.6 Effects of the physical and the data link layer on the packet layer

Table 2-7 Procedures For Virtual Circuit Service
(Page 1 of 15)

CCITT Part	Description	Implementation
4	Procedures for virtual circuit services	Noted
4.1	Procedures for virtual call service	Implemented as specified
41.1	Ready state	Implemented as specified Implementation notes: DIGIPAC® interprets the logical channel group number and logical channel number as a single 12-bit LCN field
4.1.2	Call request packet	Implemented as specified Implementation notes: DIGIPAC® provides a Direct Call subscriber option on a per logical channel basis. A call request on a logical channel with a Direct Call envelope need not supply a called DTE address. DIGIPAC® also supports a mnemonic Address feature, where the mnemonic address is contained in a facility and the called DTE address field is left empty by the calling DTE
4.1.3	Incoming call packet	Implemented as specified Implementation notes: The INCOMING CALL packet normally uses the logical channel in the READY state with the lowest number. The INCOMING CALL packet always includes the calling DTE address.
4.1.4	Call accepted packet	Implemented as specified
4.1.5	Call connected packet	Implemented as specified

Table 2-7 Procedures For Virtual Circuit Service
(Page 2 of 15)

CCITT Part	Description	Implementation
4.1.6	Call collision	Implemented as specified Implementation notes: DIGIPAC® provides two options in addition to the operation specified in CCITT. All three options are listed below with the corresponding DIGIPAC® option names. Clear Incoming Call upon collision (per CCITT)-DIGIPAC® "Net" option. Clear Call Request upon collision -DIGIPAC® "EXT" option. Clear both calls - DIGIPAC® "BOTH" option.
4.1.7	Clearing by the DCE	Implemented as specified Implementation notes: DATA, RESET or INTERRUPT packets arriving from the network, after a CLEAR packet has been received from the network will be discarded. A DTE which has initiated a CLEAR REQUEST may still receive packets after it has sent the CONFIRMATION. Enforcement of timer T23 is a DTE responsibility. If a CLEAR REQUEST is received on a logical channel in a READY state, the DCE returns CLEAR CONFIRMATION on the same logical channel. Clearing is not end-to-end in the DIGIPAC® network. See section 5.2.4.1 "Clearing cause field" regarding non-zero clear causes.
4.1.8	Clearing by the DCE	Implemented as specified Implementation notes: The specified procedures apply to both X.25 (1980) and X.25 (84/88) service types.
4.1.9	Clear collision	Implemented as specified
4.1.10	Unsuccessful call	Implemented as specified

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	**Description**	**Implementation**
4.1.11	Call progress signals	Implemented as specified Implementation notes: There is a direct mapping between restart causes and reset/clear causes. A RESTART REQUEST is mapped into a RESET INDICATION for PVC, and a CLEAR INDICATION for SVC, Clear indications are not transmitted over PVCs. On SVC, CLEAR INDICATION is transmitted for the following reasons: ---DTE transmits a packet with an invalid format (procedure error) ---Packet received from DTE is not valid for DTE state (procedure error). ---Unable to complete call. ---Remote DTE not responding (Out of order) ---Network congestion. The DIGIPAC® network transmits a RESET Indication SVCs AND PVCs for the following reasons: ---Value of Q bit changed during a packet sequence (procedure error) ---Unauthorized INTERRUPT received (procedure error). --- Unauthorized INTERRUPT CONFIRMATION received (procedure error) ---Unauthorized RESET CONFIRMATION received (procedure error). ---DATA field too long in DATA packet (procedure error). ---Unauthorized DATA packet received (procedure error) The DIGIPAC® network also transmits a RESET INDICATION on PVC for the following reasons: ---Improper packet format (Undefined packet type or invalid format) ---PVC becomes available (network operational). ---PVC becomes unavailable (incompatible destination). ---RESTART INDICATION: The network operational cause is sent immediately after link connection occurs.

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	Description	Implementation
4.1.12	Data Transfer state	See notes for paragraph 4.3
4.2	Procedures for permanent virtual circuits	Implemented as specified Implementation notes: A RESET INDICATION (Cause: out-of-order) indicates that the PVC is not available. For PVCs there is no call setup or clearing The procedures for the control of packets between DTE and DCE while in the data transfer state are contained in section 4.3. If a momentary failure occurs within the network, the DCE will reset the permanent virtual circuit as described in section 4.4.3, with the cause "Network Congestion" and then will continue to handle data traffic. If the network has a temporary inability to handle data traffic, the DCE will reset the PVC with the cause "Network Operational"..
4.3	Procedures for data and interrupt transfer	Implemented as specified Implementation notes: The data transfer and interrupt procedures described in this section apply independently to each logical channel assigned for virtual calls or permanent virtual circuits existing at the DTE/DCE interface. Normal network operation dictates that user data in data and interrupt packets is passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications. The order of bits in data and interrupt packets is preserved. Packet sequences are delivered as complete packet sequences. DTE diagnostic codes are treated as described in section 5.2.5, 5.4.3, and 5.5.1.

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	Description	Implementation
4.3.1	States for data transfer	Implemented as specified Implementation notes: An unauthorized data or interrupt packet, (that is, one that is received during a reset procedure before the RESET CONFIRMATION is sent), causes the DCE to reset the call. An SVC logical channel is the data transfer state after completion of call establishment and prior to a clearing or a restart procedure. A PVC logical channel is continually in the data transfer state except during the restart procedure. Data interrupt, flow control , and reset packets may be transmitted and received by a DTE in the data transfer state of a logical channel at the DTE/DCE interface. In the state, the flow control and reset procedures described in section 4.4 apply to data transmission on that logical channel to and from the DTE. When an SVC is cleared, data and interrupt packets may be discarded by the network,. In addition, data, interrupt, flow control, and reset packets transmitted by a DTE will be ignored by the DCE when the logical channel is in the DCE clear indication state. Hence it is left to the DTE to define DTE to DTE protocols able to cope with the various possible situations that may occur.

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	**Description**	**Implementation**
4.3.2	User data field length of data packers	Implemented as specified Implementation notes: Does not required the user data area to be an integral number of octets. A subscriber option is available to pad all non-full I-frames sent to a DTE with zeros. The standard maximum user data field length is 128 octets. In addition, other maximum user data field lengths are supported by DIGIPAC® and may be offered from the following list 16,32,64,256,512,1024,2048, octets. An optional maximum user data field length may be selected for a period of tame as the default maximum user data field length common to all virtual calls at the DTE/DCE . interface. A value other than the default may be selected for a period of time for each PVC . Negotiation of maximum user data length on a per call basis may be made with the flow control parameter negotiation facility. The user data field of data packets transmitted by a DTE or DCE may contain any number of bits up to the subscribed maximum for the interface. DIGIPAC® support packet splitting and recombination in any combination of packet sizes up to 2048 octets. Each direction and each end of a call can be set up to have different maximum packet sizes...
4.3.3	Delivery confirmation bit	Implemented as specified
4.3.4	More Data mark	Implemented as specified Implementation notes: DIGIPAC® supports packet splitting and recombination in any combination of packet sizes up to 2048 octets.
4.3.5	Complete packet sequence	Implemented as specified Implementation notes: DIGIPAC® supports packet splitting and recombination in any combination of packet sizes up to 2048 octets.

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	**Description**	**Implementation**
4.3.6	Qualifier bit	Implemented as specified Implementation notes: In some cases, an indicator may be needed with the user data field to distinguish between two types of information., It may be necessary to differentiate, for example, between user data and control information. If such a mechanism is needed, an indicator in the data packet header called the Qualifier bit (Q bit) may be used The use of the LCN is optional. If it is not needed, the Q bit is set to 0. The Q-bit is reset on inconsistent Q-bit within a single complete packet sequence. (Cause: local procedure error) and a DIGIPAC® diagnostic code (Hex/Dec #53/83)
4.3.7	Interrupt procedure	Implemented as specified Implementation notes: The interrupt procedure allows a DTE to transmit data to the remote DTE, without following the flow control procedure applying to data packets. The interrupt procedure can only apply in the flow control ready state within the data transfer state. The arrival of a second interrupt from a DTE before the first is confirmed is considered a protocol violation and causes a reset to be sent (diag hex/dec 2C/44). DIGIPAC® waits for an INTERRUPT CONFIRMATION after an INTERRUPT has been delivered. The INTERRUPT CONFIRMATION is always end-to-end. The interrupt procedure has no effect on the transfer and flow control procedures applying to the data packets on the SVC or PVC.

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	**Description**	**Implementation**
4.3.8	Transit delay of data packets	Implemented as specified
4.4	Procedures for flow control	Implemented as specified Implementation notes: Paragraph 4.4 only applies to the data transfer state and specifies the procedures covering flow control of data packets and reset on each logical channel used for an SVC and PVC.
4.4.1	Flow control	Implemented as specified
4.4.1.1	Numbering of data packets	Implemented as specified Implementation notes: Supports only module 8 sequence numbering. DIGIPAC® does not support the extended packet sequence numbering facility module 128.
4.4.1.2	Window description	Implemented as specified

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	Description	Implementation
4.4.1.3	Flow control principles	Implemented as specified Implementation notes: No action is taken if the DTE does not rotate its packet level window. A P(S) which is out of sequence but within the window is considered an error, and is reset (Cause: local procedure error). The remote DCE rotates the internal window only when the DTE acknowledges at the packet level via an X.25 window rotation. The local DCE rotates the local X.25 window only, if after such a rotation, the internal window can accommodate all the DATA packets that the local DTE is authorized to send (according to the local X.25 window opening). Normally the DIGIPAC® internal window size is larger than either of the X.25 window sizes. In this case DATA would not be buffered at the local DCE, and the internal window size would equal the maximum number of packets in the network. A larger internal window size is used for larger throughput classes. If all three window sizes are the same, there is end-to-end P(R) significance. If the local X.25 window size is larger than the internal window size, the DATA is initially buffered at the local DCE, but as these packets are transmitted, the local window is never opened more than the internal window size. The default local window size is two (2). The DTE may choose (at subscription time) a network option that will set the DTE local window size to any value between 1 and 7. If a virtual circuit exists between DTEs which have both subscribed to a value of 1, DTE end-to-end significance of P(R) is guaranteed, and the maximum number of packets which can be in transit on the virtual call in a given direction is one (1).

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	Description	Implementation
		A RESET INDICATION is sent when an invalid P(R) is received. The DTE can advance the packet level window by using DATA, RR, or RNR packets. Under no conditions does DIGIPAC® purposely keep the local X.25 window closed. DIGIPAC® network always attempts to keep the X.25 window at least partially open.
4.4.1.4	Delivery confirmation	Implemented as specified Implementation notes: On receipt of confirmation for a D bit, packet acknowledges all non-D-bit packets up to the next outstanding D-bit packet according to the internal window opening, or all outstanding packets if there are no outstanding D-bit packets. This is a form of retroactive local acknowledgment.
4.4.1.5	DTE and DCE Receive Ready (RR) packets	Implemented as specified
4.4.1.6	DTE and DCE Receive Not Ready (RNR) packets	Implemented as specified Implementation notes: Data packets are not transmitted after receiving a DTE RNR. After the DTE has sent an RR, DIGIPAC® will begin transmitting data packets to the DTE. The DTE receives any packets that were in transit before DIGIPAC® processes the packet level RNR and may receive data packets until the window is closed. A packet level RNR is never generated by DIGIPAC®. A DTE generated RNR has local significance only and is not carried to a remote DTE.

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	Description	Implementation
4.4.2	Throughput characteristics and throughput classes	Implemented as specified Implementation notes: Achievable throughput is dependent on number of active logical channels. The throughput class is expressed in bits per second. The maximum data field length is specified for an SVC or PVC, and thus the throughput class can be interpreted by the DTE as the maximum number of full data packets per second that the DTE/DCE interface may transmit/receive over a period. In the absence of the default throughput classes assignment facility, the default throughput classes for both directions of transmission correspond to the user class of service of the DTE, but do not exceed the maximum throughput class supported by the network. Negotiation of throughput classes on a per call basis may be made with the throughput class negotiation facility.
4.4.3	Procedure for reset	Implemented as specified Implementation notes: DATA and INTERRUPT packets immediately preceding a RESET REQUEST can be bypassed internally in the network. If these packets are bypassed they are discarded. Once the RESET REQUEST is received, any packets arriving at the DCE from the network are discarded until the reset procedure is completed. The DTE may still receive packets after it has sent a RESET REQUEST and before it receives a RESET CONFIRMATION. The network is always ready to accept data after a DTE resetting procedure has been completed. While the virtual circuit is partially reset, any DATA or INTERRUPT packet that is transmitted is stored in the DCE until the reset has been completed.

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	Description	Implementation
4.4.3.1	Reset request packet	Implemented as specified Implementation notes: The following conditions result in the DCE sending a `RESET INDICATION' with cause "local procedure error": - invalid P (R) - invalid P (S) - Q bit value change in a packet sequence - unauthorized DATA or INTERRUPT packet - data field too long in DATA or INTERRUPT. DIGIPAC® resets a PVC after a network failure (Cause: network congestion), indicating that the PVC is not available; and, when the failure has been removed, resets again (Cause: Remote DTE operational) indicating that the PVC is now available. In the case of a DTE being out of order, DIGIPAC® Resets a PVC with cause: Out of order.
4.4.3.2	Reset indication packet	Implemented as specified Implementation notes: When a PVC becomes available, a RESET INDICATION is generated with cause - DTE Operational.
4.4.3.3	Reset collision	Implemented as specified

Table 2-7 Procedures For Virtual Circuit Service
(Page 13 of 15)

CCITT Part	Description	Implementation
4.4.3.4	Reset confirmation packets	Implemented as specified Implementation notes: If no RESET CONFIRMATION is received after a RESET INDICATION is sent, the DIGIPAC® waits for the confirmation for a period T12 (value supplied in service data) before time-out occurs. During this interval, any data sent by the remote DTE is held by the network. If the remote DTE then issues a RESET REQUEST, the internal reset that crosses the network does not result in a RESET INDICATION by the DCE that is waiting for the RESET CONFIRMATION. When a RESET REQUEST is received, an internal reset packet is sent to the remote DCE. When the internal reset arrives, an internal confirming reset is returned to the originating DCE at the same time a RESET INDICATION is sent to the DTE. A RESET CONFIRMATION is sent to the remote DTE when the internal confirming reset arrives. The RESET CONFIRMATION which the remote DTE returns has no end-to-end significance. Any previous busy (that is, DTE RNR) condition is cleared. Any packet sequence in the process of being transmitted when the reset occurred is considered terminated. No interrupts are left outstanding. Packet level receive and transmit windows are open. See "CCITT Annex D-1/X.25 DCE Time-outs," regarding T12
4.5	Effects of clear, reset, and restart procedures on the transfer of packets	Implemented as specified
4.6	Effects of the physical layer and the data link layer on the packet layer	Implemented as specified

Table 2-7 Procedures For Virtual Circuit Service
(Page 14 of 15)

CCITT Part	**Description**	**Implementation**
4.6.1	General principles	Implemented as specified Implementation notes: In general, if a problem is detected in one layer and can be solved in this layer according to the DCE error recovery procedures provided in this Recommendation without loss or duplication of data, the adjacent layers are not involved in the error recovery. If an error recovery by the DCE implies a possible loss or duplication of data, then the higher layer is informed. The reinitialization of one layer of the DCE is only performed if a problem cannot be solved in this layer. Changes of operational states of the physical layer and the data link layer of the DTE/DCE do not implicitly change the state of each logical channel at the packet layer. Such changes when they occur are explicitly indicated at the packet layer by the use of restart, clear reset procedures as appropriate.
4.6.2	Definition of an out of order condition	Implemented as specified Implementation notes: In the case of a single link procedure, there is an out of order condition when: - a failure on the physical and or/data link layer is detected: such a failure is defined as a condition in which the DCE cannot transmit or cannot receive any frame because of abnormal conditions caused by such things as a local line fault between DTE and DCE. - the DCE has received or transmitted a DISC command. In the case of the Multilink procedure, an out of order condition is considered as having occurred when it is present at the same time for every single link procedure of the DTE/DCE interface.

Table 2-7 Procedures For Virtual Circuit Service
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CCITT Part	**Description**	**Implementation**
4.6.3	Actions on the packet layer when an out of order condition is detected	Implemented as specified Implementation notes: When an out of order condition is detected, the DCE will transmit to the remote end: 1) a reset with the cause "Out of Order" for each PVC, and 2) a clear with the cause "Out of Order" for each existing virtual call
4.6.4	Action on the packet layer during an out of order condition	Implemented as specified Implementation notes: During and out of order condition,: 1) the DCE will clear any incoming virtual call with the cause "Out of Order," 2) for any data, or interrupt packet received from the remote DTE on a PVC, the DCE will reset the PVC with the cause "Out of Order" 3) a reset packet received from the remote DTE on a PVC will be confirmed to the remote DTE by either reset confirmation or reset indication packet.
4.6.5	Actions on the packet layer when the out of order condition is recovered	Implementation as specified Implementation notes: When the out of order condition is recovered: 1) the DCE will send a restart indication packet with the cause "Network Operational" to the local DTE, 2) a reset with the cause "Remote DTE Operational" will be transmitted to the remote end of each permanent virtual circuit.

2.9.5 Packet Formats

This section deals with packet formats, and covers the following topics:

5.1 General

5.2 Call set-up and clearing packets

5.3 Data and interrupt packets

5.4 Flow control and reset packets

5.5 Restart packets

5.6 Diagnostic packets

5.7 Packets required for optional user facilities.

Table 2-8 Packet Formats
(Page 1 of 8)

CCITT Part	**Description**	**Implementation**
5	Packet formats	
5.1	General	Implemented as specified Implementation notes: A packet header is decoded first by logical channel and then by packet type. In a CALL REQUEST packet the addresses, facilities, and data field length are verified. In a data packet, the P(S), P(R), data field length, M bit, and Q bit are verified. Decoding is stopped whenever a procedure error is detected. Bits of an octet are numbered 8 to 1, where 1 is the low order bit and is transmitted first. Octets of a packet are consecutively numbered starting from 1 and are transmitted in this order.
5.1.1	General Format Identifier (GFI)	Implemented as specified
5.1.2	Logical channel group number	Implemented as specified
5.1.3	Logical channel number	Implemented as specified Implementation notes: Logical channel ranges beginning at an arbitrary number greater than zero are assigned at subscription time in the following order: - first for PVC, - then for outgoing virtual calls only, - then for incoming and outgoing virtual calls, - last for incoming virtual calls only. When an incoming call is to be sent to the DTE, the lowest available LCN is used in order to minimize the possibility of call collision. It is expected that the DTE uses the highest available LCN for a CALL REQUEST.

Table 2-8 Packet Formats
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CCITT Part	Description	Implementation
		The actual maximum number of logical channels for a DTE is specified at subscription time. Logical channel zero is not assigned or available to the DTE for PVC or SVC. Any packet type which is received on an out-of-range local channel (for example, one which was not assigned at subscription time) results in a DIAGNOSTIC packet on logical channel zero, provided that the option to send a diagnostic packet on the X.25 port is enable. Otherwise, the packet is discarded and there is no response from the network. If a RESTART REQUEST or RESTART CONFIRMATION is received on a logical channel other than zero, DIGIPAC® sends on SVC LCN a CLEAR INDICATION or on PVC LCN RESET INDICATION. If a RESET CONFIRMATION is received on logical channel zero or any undefined packet is received on any logical channel type, the DTE transmits a DIAGNOSTIC packet on logical channel zero, provided that the diagnostic send is enable on the X.25 port. Otherwise, the packet is discarded and there is no response from the network.
5.1.4	Packet type identifier	Implemented as specified Implementation notes: Extended packet sequence numbering, Registration Packets, and the DTE REJECT packet are not supported. Diagnostic packets are provided if subscribed to. In addition, a subscription option permits a DIAGNOSTIC packet to be received from the DTE.
5.2	Call set-up and clearing packets	Noted
5.2.1	Address block format	Implemented as specified Implementation notes: DIGIPAC® does not support the TOA/NPI address format
5.2.1.1	Format of the address block when the A bit is set to 0 (non-TOA/NPI address)	Implemented as specified

Table 2-8 Packet Formats
(Page 3 of 8)

CCITT Part	Description	Implementation
5.2.1.1.1	Calling and called DTE address length fields	Implemented as specified
5.2.1.1.2	Called and calling DTE address fields	Implemented as specified
5.2.1.2	Format of the address block when the A bit is set to 1 (TOA/NPI address)	TOA/NPI address is not supported
5.2.1.2.1	Calling and called DTE address length fields	TOA/NPI address is not supported
5.2.1.2.2	Called and calling DTE address fields	TOA/NPI address is not supported
5.2.2	Call request and incoming call packets	Implemented as specified
5.2.2.1	General format identifier	Implemented as specified Implementation notes: The General Format Identifier (GFI) contains the D bit as outlined in paragraph 4.2.2.
5.2.2.2	Address block	Implemented as specified Implementation notes: The address block is permitted to be empty on call requests if a direct call has been subscribed on the given logical channel or if a mnemonic address facility is present.
5.2.2.3	Facility length field	Implemented as specified
5.2.2.4	Facility field	Implemented as specified
5.2.2.5	Call user data field	Implemented as specified
5.2.3	Call accepted and call connected packets	Implemented as specified
5.2.3.1	Basic format	Noted
5.2.3.1.1	General format identifier	Implemented as specified Implementation notes: GFI contains the D-bit as outlined in 4.3.3.

Table 2-8 Packet Formats
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CCITT Part	**Description**	**Implementation**
5.2.3.1.2	Address block	Implemented as specified Implementation notes: Call connect packets always contain the address and facility fields; even if the address and facility lengths are 0, both length fields are provided. Call accept packets need not contain the address length field if the address and facility field are absent. Also the DTE need not provide the facility length field if the facility field is absent. However, both length fields may be provided even if neither of the associated fields are present.
5.2.3.1.3	Facility length field	Implemented as specified Implementation notes: See notes in paragraph 5.2.3.1.2.
5.2.3.1.4	Facility field	Implemented as specified Implementation notes: See notes in paragraph 5.2.3.1.2.
5.2.3.2	Extended format	Implemented as specified
5.2.4	Clear request and clear indication packets	Implemented as specified

Table 2-8 Packet Formats
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CCITT Part	Description	Implementation
5.2.4.1	Basic format	Noted
5.2.4.1.1	Clearing cause field	Implemented as specified Implementation notes: Octet 4 is the clearing cause field and contains the reason for the clearing of the call. If the DTE is only allowed to send zero clearing cause (1980 X.25 DTE) and the DCE detects a non-zero clearing cause field in a clear request. DIGIPAC® X.25 service as DCE will issue Clear Indication with clear cause Local Procedure Error and diagnostic code hex/dec 51/81. DIGIPAC® can optionally automatically set the most significant bit of clear causes received from the link for 84/88 X.25 service. DIGIPAC® 1980 X.25 DTE mode services always issue a zero clear cause field. 84/88 X.25 DTE mode service set the most significant bit in the clear cause that would otherwise have been sent to the link.
5.2.4.1.2	Diagnostic code	Implemented as specified
5.2.4.2	Extended format	Implemented as specified
5.2.4.2.1	Address block	Implemented as specified
5.2.4.2.2	Facility length field	Implemented as specified
5.2.4.2.3	Facility field	Implemented as specified
5.2.4.2.4	Clear user data field	Implemented as specified
5.2.5	DTE and DCE clear confirmation packets	Implemented as specified
5.2.5.1	Address block	Implemented as specified
5.2.5.2	Facility length field	Implemented as specified
5.2.5.3	Facility field	Implemented as specified
5.3	Data and interrupt packets	Noted

Table 2-8 Packet Formats
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CCITT Part	**Description**	**Implementation**
5.3.1	DTE and DCE data packets	Implemented as specified with the following interpretation: DIGIPAC® does not require the user data field to be an integral number of octets. However, as a subscriber option non-octet data sent to a DTE is padded to a full octet boundary with zeroes before transition.
5.3.1.1	Qualifier (Q) bit	Implemented as specified
5.3.1.2	Delivery confirmation (D) bit	Implemented as specified
4.3.1.3	Packet receive sequence number	Implemented as specified
5.3.1.4	More data bit	Implemented as specified
5.3.1.5	Packet send sequence number	Implemented as specified
5.3.1.6	User data field	Implemented as specified
5.3.2	DTE and DCE interrupt packets	Implemented as specified
5.3.2.1	Interrupt user data field	Implemented as specified
5.3.3	DTE and DCE interrupt confirmation packets	Implemented as specified
5.4	Flow control and reset packets	Noted
5.4.1	DTE and DCE receive ready (RR) packets	Implemented as specified
5.4.1.1	Packet receive sequence number	Implemented as specified
5.4.2	DTE and DCE Receive Not Ready (RNR) packets	Implemented as specified
5.4.2.1	Packet receive sequence number	Implemented as specified

Table 2-8 Packet Formats
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CCITT Part	**Description**	**Implementation**
5.4.3	Reset request and reset indication packets	Implemented as specified Implementation notes: If a non zero cause field is sent by the DTE in a reset request packet, DIGIPAC® returns either SVC CLEAR INDICATION or PVC RESET INDICATION. DTE diagnostic codes provided in valid reset request packets are carried transparently across the network. The diagnostic code field in a RESET INDICATION packet is set to zero if no diagnostic code were present in the RESET REQUEST from the DTE.
CCITT Part	**Description**	**Implementation**
5.4.3.1	Resetting cause field	Implemented as specified except as noted above.
5.4.3.2	Diagnostic code	Implemented as specified except as noted above.
5.4.4	DTE and DCE reset confirmation packets	Implemented as specified
5.5	Restart packets	Noted
5.5.1	Restart request and restart indication packets	Implemented as specified.
5.5.1.1	Restarting cause field	Implemented as specified
5.5.1.2	Diagnostic code	Implemented as specified
5.5.2	DTE and DCE restart	Implemented as specified
5.6	Diagnostic packet	Implemented as specified
5.6.1	Diagnostic code field	Implemented as specified
5.6.2	Diagnostic explanation field	Implemented as specified
5.7	Packets required for optional user facilities	Noted
5.7.1	DTE reject (REJ) packet for the packet retransmission facility	DIGIPAC® does not support the optional DTE REJ packet.
5.7.1.1	Packet receive sequence number	Implemented as specified

Table 2-8 Packet Formats
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5.7.2	Registration packets for the on-line facility registration facility	Not implemented
5.7.2.1	Registration request packet	Not implemented
5.7.2.1.1	Address length fields	Not implemented
5.7.2.1.2	Address field	Not implemented
5.7.2.1.3	Registration length field	Not implemented
5.7.2.1.4	Registration field	Not implemented
5.7.2.2	Registration confirmation packet	Not implemented
5.7.2.2.1	Cause field	Not implemented
5.7.2.2.2	Diagnostic code	Not implemented
5.7.2.2.3	Address length field	Not implemented
5.7.2.2.4	Address field	Not implemented
5.7.2.2.5	Registration length field	Not implemented
5.7.2.2.6	Registration field	Not implemented

2.9.6 Procedures for Optional User Facilities

This section describes procedures for optional user facilities (packet layer), and covers the following topics:

6.1 On-line facility registration

6.2 Extended packet sequence numbering

6.3 D bit modification

6.4 Packet Retransmission

6.5 Incoming calls barred

6.6 Outgoing calls barred

6.7 One-way logical channel outgoing

6.8 One-way logical channel incoming

6.9 Non-Standard default packet sizes

6.10 Non-Standard default window sizes

6.11 Default throughput classes

6.12 Flow control parameter negotiation

6.13 Throughput class negotiation

6.14 Closed user group related facilities

6.15 Bilateral closed user group related facilities

6.16 Fast select

6.17 Fast select acceptance

6.18 Reverse changing

6.19 Reverse changing acceptance

6.20 Local charging prevention

6.21 Network user identification (NUI) related facilities

6.22 Charging information

6.23 RPOA related facilities

6.24 Hunt Group

6.25 Call redirection and call deflection facilities

6.26 Call line address modified notification

6.27 Transit delay selection and indication

6.28 TOA/.NPI address subscription

Table 2-9 Procedures For Optional User Facilities (Packet Layer)
(Page 1 of 3)

CCITT Part	Description	Implementation
6	Procedures for optional user facilities (packet layer)	Noted
6.1	On-line facility registration	Not implemented
6.2	Extended packet sequence numbering	Not implemented
6.3	D bit modification	Implemented as specified
6.4	Packet Retransmission	Not implemented
6.5	Incoming calls barred	Not implemented
6,6	Outgoing call barred	Implemented as specified
6.7	One-way logical channel outgoing	Implemented as specified Implemented notes: DIGIPAC® allows specification of ranges of one-way logical channels at subscription time for both incoming and outgoing calls. In addition, a DTE may be specified as being allowed no incoming or outgoing calls.
6.8	One-way logical channel incoming	see paragraph 6.7
6,9	Non-standard default packet sizes`	Implemented as specified The range of values supported is 16, 32, 64, 256, 512, 1024, and 2048.
6.10	Non-standard default window sizes	Implemented as specified The range of values is from 1 to 7
6.11	Default throughput classes assignments	Implemented as specified The range of values is from 75 bit/s to 64 kbit/s
6.12	Flow control parameter negotiation	Implemented as specified
6.13	Throughput class negotiation	Implemented as specified
6.14	Closed user group related facilities	Implemented as specified Implemented notes: Implemented as specified in CCITT X.301 9 draft 1992 version)
6.14.1	Closed user group	Implemented as specified
6.14.2	Closed user group with outgoing access	Implemented as specified

Table 2-9 Procedures For Optional User Facilities (Packet Layer)
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CCITT Part	**Description**	**Implementation**
6.14.3	Closed user group with incoming access	Implemented as specified
6.15	Bilateral closed user group related facilities	Not implemented
6.16	Fast select acceptance	Implemented as specified Implementation notes: An additional option is supported to control whether a DTE is permitted to originate a fast select call.
6.17	Fast select acceptance	Implemented as specified
6.18	Reverse charging	Implemented as specified
6.19	Reverse charging acceptance	Implemented as specified
6.20	Local charging prevention	Implemented as specified
6.21	Network user identification	Implemented as specified
6.21.1	NUI subscription	Implemented as specified
6.21.2	NUI override	Not implemented
6.21.3	NUI selection	Implemented as specified
6.22	Charging information	Implemented as specified
6.23	RPOA related facilities	Implemented as specified
6,23,1	RPOA subscription	Implemented as specified
623,2	RPOA selection	Implemented as specified Implementation notes: Only the basic format is supported. That is, only one RPOA transit network may be specified in a call request..
6.24	Hunt Group	Implemented as specified
6.25	Call redirection and call deflection facilities	Implemented as specified except for call deflection Implementation notes: DIGIPAC® offers systematic call redirection on subscriber request. The subscriber contacts network operation to issue a REFUSE operator command to redirect incoming calls destined to this DTE

Table 2-9 Procedures For Optional User Facilities (Packet Layer)
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CCITT Part	Description	Implementation
6.25.1	Call redirection	Implemented as specified Implementation notes: (CCITT note 2) Call redirection cannot be chained. Conditions for the complementary address of the originally called address to be preserved after call redirection: - primary and all secondary addresses must be X.121 - primary and secondary addresses must all be the same length and contain no complimentary addresses.
6.25.2	Call deflection related facilities	Not implemented
6.25.1	Call deflection subscription	Not implemented
6.25.2	Call deflection selection	Not implemented
6.25.3	Call redirection of call deflection notification	Implemented as specified except for the reason for call deflection
6.26	Called line address modified notification	Implemented as specified
6.27	Transit delay selection and indication	Implemented as specified
6.28	TOA/NPI address subscription	Not implemented

2.9.7 Formats For Facility Fields and Registration Fields

This section describes formats for facility fields and registration fields, and covers the following topics:

7.1 General

7.2 Coding of facility field in call set-up and clearing packets

7.3 Coding of registration field of registration packets.

Table 2-10 Formats For Facility Fields and Registration Fields
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CCITT Part	Description	Implementation
7	Formats for facility fields and registration fields	Noted
7.1	General	Implemented as specified Implementation noes: X.25 84/88 does not allow duplicate facilities in the facility field.
7.2	Coding of facility field in call set-up and clearing packets	Implemented as specified.
7.2.1	Coding of the facility code fields	Implemented as specified
7.2.2	Coding of the facility parameter fields	Noted
7.2.2.1	Flow control parameter negotiation facility	Noted
7.2.2.1.1	Packet size	Implemented as specified. Range is up to 2048 octets.
7.2.2.1.2	Window size	Implemented as specified
7.2.2.2	Throughput class negotiation facility	Implemented as specified
7.2.2.3	Closed user group selection facility	Noted
7.2.2.3.2	Extended format	Implemented as specified Implementation notes: The index to the closed user group selected for the virtual call is in the form of four decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit and bit 1 of the second octet being the low order bit of the fourth digit. Indexes to the same closed user group at different DTE/DCE interfaces may be different.
7.2.2.4	Closed user group with outgoing access selection facility	Noted
7.2.2.4.1	Basic format	Implemented as specified
7.2.2.4.2	Extended format	Implemented as specified
7.2.2.5	Bilateral closed user group selection facility	Not implemented

Table 2-10 Formats For Facility Fields and Registration Fields
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CCITT Part	**Description**	**Implementation**
7.2.2.6	Reverse charging and fast select facilities	Implemented as specified Implementation notes: X.25 verifies that bits 6, 5, 4, 3, and 2 are all zero.
7.2.2.7	NUI selection facility	Implemented as specified
7.2.2.8	Charging information facility	Noted
7.2.2.8.1	Parameter field for requesting service	Implemented as specified
7.2.2.8.2	Parameter field indicating monetary unit	Not implemented
7.2.2.8.3	Parameter field indicating segment count	Implemented as specified Implementation note: Segment counts are provided for the current tariff period only.
7.2.2.8.4	Parameter field indicating call duration	Implemented as specified Implementation note: Call duration applies to the current tariff period only.
7.2.2.9	RPOA selection facility	Noted
7.2.2.3.1	Basic format	Implemented as specified Implementation notes: The index to the closed user group selected for the virtual call is in the form of two decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 being the low order bit of the first digit and bit 1 being the low order bit of the second digit. Indexes to the same closed user group at different DTE/DCE interfaces may be different.
7.2.2.9.1	Basic format	Implemented as specified
7.2.2.9.2	Extended format	Not implemented
7.2.2.10	Call deflection selection facility	Not implemented
7.2.2.11	Call redirection or call deflection notification facility	Implemented as specified, (except for the reason for call deflection)
7.2.2.12	Called line address modified notification facility	Implemented as specified
7.2.2.13	Transit delay selection and indication facility	Implemented as specified

Table 2-10 Formats For Facility Fields and Registration Fields
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CCITT Part	Description	Implementation
7.3	Coding of the registration field of registration packets	Not implemented
7.3.1	Coding of the registration code fields	Not implemented
7.3.2	Coding of the registration parameter fields	Not implemented
7.3.2.1	Facilities that may be negotiated only when all logical channels used for virtual calls are in state p1	Not implemented
7.3.2.2	Facilities that may be negotiated at any time	Not implemented
7.3.2.3	Availability of facilities	Not implemented
7.3.2.4	Non-negotiable facilities values	Not implemented
7.3.2.5	Default throughput classes	Not implemented
7.3.2.6	Non-standard default packet sizes	Not implemented
7.3.2.7	Non-standard default window sizes	Not implemented
7.3.2.8	Logical channel types ranges	Not implemented

2.9.8 Compliance to Annexes in CCITT Recommendation X.25

The following section describes compliance with the annexes to the CCITT Recommendation for X.25. The annexes discussed are:

Annex A	Range of logical channels used for virtual calls and permanent virtual circuits
Annex B	Packet layer DTE/DCE interface state diagrams
Annex C	Actions taken by the DCE on receipt of packets in a given state of the packet layer DTE/DCE
Annex D	Packet layer DCE time-outs and DTE time-limits
Annex E	Coding of X.25 network generated diagnostic fields in clear, reset and restart indication, registration confirmation, and diagnostic packets
Annex F	Applicability of the on-line registration facility to other facilities
Annex G	CCITT specified DTE facilities to support the OSI Network service
Annex H	Subscription-time optional user facilitates that may be associated with a network user identifies in conjunction with the NUI override facility

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CCITT Annex A Range of logical channels used for virtual calls, and permanent virtual circuits.	Implemented as specified Implementation notes Note 1: An additional option is supported to reverse the standard use of logical channels (to allow the DIGIPAC® X.25 service to be used as a DTE). Note 2: Logical channel ranges may start at 1 or at a higher number. The actual maximum number of logical channels for a DTE is specified at subscription time. Gaps between ranges are NOT allowed. Note 3: It is possible to set aside a range of LCNs for PVCs, while only assigning PVCs to a portion of this range. This allows the remainder of the PVC LCN range to be available for future PVC assignment without rearranging other LCN ranges.
CCITT Annex B Packet level DTE/DCE interface state diagrams	Noted
CCITT Annex B-1/X.25 Diagram of states for the transfer of restart packets. CCITT Annex B-2/X.25 Diagram of states for the transfer of call set-up and call clearing packets within the packet level ready (r1) state	Implemented as specified Implemented as specified
CCITT Annex B-3/X.25 Diagram of states for the transfer of reset packets within the data transfer (p4) state	Implemented as specified
CCITT Annex C Actions taken by the DCE on receipt of packets in a given state of the packet layer DTE/DCE interface as perceived by the DCE.	Implemented as specified with the following interpretations:
Table C-1/X.25 Special cases	Diagnostic packets will be issued to a DTE only on a subscription basis.

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Table C-2/X.25 Actions taken by the DCE on receipt of packets in a given state of the packet layer DTE/DCE interface as perceived by the DCE: restart and registration procedure	Implemented as specified with the exception of Registration requests which are not supported, Implementation notes: Actions in the case of Restart packets exceeding the maximum permitted length: In state r1, long Restart packets will be acted on along with the issuing of diagnostic code #39 if the service is configured as 1980. ("Acted on" means the interface goes to r2.) If the service is configured as 1984/88 then long Restart packets will be discarded and diagnostic code #39 issued. In state r2, long Restart packets will be discarded. In state r3, long Restart packets will prompt diagnostic code #39 and another Restart Indication. T10 will also be reset and begin running again.

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CCITT Table C-3/X.25 Actions taken by the DCE on receipt of packets in a given state of the packet layer DTE/DCE interface as perceived by the DCE: call set-up and clearing on logical channel assigned to virtual call (see Note 1)	This table is interpreted as follows: DIGIPAC® issues a clear indication as a result of an error condition in state p6, and enters state p7. On the first T13 time-out a clear indication packet will be immediately transmitted to the DTE and state p7 will continue. On the second T13 time-out, a diagnostic packet with diagnostic code #50 may be sent and the DCE enters P1 sate as stated in Table D-1 of the 1988 CCITT Recommendation X.25. In state p7, if a clear request/clear confirm is received from the DTE, state p1 will be entered. Clear requests received with cause field not equal to DTE Originated will be treated in a manner similar to the preceding discussion. State p7 will be entered and a clear indication generated. However, on T13 time-out a clear indication packet will again be transmitted. This will ensure DTE/DCE agreement on the state of the interface. A subsequent T13 time-out will be treated above. When the DIGIPAC® DCE transmits a Clear Indication to the DTE, and RESET INDICATION INTERRUPT, or DATA packet awaiting transmission on the cleared LCN at the DIGIPAC® DCE is discarded.
CCITT Annex D. Packet layer DCE time-outs and DTE time-limits	Implemented as specified.

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CCITT Table D-1/X.25 DCE Time-outs	Implemented as specified Implementation notes: DIGIPAC® operating as DCE implements the following timers according to X.25 (1988) for services configured as X.25 (84/88) and X.25 1980. Note 1: Upon a second T10 time-out, the DCE enters the r1 state and may issue (service data option) a diagnostic packet #52. Note 2: Upon a second T12 time-out for virtual calls, a Clear Indication packet is transmitted (local procedure error, diagnostic #51). Upon a second T12 time-out for PVCs, the DCE enters the state d1 and may issue (service data option) a diagnostic packet #51. Upon a second T13 time-out, the DCE enters the p1 state and may issue (service data option) a diagnostic packet #50. T10 DIGIPAC® implementation: NAME: Restart timer RANGE: 15-915 seconds and OFF INTERVAL: 15 seconds DEFAULT: 60 seconds T11 DIGIPAC® implementation: NAME: Call timer RANGE: 15-915 seconds and OFF INTERVAL: 15 seconds DEFAULT: 180 seconds

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	T12 DIGIPAC® implementation: NAME: Reset timer RANGE: 15-915 seconds and OFF INTERVAL: 15 seconds DEFAULT: 60 seconds T13 DIGIPAC® implementation: NAME: Clear timer RANGE: 15-915 seconds and OFF INTERVAL: 15 seconds DEFAULT: 60 seconds
CCITT Table D-2/X.25 DTE Time-outs	Implemented as specified with the exception of T28 (see section 6.1). Implementation notes: DIGIPAC® operating as DTE implements the following timers according to X.25 (1988) for services configured as X.25 (84/88) and for services configured for X.25 (1980). Note 1: Upon a second T20 time-out, the DTE enters the r1 state and may issue (service data option) a diagnostic packet #52. Note 2: Upon a second T22 time-out for virtual calls, a clear request packet is transmitted (local procedure error, diagnostic #51). Upon a second T22 time-out for PVCs, the DTE enters the state d1 and may issue (service data option) a diagnostic packet #51. Upon a second T23 time-out, the DTE enters the p1 state and may issue (service data option) a diagnostic packet #50. T20 DIGIPAC® implementation: NAME: Restart timer RANGE: 15-915 seconds and OFF INTERVAL: 15 seconds DEFAULT: 60 seconds

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	T21 DIGIPAC® implementation: NAME: Call timer RANGE: 15-915 seconds and OFF INTERVAL: 15 seconds DEFAULT: 180 seconds T22 DIGIPAC® implementation: NAME: Reset timer RANGE: 15-915 seconds and OFF INTERVAL: 15 seconds DEFAULT: 60 seconds T23 DIGIPAC® implementation: NAME: Clear timer RANGE: 15-915 seconds and OFF INTERVAL: 15 seconds DEFAULT: 60 seconds T28 DIGIPAC® implementation: - DIGIPAC® X.25 service does not support registration packets.
CCITT Annex E Coding of X.25 network generated diagnostic fields in clear, reset, and restart indication, registration confirmation, and diagnostic packets.	Implemented as specified, except for registration confirmation.
CCITT Table E-1/X.25	Implemented with no changes
CCITT Annex F Applicability of the on-line facility registration facility to other facilities	Not implemented.
CCITT Annex G CCITT - specified DTE facilities to support the OSI Network service Section G1 Introduction	Implemented as specified. Implemented as specified.
Section G2 Coding of the facility fields	Implemented as specified.
CCITT Table G-1/X.25 Coding of the facility code field	This table is implemented with no changes.
Section G.3 Coding of the facility parameter field Section G.3.1 Calling address extension facility	 Implemented as specified. X.25 supports up to 40 decimal digits.
Section G.3.2 Called address extension facility	Implemented as specified. X.25 supports up to 40 decimal digits.

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Section G.3.3 Quality of service negotiation facilities	
Section G.3.3.1 Minimum throughput class facility Section G.3.3.2 End-to-end transit delay facility	Implemented as specified. Implemented as specified. X.25 does not check if the optional parameters are present on the call accepted or call connected packets.
Section G.3.3.3 Priority facility	Implemented as specified
Section G.3.3.4 Protection facility	Implemented as specified
Section G.3.4 Expedited data negotiation facility CCITT Annex H Subscription-time optional user facilities that may be associated wit a network user identifier in conjunction wit the NUI override facility	Implemented as specified Not implemented
CCITT Appendix IV Information on address in call set-up and clearing packets	Implemented as specified Implementation Notes:
IV.1.1 - Ignore Local Address (ILA)	DIGIPAC® offers a non-CCITT specified option called Ignore Local Address (ILA). Normally, when this option is NOT enabled, if a call request is received from the link containing a calling address, the network X.25 service insists this address be defined for the calling port. Similarly, if a call accept is received from the link containing a called address, the network X.25 service insists this address be defined for the called port. When the ILA option is enabled, the address checks described above are not performed.

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IV.1.2 - Complementary address	DIGIPAC® offers two separate options on a per port basis allowing complementary addresses to be presented alone in call set-up packets. 1) calling complementary address may be presented alone in a call request packet; called complementary address in a call accepted and clear request (with CLAMN facility) packets 2) called complementary address WILL be presented alone in incoming call packet, calling complementary address in call connected packet and clear indication packet (with CLAMN facility) When selected, option (1) allows both presentation of complementary address alone or together with main addresses. Option (2) causes complementary address alone to be presented by the network in the packets indicated. If not selected, the addresses shall always include the main addresses possibly followed by the complementary addresses if any.

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IV.2 - Addresses in call request packet. The Calling address -	Subscription; Single DNA - ILA subscribed: A calling DTE address is optional. If provided, the calling DTE main address is not checked against the port DNA and the address provided is used in the call request packet. If no calling address is provided, the port DNA is inserted. A calling complimentary address may be provided following the main address, but not alone. If the complementary address is presented alone and as the ILA option takes precedence, the complementary address will be interpreted as a main address and possibly cause the call to be cleared because of invalid address length. Subscription; Multiple DNAs - ILA subscribed: A calling DTE address is optional. If provided, the calling DTE main address is not checked against any of the DNAs specified for the port. If a calling DTE address is not provided, the first DNA in the list is inserted; otherwise, the calling DTE address provided is used. A calling DTE complimentary address may be provided following the main address, but not alone. If the complementary address is presented alone and as the ILA option takes precedence, the complementary address will be interpreted as a main address and possibly cause the call to be cleared because of invalid address length. Subscription; Calling DTE having subscribed to the Hunt group facility: If the calling DTE is in a hunt group, the calling address must be the specific address unless the calling DTE subscribes to ILA in which case the calling address may be the hunt group address (or any other valid address).

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IV.3 - Addresses in incoming call packets. The Called address -	The called DTE main address presented to a hunt group member - called DTE is the specific address of the hunt group member; NOT the hunt group address. Subscription; Single DNA subscribed: The network provides the called DTE main address possibly followed by a called complementary address provided by the calling DTE, or the called complementary address alone (as per an option to be subscribed for the port; this is the same option as for call connected and clear indication packets - see IV.5 and IV.7). Subscription; Multiple DNA subscribed: The network provides the called DTE main address possibly followed by a complementary address if provided by the calling DTE, or the called complementary address alone (as per an option to be subscribed for the port - this is the same option as for call connected and clear indication packets - see IV.5 and IV.7).
The Calling address	The calling address presented in an incoming call packet consists of a main address possibly followed by a calling complementary address if provided by the calling DTE. If the calling DTE is in a hunt group, the calling address is the specific address or whatever address was provided by the calling DTE (i.e., in the case of calling DTE subscribing to ILA). Presentation of the calling address may be suppressed by a port subscription option.

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IV.4 - Addresses in call accept packets	Subscription; Single DNA - ILA subscribed: If the called DTE address is not provided, the network inserts the called DTE address indicated in the incoming call packet. If the called DTE address is provided the provided address, which need not match the port DNA, is used. A called DTE complementary address may be provided following the main address, but not alone. The main address AND the complementary address must be the same as in the incoming call packet unless the CLAMN facility is present in the call accept packet; otherwise, the network inserts the CLAMN facility. Subscription; Multiple DNA - ILA subscribed: If the called DTE address is not provided, the network inserts the called DTE address indicated in the incoming call packet. If the called DTE address is provided, the provided address, which need not match the port DNA, is used. A called DTE complementary address may be provided following the main address, but not alone. The main address AND the complementary address must be the same as in the incoming call packet unless the CLAMN facility is present in the call accept packet; otherwise, the network inserts the CLAMN facility. Use of CLAMN facility: When a called DTE uses the CLAMN facility it just provide a changed called DTE address; i.e., changed complementary address (single DNA) or changed main address and/or changed complementary address (multiple DNA). Also the changed called DTE address must be one valid for the interface if ILA is not subscribed. When ILA is subscribed by the called DTE, it must provide a changed called DTE address; i.e., changed main address and/or changed complementary address.

Table 2-11 X.25 CCITT Annex Compliance
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IV.5 - Addresses in call connect packets	The network always provides the called and calling address in call connect packets. However, by subscription, a port may suppress the presentation of either or both addresses. The subscription option which causes suppression of the calling address in a call connect also causes suppression of the calling address in an incoming call.
IV.6 - Address in clear request packets	Called address from called DTE: A called DTE address may be present only in conjunction with CLAMN facility and in direct response to an incoming call. the called address may consist of: 1) a complementary address alone, different from the one in the incoming call (when subscribe to option discussed in IV.2 and IV.4) or (2) a main address different from the one in the incoming call and valid for the interface possibly followed by any complementary address or 3) a main address the same as presented in the incoming call packet followed by a changed complementary address If the ILA option is subscribed at the called end, the called DTE cannot present a called DTE address consisting of a complementary address alone.

Table 2-11 X.25 CCITT Annex Compliance
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IV.7 - Address in clear indication packets	Called address: A called DTE address is present only in conjunction with the CLAMN facility and in direct response to a call request. The called address may consist of: 1) a main address different from the one in the call request possibly followed by any complementary address or 2) a main address the same as the one in the call request followed by a changed complementary address Calling address: 1) a complementary address alone (same option applicable to IV.3 and IV.5) 2) a main address followed by a complementary address.
IV.8 - Addresses in clear confirmation packets	As specified
IV.9 - Addresses in call redirection and call deflection related facilities	The called addresses indicated in an incoming redirected call consist: 1) in the called address field of the address of an alternative DTE with a format indicated in IV.3 2) in the call redirection notification facility of the originally called DTE address consisting of a main address followed by a complementary address if such was present in the call request packet.

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3. U S WEST DIGIPAC® Network Features

3.1 Network Features

Please reference the following Table 3-1

<u>KEY</u>: 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			
Default throughput Classes Assignment	NA	S	S
Incoming Calls Barred	S	S	NA
Outgoing Calls Barred	S	S	S
One-way Logical Channel Outgoing	S	S	S
One-way Logical Channel Incoming	S	S	NA
Closed User Group	S	S	NA
CUG with Outgoing Access	S	S	S
CUG with Incoming Access	S	S	S
Incoming Calls Barred Within a CUG	S	S	NA
Outgoing Calls Barred Within a CUG	S	S	NA
Reverse Charging	S	S	NA
Reverse Charging Acceptance	S	S	S
RPOA Selection	S	S	S
Nonstandard Default Packet Sizes	S	S	S
Multiple Circuits to the same DTE	S	S	S
Flow Control Parameter Negotiation	NA	S	NA
Throughput Class Negotiation	S	S	S
Fast Select	S	S	S
Fast Select Acceptance	S	S	S
Closed User Group Selection	S	S	NA
Local Charging Prevention	S	S	S
Network User Identification	S	S	NA
Charging Information	S	S	NS
Multi-Line Hunt Group	S	S	NA
Call Redirection	S	S	NA
Call Line Address Modification Notification	S	S	NA
Call Redirection Notification	S	S	NS
Direct Call	S	S	NA
Packet Retransmission	S	NA	NA
Bilateral Closed User Group	NS	NS	NS
	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	NA	NA
Standard Profile Selections	S	S	NA
Permanent Virtual Circuits	S	S	S
D-bit Modification	NS	S	NS
Transmit Delay Selection and Notification	NS	S	NS
Bilateral CUG Selection	NS	NS	NS
Transit Network Identification	NA	NA	S
Call Identifier	NA	NA	S

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

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Tables

4. U S WEST 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 through 4-6 specify the options for the modem types required to accommodate the available DIGIPAC® synchronous X.25 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 4-7 through 4-8 list 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 U S WEST Communications, Inc. Marketing Representative may be contacted for assistance with questions and for further clarification.

4.2 Dial Access

DIGIPAC® supports dial access to X.25 by way of the X.32 recommendation and information on how X.32 is implemented in the DIGIPAC® is contained in Module 4 of this Techincal Publication.

4.3 Direct Access

DIGIPAC® supports direct access ports for X.25 interfaces that provide a full duplex interface, from 2400 to 56000 bit/s. Modem transmission interfaces for analog voice grade data channels are supported for 2400, bit/s, 4800 bit/s and 9600 bit/s. Modem transmission interfaces for digital data channels are supported for 2400 bit/s, 4800 bit/s, 9600 bit/s and 56000 bit/s.

4.4 Physical Interface Description

4.4.1 Direct Access - Synchronous Analog

- Direct Access - Synchronous - 2400 bit/s

  Line: 4-Wire; Two-point voice grade data channel

  Modem: 201C compatible; Full duplex operation

  See Table 4-1 for options

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

- Direct Access - Synchronous - 4800 bit/s

  Line: 4-Wire; Two-point voice grade data channel

  Modem: 208B compatible; Full duplex operation

  See Table 4-2 for options

  Modem: CCITT V.27 bis compatible; Full duplex operation

  Interface specifications and operation in accordance with CCITT Recommendation V.27 - 1988 " 4800 Bits Per Second Modem With Manual Equalizer Standardized For Use One Leased Telephone-Type Circuits".

  See Table 4-2 for options

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

- Direct Access - Synchronous - 9600 bit/s

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

  Modem: CCITT V.32 compatible using Trellis Coded Modulation scheme

  Interface specifications and operation in accordance with CCITT Recommendation V.32 - 1988 "A Family of 2-Wire Modems Operating At Data Signaling Rates Of Up To 9600 bit/s For Use One The General Switched Telephone Network and On Leased Telephone - Type Circuits"

  See Table 4-3 for options

  Port: EIA RS-232-D; (CCITT V.24/V.28/V.54)

- Direct Access - Synchronous - 9600 bit/s

  Line: 4-Wire; Two-point voice grade data channel

  Modem: CCITT V.29 compatible; full duplex operation

  Interface specifications and operation in accordance with CCITT Recommendation V.29 - 1988 "9600 Bits Per Second Modem For Use On Point-To-Point 4-Wire Leased Telephone - Type Circuits"

  See Table 4-4 for options

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

4.4.2 Direct Access - Synchronous Digital

- Direct Access - Synchronous - 2400 bit/s, 4800 bit/s, 9600 bit/s

  Line: 4-Wire; Dedicated digital channel

  Modem: DSU/CSU compatible

  Interface specifications and operation in accordance with Pre-divestiture PUB 41021 "Digital Data System - Channel Interface Specifications", March 1973, with Addendum, October 1981; and AT&T PUB 62310, "Digital Data System Channel Interface Specification", September 1983.

  See Table 4-5 for options

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

- Direct Access - Synchronous - 56000 bit/s

  Line: 4-Wire; Dedicated digital channel

  Modem: DSU/CSU compatible

  Interface specifications and operation in accordance with Pre-divestiture PUB 41021 "Digital Data System - Channel Interface Specifications", March 1973, with Addendum, October 1981; and AT&T PUB 62310, "Digital Data System Channel Interface Specification", September 1983.

  See Table 4-7 for options

  Port: CCITT V.35 WITH V.54 recommended

Table 4-1 Direct Access - Synchronous- 2400 bit/s 201C Compatible - (4-Wire)
(Page 1 of 2)

REQUIRED MODEM OPTIONS (DIGIPAC® AND CUSTOMER)	
1.	4-Wire Private Line Operation
2.	Synchronous operation.
3.	Constant transmit operation, - PL operation
4.	Data rate: 2400 bit/s.
5.	Transmit signal level: CUSTOMER = 0.0 dBm DIGIPAC® = -8.0 dBm
6.	Line impedance: 600 ohms.
7.	Transmitter timing source: Modem clock (INTERNAL).
8.	Scrambler/descrambler feature, disabled.
9.	Recovered clock New Sync, disabled.
10.	External control of Data Set Ready (CC) lead, pin 6, by the Data Station Terminating Equipment, disabled.
11.	DTE control of data rate via the CH lead (pin 23), disabled. Terminal cannot control modem data rate.
12.	Amplitude and delay compromise equalizers, disabled.

Table 4-1 Direct Access - Synchronous- 2400 bit/s 201C Compatible - (4-Wire)
(Page 2 of 2)

DIGIPAC® MODEM OPTIONS	
1.	Carrier detect sensitivity: Acquisition = -24 dBm Release = -29 dBm.
2.	Request to Send (CA/pin 4) to Clear To Send (CB/pin 5) delay: 0 ms.
3.	Signal Quality alarm to DTE (via pin 21), disabled. Not a function of the DIGIPAC® port interface lead.
4.	Signal Quality monitor inhibit Carrier Detect (CF lead), disabled. Signal Quality monitor circuit may not inhibit Carrier Detect (force CF lead OFF).
5.	Anti-streaming/Anti-streaming timer, disabled. Normally disable on two point private line circuits.
6.	Receive signal element clock lead DD (pin 17) clamped ON when Received Line Signal Detector (CF) is OFF.
7.	Receiver is enabled when Request To Send (CA lead) is ON. Modem may receive and transmit data simultaneously; full-duplex operation.
8.	Data Terminal Ready (CD lead, pin 20) forced ON continuously.
9.	Data Set Ready (CC) lead forced ON during Analog Loopback test.
10.	Data Set Ready (CC) lead forced ON during Self-Test, Remote Terminal test and Remote Digital Loopback.
11.	DTE control of Analog Loopback via pin 25, disabled. Analog Loopback assigned to pin 18.
12.	DTE control of Analog Loop back via the LL lead, enabled and assigned to pin 18.
13.	Analog Bilateral Loopback; enabled. Analog and Voice Frequency Loopback occur when an Analog Loopback is invoked.
14.	Enable modem's ability to respond to Remote Digital Loopback (RDL) signal from remote modem.
15.	DTE control of Remote Digital Loopback via pin 21, enabled.
16.	Frame and signal grounds separated by 100 ohms.

Table 4-2 Direct Access - Synchronous - 4800 bit/s CCITT Recommendation V.27 OR 208B Compatible - (4-Wire)
(Page 1 of 2)

REQUIRED MODEM OPTIONS (DIGIPAC® AND CUSTOMER)	
1.	Communication protocol: CCITT V.27 or 208A, per service ordered.
2.	4-Wire Private Line operation.
3.	Synchronous operation.
4.	Constant transmit carrier - PL operation.
5.	Data rate: 4800 bit/s.
6.	Transmit signal level: CUSTOMER = 0.0 dBm DIGIPAC® =-8.0 dBm
7.	Line impedance: 600 ohms.
8.	Carrier detect thresholds: Acquisition = Low (-26 to 34 dBm) Release = Low (-31 to 35 dBm)
9.	Transmitter timing source: CUSTOMER = Modem receive (SLAVE) DIGIPAC® = Modem clock (INTERNAL)
10.	Receive quick poll mode, inhibited. This conditions the modem's adaptive equalizers for standard CCITT V.27 training sequences.
11.	Scrambler/descrambler feature, disabled.
12.	Recovered clock New Sync, disabled.
13.	Signal quality and Round Robin Retrain, disabled.
14.	DTE control of data rate via the CH lead (pin 23), disabled. Terminal cannot control modem data rate.
15.	Amplitude and delay compromise equalizers, disabled.
16.	One-second adaptive equalizer and carrier detect holdover during receive carrier breaks. Modem receiver will override line signal breaks of one second or less.

Table 4-2 Direct Access - Synchronous - 4800 bit/s CCITT Recommendation V.27 OR 208B Compatible - (4-Wire)
(Page 2 of 2)

DIGIPAC® MODEM OPTIONS	
1.	Request to Send normal; controlled by DTE (CA lead, pin 4).
2.	Request To Send (CA/pin 4) to Clear To send (CB/pin 5) delay: 8ms.
3.	Signal Quality alarm to DTE (via pin 21), disabled. Not a function of the DIGIPAC® port interface lead.
4.	Train-On-Data, enabled. When receiver loses equalization, normally due to deteriorated signal quality, the receiver adaptive equalizer will attempt to retrain on incoming data.
5.	Receive signal element clock lead DD (pin 17) state not dependent on Carrier Detect state. Receive clock output not clamped ON when Received Line Signal Detector (CF) is off.
	Anti-streaming/Anti-streaming timer, disabled. Normally disable on two point private line circuits.
6.	One-second adaptive equalizer and carrier detect holdover during receive carrier breaks. Modem receiver and equalizer will override receive line signal breaks on one second or less.
7.	Data Set Ready (CC) lead forced ON during Analog Loopback test.
	Data Set Ready (CC) lead (pin 6) state, independent of Data Terminal Ready (CD) lead state (pin 20).
8.	Errors are not injected into the transmitted test pattern during Self-Test.
9.	DTE control of Analog Loopback via the LL lead, enabled and assigned to pin 18.
10.	Analog Bilateral Loopback; enabled. Analog and Voice Frequency Loopback occur when an Analog Loopback is invoked.
11.	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.
12.	
	DTE control of Remote Digital Loopback via pin 21, enabled.
13.	Frame and signal grounds separated by 100 ohms.
14.	
15.	

Table 4-3 Direct Access - Synchronous - 9600 bit/s CCITT Recommendation V.32 Compatible - (2-Wire) Using Trellis Coded Modulation (Page 1 of 2)

REQUIRED MODEM OPTIONS DIGIPAC® AND CUSTOMER	
1.	Communication protocol compatibility: CCITT
2.	Private line operation.
3.	2-Wire facility operation.
4.	Data transmission: Synchronous operation.
5.	Trellis Coded Modulation, enabled.
6.	Data rate: 9600 bit/s.
7.	Transmitter timing source: CUSTOMER = Modem receive (SLAVE) DIGIPAC® = Modem clock (INTERNAL)
8.	Transmit signal level: -12.0 dBm
9.	Constant transmit carrier. Carrier stays on independent of RTS from the DTE.
10.	Line impedance: 600 ohms.
11.	Private line handshake mode: CUSTOMER = Originate DIGIPAC® = Terminate
12.	Loss of carrier disconnect, disabled. Modem will maintain data connection when loss of received carrier is detected.

Table 4-3 Direct Access - Synchronous - 9600 bit/s CCITT Recommendation V.32 Compatible - (2-Wire) Using Trellis Coded Modulation (Page 2 of 2)

DIGIPAC® MODEM OPTIONS	
1.	Automatic answering enabled. Modem automatically answers calls and switches to data mode.
2.	Send space disconnect, enabled. Transmits 2 to 4 seconds of spaces at end of call to disconnect remote modem.
3.	Receive space disconnect, enabled. Modem disconnects upon receiving approximately 2 seconds of space signal from remote modem.
4.	Request to Send (CA/105) To Clear To Send (CB/106) delay: within 2 ms.
5.	Receive Line Signal Detector, circuit CF/109 (pin 8) turns OFF and ON in response to the OFF and ON transitions of received carrier, not forced ON.
6.	Data Terminal Ready (CD) is transitive. An OFF transition causes the modem to terminate the connection (go on-hook), then return to the command mode.
7.	DTE control of data rate via circuit CH/111 (pin 23), disabled. Terminal cannot control modem data rate.
8.	Data Set Ready (circuit CC/107) normal, indicates when modem is ready to exchange control signals with the DTE to initiate transfer of data.
9.	Data Set Ready (circuit CC/107) forced ON during Analog Loopback test.
10.	DTE control of Analog Loopback via circuit LL/141, enabled and assigned to pin 18.
11.	Modem goes off-hook (busy) when an Analog Loopback test is invoked.
12.	DTE control of Remote Digital Loopback via circuit RL/140 (pin 21), enabled.
13.	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.
14.	Test mode indication to DTE via circuit TM/142, (pin 25), enabled.
15.	Signal quality abort, enabled. Modem will initiate retrain procedures upon detection of unsatisfactory signal reception or loss of equalization.
16.	Frame and signal grounds separated by 100 ohms.

Table 4-4 Direct Access - Synchronous - 9600 bit/s CCITT Recommendation V.29 Compatible - (4-Wire)
(Page 1 of 2)

REQUIRED MODEM OPTIONS (DIGIPAC® AND CUSTOMER)	
1.	Communication protocol compatibility: CCITT V.29
2.	Synchronous operation.
3.	4-Wire Private Line operation
4.	Constant transmit carrier - PL operation.
5.	Data rate: 9600 bit/s. Fall back rate: 4800 bit/s
6.	Transmit signal level: CUSTOMER = 0.0 dBm DIGIPAC® = - 8.0 dBm
7.	Line impedance: 600 ohms.
8.	Carrier detect thresholds: Acquisition = Low (-26 to 34 dBm) Release = Low (-31 to 35 dBm)
9.	Transmitter timing source: CUSTOMER = Modem receive (SLAVE) DIGIPAC® = Modem clock (INTERNAL)
10.	Round robin retrain, enable. If receiver loses equalization, the modem interrupts the data transmission and transmits an outbound training sequence.
11.	DTE control of data rate via the CH lead (pin 23), disabled. Terminal cannot control modem data rate.
12.	Amplitude and delay compromise equalizers, disabled or set to Short Haul.

Table 4-4 Direct Access - Synchronous - 9600 bit/s CCITT Recommendation V.29 Compatible - (4-Wire)
(Page 2 of 2)

DIGIPAC® MODEM OPTIONS	
1.	Request to Send (CA/pin 4) to Clear To Send (CB/pin 5) delay: 15 ms.
2.	Signal Quality alarm to DTE (via pin 21), disabled. Not a function of the DIGIPAC® port interface lead.
3.	Train-On-Data. enabled. When receiver loses equalization, normally due to deteriorated signal quality, the receiver adaptive equalizer will attempt to retrain on incoming data.
	Anti-streaming/Anti-streaming timer, disabled. Normally disable on two point private line circuits.
4.	
	One-second adaptive equalizer and carrier detect holdover during receive carrier breaks. Modem receiver and equalizer will override receive line signal breaks of one second or less.
5.	
	Data Set Ready (CC) lead forced ON during Analog Loopback test.
6.	Analog Bilateral Loopback; enabled. Analog and Voice Frequency Loopback occur when an Analog Loopback is invoked.
7.	Digital Bilateral Loopback; enabled. A digital loopback occurs towards the facility and DTE when a Digital Loopback is invoked.
8.	Errors are not injected into the transmitted test pattern during Self-Test.
9.	DTE control of Analog Loopback via the LL lead (pin 18), enabled. A V.54 function that allows an Analog Loopback test to be performed remotely for fault isolation.
10.	Enable modem's ability to respond to Remote Digital Loopback (RDL) signal from remote modem. The modem responds to a digital loopback signal from the far end modem for fault isolation; a V.54 function.
11.	
	DTE control of Remote Digital Loopback via pin 21, enabled. A V.54 function that allows the remote modem to be placed into a digital loopback for fault isolation.
12.	Frame and signal grounds separated by 100 ohms.
13.	

Table 4-5 Direct Access - Synchronous - 2400/4800/9600 bit/s Digital - CSU/DSU Compatible - (4-Wire)
(Page 1 of 2)

REQUIRED CSU/DSU OPTIONS (DIGIPAC® AND CUSTOMER)	
1.	Data transmission: Synchronous operation.
2.	Data rate: 2400, 4800 or 9600 bit/s, according to service requested.
3.	Line impedance: 600 ohms.
4.	Transmitter timing source: CUSTOMER = Modem receive (SLAVE) DIGIPAC® = Modem clock (INTERNAL)
RECOMMENDED MODEM OPTIONS (CUSTOMER)	
1.	Enable modem's ability to respond to Remote Digital Loopback (RDL) signal from remote modem. The modem responds to a digital loopback signal from the far end modem for fault isolation; a V.54 function.

Table 4-5 Direct Access - Synchronous - 2400/4800/9600 bit/s Digital - CSU/DSU Compatible - (4-Wire)
(Page 2 of 2)

DIGIPAC® MODEM OPTIONS	
1.	Request To Send circuit C/l05 (pin 4) to Clear To Send, circuit CB/106 (pin 5) delay: 10 ms.
2.	System status, OFF. During reception of out-of-service code or no signal reception, Data Set Ready operate normally; not turned OFF.
3.	Circuit assurance, off. During reception of out-of service code or no signal reception (DCD Low), Clear-To-Send operate normally; not turned OFF.
4.	Test mode indication to DTE via circuit TM/142, (pin 25), enabled.
5.	DTE control of Remote Terminal Test via circuit CI/112 (pin 12), disabled. Circuit CI/112 (pin 12) not functional DIGIPAC® port interface lead.
6.	Data Set Ready circuit CC/107 (pin 6) forced ON during Analog Loopback test.
7.	Analog and Voice Frequency Loopback occur when an Analog Loopback is invoked. During Analog Loopback, the signal on the receive VF line will be looped back over the transmit VF line.
8.	DTE control of Analog Loopback via circuit LL/141 (pin 18), enabled. A V.54 function that allows an Analog Loopback test to be performed remotely for fault isolation.
9.	Enable modem's ability to respond to remote Digital Loopback (RDL) signal from remote modem. The modem responds to a digital loopback signal from the far end modem for fault isolation; a V.54 Function.
10.	DTE control of Remote Digital Loopback via circuit RL/140 (pin 21), enabled. A V.54 function that allows the remote modem to be placed into a digital loopback.
11.	Bilateral remote terminal testing, enabled. Remote Terminal test, bilateral digital loopback occurs (digital loopback occurs towards the facility and DTE).
12.	Frame and signal grounds separated by 100 ohms.

Table 4-6 Direct Access - Synchronous - 56000 bit/s Digital - CSU/DSU Compatible - (4-Wire)
(Page 1 of 2)

REQUIRED CSU/DSU OPTIONS (DIGIPAC® AND CUSTOMER)	
1.	Data transmission: Synchronous operation.
2.	Data rate: 56000 bit/s.
3.	Line impedance: 600 ohms.
4.	Transmitter timing source: CUSTOMER = Modem receive (SLAVE) DIGIPAC® = Modem receive (SLAVE)
RECOMMENDED MODEM OPTIONS (CUSTOMER)	
1.	Enable modem's ability to respond to Remote Digital Loopback (RDL) signal from remote modem. The modem responds to a digital loopback signal from the far end modem for fault isolation; a V.54 function.

Table 4-6 Direct Access - Synchronous - 56000 bit/s Digital - CSU/DSU Compatible - (4-Wire) (Page 2 of 2)

DIGIPAC® MODEM OPTIONS	
1.	Request to Send circuit CA/105 (pin C) to Clear to Send, circuit CB106 (pin D) delay: 10 ms.
2.	System status, off. During reception of out-of-service code or no signal reception, Data Set Ready operate normally; not turned OFF.
3.	Circuit assurance, off. During reception of out-of service code or no signal reception (DCD low), Clear-To-Send operate normally; not turned OFF.
4.	Test mode indication to DTE via circuit TM/142, (pin K), enabled.
5.	Data Set Ready circuit CC/107 (pin E) forced ON during Analog Loopback test.
6.	Analog and Voice Frequency Loopback occur when an Analog Loopback is invoked. During Analog Loopback, the signal on the receive VF line will be looped back over the transmit VF line.
7.	DTE control of analog Loopback via circuit LL/141 (pin L), enabled. A V.54 function that allows an Analog Loopback test to be performed remotely for fault isolation.
8.	Enable modem's ability to respond to Remote Digital Loopback (RDL) signal from remote modem. The modem responds to a digital loopback signal from the far end modem for fault isolation; a V.54 function.
9.	DTE control of Remote Digital Loopback via circuit RL/140 (pin BB), enabled. A V.54 function that allows the remote modem to be placed into a digital loopback.
10.	Bilateral remote terminal testing, enabled. Remote Terminal test, bilateral digital loopback occurs (digital loopback occurs towards the facility and DTE).
11.	Frame and signal grounds separated by 100 ohms.

Table 4-7 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		
2400	Synch	CCITT V.22 bis	N/A	LN1-	UG- -	02DM2.8PS.PT	02DA2..PX
		CCITT V.22 bis	N/A	LN1-	UG- -	02DM2.8PS.PT	DIGITAL**
		201C	LG- -	LN1-	UG- -	04DM2.4P.PX	04DA2..PI
		201C	LG- -	LN- -	UG- -	04DM2.4P.PX	DIGITAL**
4800	Synch	208A	LG- -	LN1-	UG- -	04DM2.5P.PX	04DA2..PI
		208A	LG- -	LN- -	UG- -	04DM2.5P.PX	DIGITAL**
		CCITT V.27	LG- -	LN1-	UG- -	04DM2.7P.PX	04DA2..PI
		CCITT V.27	LG- -	LN- -	UG- -	04DM2.7P.PX	DIGITAL**
9600	Synch	CCITT V.32	N/A	LN1-	UG- -	02DM2.9PS.PT	02DA2..PX
		CCITT V.32	N/A	LN1-	UG- -	02DM2.9PS.PT	DIGITAL**
		CCITT V.29	LG- -	LN1-	UG- -	04DM2.6P.PX	04DA2..PI
		CCITT V.29	LG- -	N/A	N/A	04DM2.6P.PX	04DB2..-X
		CCITT V.29	LG- -	LN- -	UG- -	04DM2.6P.PX	DIGITAL**

Table 4-8 NC and NCI Code Combinations - Digital Data Channel

SPEED (bit/s)	SERVICE	ACCESS PORT		NC CODE		NCI CODE CKL 1-PS	NCI CODE CKL 2-CS
		PSSP	PSN	ACCESS	NON-ACCESS		
2400	Synch	YES	YES	XA-P	US- -	04DU5.24	04DU5.24
		YES	YES			04DU5.24	DIGITAL**
4800	Synch	YES	YES	XB-P	US- -	04DU5.48	04DU5.48
		YES	YES			04DU5.48	DIGITAL**
9600	Synch	YES	YES	XG-P	US- -	04DU5.96	04DU5.96
		YES	YES			04DU5.96	DIGITAL**
56000	Synch	YES	YES	XH-P	US- -	04DU5.56	04DU5.56
		YES	YES			04DU5.56	DIGITAL**

** "Digital" indicates a digital channel interface code.

See appropriate U S WEST Technical Publication for additional information on Digital Channel Interface Codes.

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Chapter and Section **Page**

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.

CONTENTS

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 U S WEST Communications, Inc. Technical Publications

PUB 77331 *"Digital Data Over Voice Digital Access Arrangements, Network Interface Specifications"*, Issue D, July 1995.

6.9 Ordering Information

All documents are subject to change and their citation in this document reflects the most current information available at the time of printing. Readers are advised to check status and availability of all documents.

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