

U S WEST
Communications, Inc.
Technical Publication

SIMULTANEOUS VOICE DATA
SERVICE (SVDS)
(DIGITAL DATA OVER VOICE
TECHNOLOGY)

DIGITAL ACCESS ARRANGEMENT
NETWORK INTERFACE SPECIFICATIONS

NOTICE

Technical Publication 77331 defines the network interface and operational requirements for Digital Data Over Voice (DDOV) transport technology deployed in U S WEST as Simultaneous Voice and Data Service (SVDS). Availability of this channel service will be depended on both facility and tariff limitations. Consult the appropriate tariff to ascertain availability of SVDS.

SVDS is an end-to-end digital data transport service which provides simultaneous voice and full duplex data transmission of up to 19.2 kbit/s over a single, non-loaded subscriber cable pair. This service operates in conjunction with switched voice services such as single line residential or business, Centrex, etc. The voice channel connects to the subscriber line side of a serving end office switch and the derived data channel extends dedicated digital transport on same cable pair used to deliver switched voice services. SVDS accommodates point-to-point, multipoint or subrate multiplexed user requirements.

U S WEST Communications, Inc. reserves the right to revise this document for any reason, including but not limited to, conformity with standards promulgated by various governmental or regulatory agencies; utilization of advances in the state of the technical arts; or to reflect changes in the design of equipment, techniques, or procedures described or referred to herein.

Liability to anyone arising out of use or reliance upon any information set forth herein is expressly disclaimed, and no representation or warranties, expressed or implied, are made with respect to the accuracy or utility of any information set forth herein.

This document is not to be construed as a suggestion to any manufacture to modify or change any of its products, nor does this publication represent any commitment by U S WEST Communications, Inc. to purchase any specific products . Further, conformance to this publication does not constitute a guarantee of a given supplier's equipment and/or its associated documentation.

Future issues of Technical Publication 77331 will be announced to the industry at least 45 days prior to the issuance date. This notice, which will come through our standard customer notification channels, will allow the customer time to comment on the proposed revisions.

Ordering information for U S WEST Technical Publications can be obtained from the reference section of this document. If further information is required, please contact:

U S WEST Business Resources,
Manager – Information Release,
1801 California, Room 1320,
Denver, CO 80202,
(303) 298-0117.

Throughout this publication, the term U S WEST signifies U S WEST Communications, Inc.

CONTENTS

Chapter and Section	Page
1. Introduction.....	1-3
1.1 General.....	1-3
1.2 Service Overview	1-4
1.3 Purpose	1-4
1.4 RDVM Specification Disclosure	1-5
1.5 Reason for Reissue.....	1-5
1.6 Document Organization.....	1-5
1.7 Document Terminology	1-6
2. Services	2-1
2.1 Derived Data Channel.....	2-1
2.1.1 Point-to-Point (2-point)	2-1
2.1.2 Multipoint	2-2
2.1.3 Subrate Multiplexed Data	2-3
2.1.4 Interconnecting Digital Services.....	2-4
2.2 Voice Channel.....	2-4
2.2.1 Description.....	2-4
2.2.2 Foreign Dial Tone	2-4
3. NC and NCI Code Sets.....	3-1
3.1 Purpose	3-1
3.2 Network Channel Codes	3-1
3.3 Network Channel Interface Codes	3-2
4. Data Channel Service Objectives.....	4-1
4.1 Parameters	4-1
4.1.1 Error-Free Seconds	4-1
4.1.2 Errored-Second	4-1
4.2 Objectives	4-1
4.2.1 End-User to Carrier.....	4-1
4.2.2 End-User to End-User	4-1
4.2.3 Service Acceptance Limit	4-2
4.2.4 Immediate Action Limit	4-2
5. System Description	5-1
5.1 System Architecture	5-1
5.2 Overview	5-1
5.3 Transmission	5-2
5.4 Operation.....	5-2

CONTENTS (Continued)

Chapter and Section	Page
5.5 Maintenance and Testing	5-2
5.5.1 Customer Responsibilities.....	5-2
5.5.2 U S WEST Responsibilities.....	5-2
5.5.3 Data Loopback - Remote Test Capability	5-3
5.6 Summary of System Characteristics	5-3
5.6.1 Voice Channel	5-3
5.6.2 Data Channel.....	5-4
6. Subscriber Loop Characteristics.....	6-1
6.1 Operational Requirements	6-1
6.2 Provisioning Requirements	6-1
6.3 Line Impedance	6-1
6.4 Transmission Path Characteristics.....	6-2
6.5 Test Voltages	6-2
6.6 Physical Interface.....	6-2
7. RDVM Requirements.....	7-1
7.1 FCC Compliance.....	7-1
7.2 Maintenance and Network Affecting Requirements.....	7-1
7.3 Interconnect Specifications - RDVM to Telephone Set.....	7-1
7.4 Voice Channel Requirements.....	7-1
7.4.1 Switched Network Characteristics.....	7-2
7.4.2 Added Insertion Loss and Loop Resistance	7-2
7.4.3 Attenuation Distortion.....	7-2
7.4.4 Return Loss.....	7-2
7.4.5 Longitudinal Balance	7-2
7.4.6 Idle Channel Noise	7-2
7.4.7 DC Current	7-3
7.4.8 DC Voltage	7-3
7.4.9 Failure Mode and Power	7-3
7.4.10 Physical Interface	7-3
7.5 Data Channel Requirements.....	7-3
7.5.1 Active State.....	7-3
7.5.2 Idle State.....	7-3
7.5.3 Line Rate	7-4
7.5.4 Synchronization.....	7-4
7.5.5 Data Terminal Equipment (DTE) Disruption.....	7-4
7.5.6 Anti-Streaming Feature	7-4
7.5.7 Channel Polarity.....	7-4

CONTENTS (Continued)

Chapter and Section	Page
7.5.8 Data Only Mode	7-4
7.5.9 Data Throughput	7-5
7.5.10 Synchronous Data Rate Support	7-5
7.5.11 Asynchronous Data Rate Support	7-5
7.6 Receiver Requirements.....	7-5
7.6.1 Equalization Requirements.....	7-6
7.6.2 Framing Requirements	7-6
7.6.3 Timing Recovery.....	7-6
7.7 Digital Signal at the Network Interface	7-6
7.7.1 Scope.....	7-6
7.7.2 PAM Transmission.....	7-7
7.7.3 AMI Symbol Encoding	7-7
7.8 TCM Requirements	7-8
7.8.1 TCM Frame.....	7-8
7.8.2 TCM Burst	7-8
7.9 Fault Isolation Loopbacks	7-9
7.9.1 Required Loopbacks	7-9
7.9.2 Recommended Loopbacks	7-9
7.9.3 Other Loopbacks.....	7-9
8. RDVM Data Terminal Equipment Interface	8-1
8.1 Interface Recommendations.....	8-1
8.2 Recommended Data Interchange Circuits - DCE (RDVM) Source Signals.....	8-1
8.2.1 Circuit AB – Signal Ground	8-1
8.2.2 Circuit BB – Received Data	8-1
8.2.3 Circuit CB – Clear To Send.....	8-1
8.2.4 Circuit CC – DCE Ready	8-2
8.2.5 Circuit CF – Received Line Signal Detector	8-2
8.2.6 Circuit DB – Transmitter Signal Element Timing.....	8-2
8.2.7 Circuit DD – Receiver Signal Element Timing.....	8-2
8.2.8 Circuit SCB – Secondary Clear to Send as a Receive Channel..	8-2
8.2.9 Circuit TM – Test Mode.....	8-2
8.3 Recommended Data Interchange Circuits - DTE Source Signals	8-3
8.3.1 Circuit BA – Transmitted Data.....	8-3
8.3.2 Circuit CA – Request To Send	8-3
8.3.3 Circuit CD – DTE Ready.....	8-3
8.3.4 Circuit LL – Local Loopback.....	8-3
8.3.5 Circuit SCA – Secondary Request To Send as a Transmit Channel.....	8-3

CONTENTS (Continued)

Chapter and Section	Page
8.4 Network Controls	8-3
8.5 Request To Send – Clear To Send	8-4
8.6 End-to-End Data Interchange	8-4
8.7 Synchronous Operation	8-5
8.8 Asynchronous Operation.....	8-5
9. Definitions.....	9-1
9.1 Acronyms	9-1
9.2 Glossary	9-2
10. References.....	10-1
10.1 ANSI IEEE/EIA/T1 Documents	10-1
10.2 Bellcore Technical Publications.....	10-1
10.3 Bellcore Technical Advisories	10-1
10.4 Bellcore Technical References	10-2
10.5 U S WEST Technical Publication	10-2
10.6 Other Publications	10-2
10.7 Document Ordering Information.....	10-2
 Appendix	
A SVDS Companion Voice Frequency Service Type.....	A-1
 Figures	
2-1 Point-To-Point SVDS - End-User to End-User Configuration	2-1
2-2 Point-To-Point SVDS - End-User to Carrier Configuration.....	2-1
2-3 SVDS Multipoint Circuit Arrangement	2-2
2-4 Multiplexed Subrate Data Circuit Configuration	2-3
5-1 SVDS System Architecture	5-1
6-1 Network Interface - Miniature 6-Position Jack.....	6-2
7-1 PAM Transmitter Model.....	7-7
7-2 Single Transmitted Pulse Into a 135 Ω + 0.039 μ F Load.....	7-7
 Tables	
3-1 NC Codes – SVDS	3-1
3-2 NC Codes – 64 kbit/s Subrate Multiplexed (DS0-B) Channel.....	3-1
3-3 NCI Codes – SVDS.....	3-2
3-4 NCI Codes – Digital Services	3-2
8-1 DCE to DCE Control Codes	8-4
A-1SVDS Companion Switched Voice Frequency Services Cable Length and Loss Guidelines.....	A-2

1. Introduction

1.1 General

Technical Publication 77331 defines the network interface and operational requirements for Digital Data Over Voice (DDOV) transport technology deployed in U S WEST as Simultaneous Voice and Data Service (SVDS). Availability of SVDS will be dependent on both facility and tariff limitations. Consult the appropriate tariff to ascertain availability of SVDS.

1.2 Service Overview

SVDS is an end-to-end digital data transport service that operates in conjunction with switched voice services such as single line residential or business, Centrex, etc. The voice channel connects to the subscriber line side of a serving end office switch.

The data service is a full duplex digital data channel that operates at data rates of 2.4, 4.8, 9.6 and 19.2 kbit/s. This is a derived channel using the same non-loaded subscriber cable pair used to deliver the switched voice service. Data channel deriving is accomplished through the use of a Remote Data/Voice Multiplexer (RDVM) located at the customer's premises, and a companion Central office Data/Voice Multiplexer (CDVM). SVDS provides dedicated digital transport to accommodate point-to-point, multipoint or sub-rate multiplexed user requirements.

The Network Interface (NI), the interface between the U S WEST provided network and the Customer Provided Equipment (CPE) is identified in this publication as requirements of the Remote Data/Voice Multiplexer (RDVM).

The RDVM cited throughout this technical publication, and associated equipment is customer provided. Equipment designed and manufactured for connection to this service must comply with the requirements and specifications set forth in this publication.

1.3 Purpose

Technical Publication 77331, is a reference document providing technical disclosure information at the Network Interface (NI). This document technically describes U S WEST SVDS, and defines applicable Network Channel (NC) and Network Channel Interface (NCI) codes.

Sufficient technical detail is furnished to allow a customer to select a Simultaneous Voice and Data Service that meets their communications needs for a known application. This publication is not intended to provide complete design specifications for the RDVM, nor will it ensure the quality of performance of the CPE nor serve as a procurement specification.

1.4 RDVM Specification Disclosure

The RDVM design incorporates techniques for which Integrated Network Corporation (INC) holds patents. A license agreement must be procured from INC for the purpose of designing and manufacturing interoperable RDVM equipment. Complete detailed technical specifications are available from INC contingent on a license agreement.

Integrated Network Corporation
757 Route 202/206
PO Box 6875
Bridgewater, NJ
Tel: (201) 218-1600 Fax: (201) 218-0804

1.5 Reason for Reissue

- Remove Point Of Sale service description using SVDS as a transport.

1.6 Document Organization

This document is organized into ten chapters and Appendix A:

- Chapter 1, **Introduction** - addresses general concerns, service description, document purpose, reason for reissue and organization.
- Chapter 2, **Services** - identifies available derived data channel services, acceptable companion voice service types, and describes data channel interconnection.
- Chapter 3, **NC and NCI Code Sets** - provides Network Channel (NC) and Network Channel (NCI) codes for ordering SVDS.
- Chapter 4, **Data Channel Service Objectives** - defines parameters and performance objectives for the derived data service.
- Chapter 5, **System Description** - describes the overall system operation, transmission, equipment and loop facilities.
- Chapter 6, **Subscriber Loop Characteristics** - characterizes the cable pair, provisioning, transmission and physical interface requirements.
- Chapter 7, **RDVM Requirements** - details the specific RDVM characteristics required to be compatible with the U S WEST provided Central Office Data Voice Multiplexer (CDVM). This includes operational requirements and recommendations. Defines the signal at the network interface.

- Chapter 8, **RDVM Data Terminal Equipment Interface** - describes required and recommended inter-exchange circuits.
- Chapter 9, **Definitions** - provides a definition for acronyms and special terms used in this document.
- Chapter 10, **References** - lists documents referred to throughout this document, and provides document ordering information.
- Appendix A, **SVDS Companion Switched Voice Frequency Services** - lists acceptable companion switch voice service types, and provides cable length and loss guidelines.

1.7 Document Terminology

The terms "shall be" and "required" are used throughout this publication to indicate required parameters and to differentiate from those parameters that are recommendations.

2. Services

2.1 Derived Data Channel

2.1.1 Point-to-Point (2-point)

Point-to-point service provides for interconnecting two end-user's SVDS derived data channels directly within a serving central office as illustrated in Figure 2-1, or by way of an inter-office digital transport. SVDS point-to-point service may be interconnected to U S WEST Digital Data, DS1 or DS3 Service as illustrated in Figure 2-2.

The U S WEST provided data/voice multiplexer, denoted as a CDVM, presents a DS0-A interface for interconnection, per Bellcore TR-TSY-000458 or ANSI T1.107b-1991. Available data rates are 2.4, 4.8, 9.6 or 19.2 kbit/s.

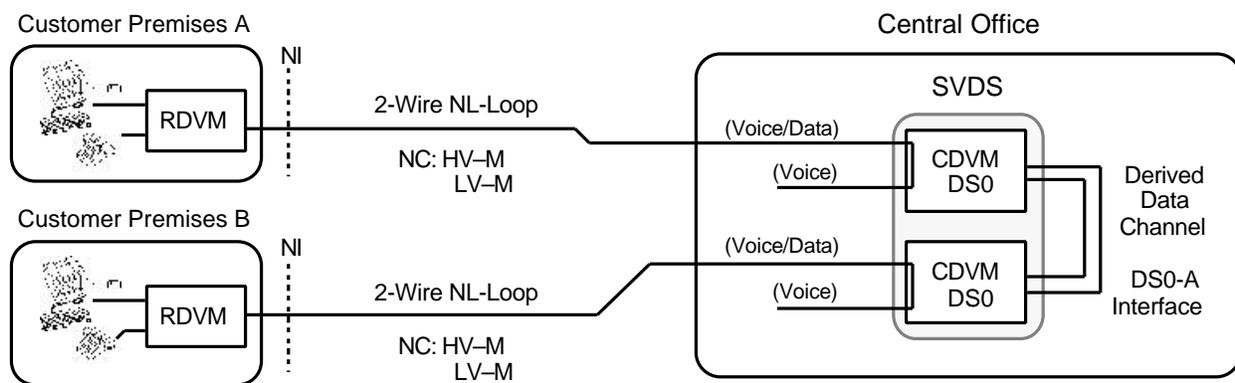


Figure 2-1 Point-To-Point SVDS - End-User to End-User Configuration

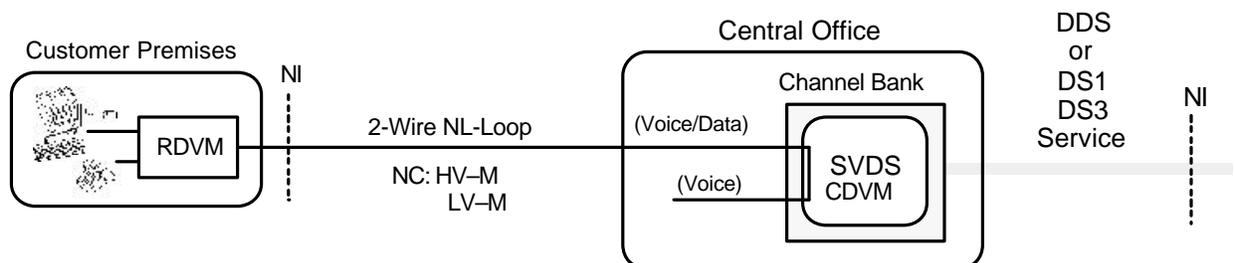


Figure 2-2 Point-To-Point SVDS - End-User to Carrier Configuration

2.1.2 Multipoint

Multipoint service provides for bridging three or more customer designated premises to form a multipoint circuit configuration. SVDS multipoint service may be combined with U S WEST Digital Data Service (DDS), that is, one or more of the links from the customer designated premises to the bridge may be via U S WEST Digital Data Service. Application of U S WEST Digital Data Service would emerge when facility transmission constraints do not permit the use of SVDS. SVDS may also be interconnected to U S WEST DS1 or DS3 Service.

SVDS derived data channels may be bridged in any U S WEST SVDS designated wire center. An end link channel transported on U S WEST Digital Data Service must be bridged in a designated U S WEST Digital Data Service hub.

The U S WEST provided data/voice multiplexer, denoted as a CDVM, presents a DS0-A interface for interconnection, per Bellcore TR-TSY-000458 or ANSI T1.107b-1991; or an interface per ANSI EIA/TIA-232-D.

Available data rates are 2.4, 4.8, 9.6 or 19.2 kbit/s. Intermixing of different data rates is not permitted. Figure 2-3 below illustrates typical multipoint SVDS circuit arrangements.

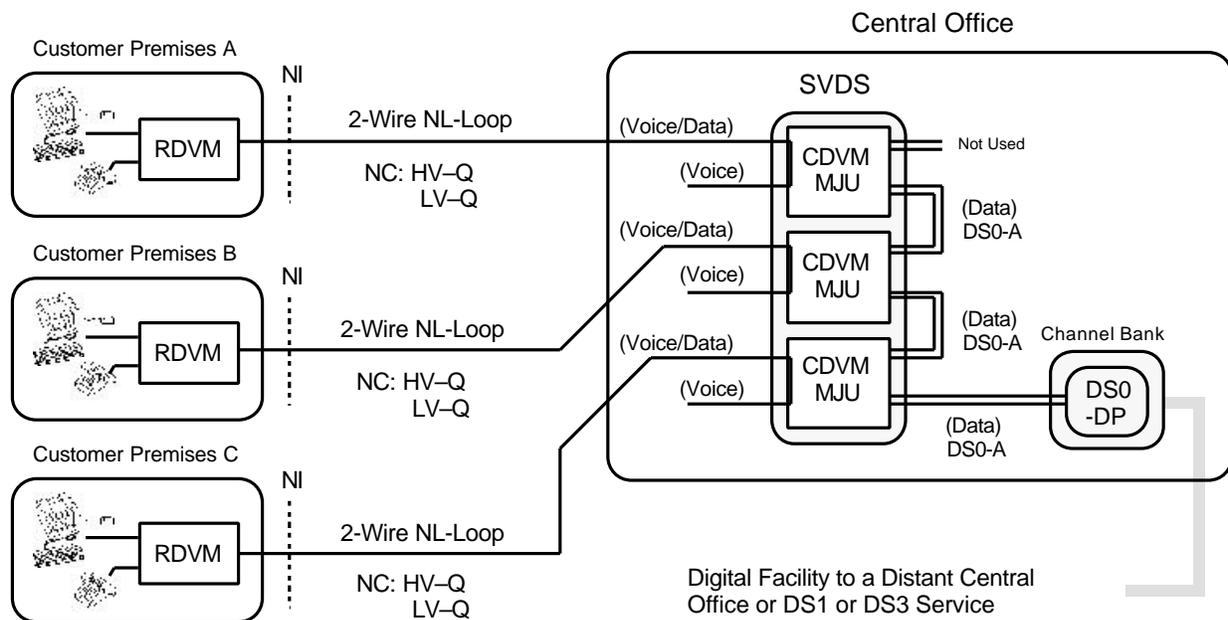


Figure 2-3 SVDS Multipoint Circuit Arrangement

2.1.3 Subrate Multiplexed Data

Subrate multiplexed data service provides for multiplexing from two to twenty individual DS0-A derived data channels into a single DS0-B channel. Up to twenty 2.4 kbit/s, ten 4.8 kbit/s, or five 9.6 derived data channels may be multiplexed into the DS0-B signal. All circuits within an individual DS0-B signal shall be the same data rate.

SVDS subrate multiplexed service may be combined with U S WEST Digital Data Service (DDS), that is, one more of the data channels from the customer designated premises to the subrate multiplexer may be via U S WEST Digital Data Service. Application of U S WEST Digital Data Service would emerge when facility transmission constraints do not permit the use of SVDS. SVDS may also be interconnected to U S WEST DS1 or DS3 Service.

SVDS derived data channels may be multiplexed in any U S WEST SVDS designated wire center. A data channel transported on U S WEST Digital Data Service must be multiplexed in a designated U S WEST Digital Data Service hub.

The U S WEST provided data/voice multiplexer, denoted as a CDVM, presents a DS0-B interface for interconnection, per Bellcore TR-TSY-000189 or ANSI T1.107b-1991. Figure 2-4 depicts a typical multiplexed circuit configuration.

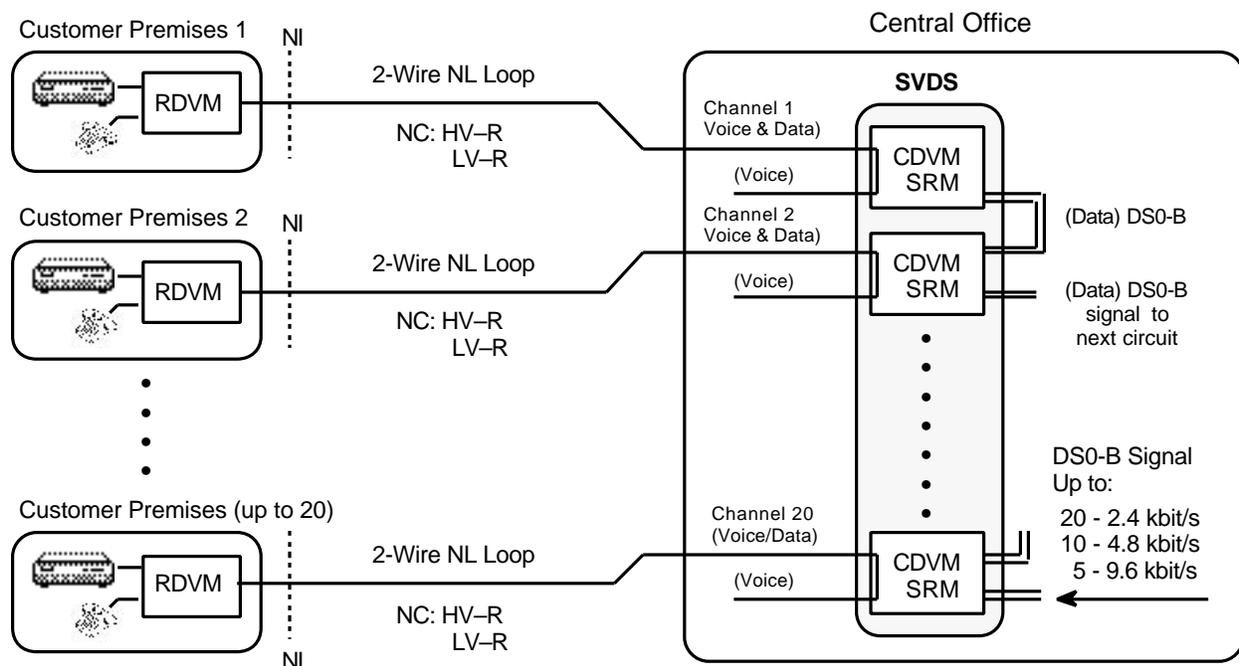


Figure 2-4 Multiplexed Subrate Data Circuit Configuration

2.1.4 Point Of Sale

Point Of Sale (POS) service, offered in U S WEST as TurboCharge ®, utilizes the subrate data multiplexing capability of SVDS. The individual derived data channel from one customer designated premises is multiplexed with up to nineteen other data channels from customer designated premises into a DS0-B channel. This DS0-B channel is then interconnected to a POS DS0-B Packet Assembler /Disassembler (PAD) which permits POS terminal equipment to communicate with Information Service Providers via Virtual Circuits supported by X.25 protocol, through the Public Packet Switched Network.

SVDS service description as defined in Section 2.1 preceding, applies to POS service, except POS service provides for a single data channel rate of 2.4 kbit/s which enables multiplexing of up to twenty data channels into a DS0-B channel. Also, combining of services and associated requirements are as defined in Section 2.1 preceding.

Figure 2-5 depicts a SVDS POS circuit configuration.

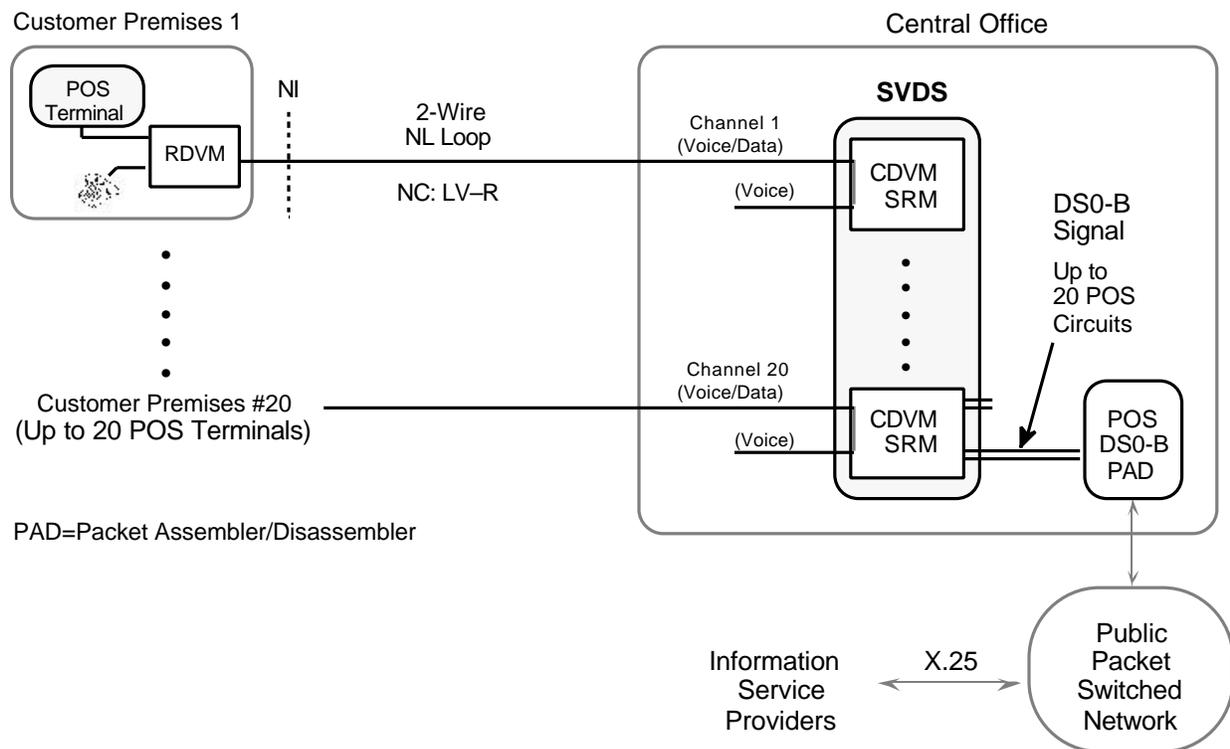


Figure 2-5 SVDS POS Circuit Configuration

2.1.5 Interconnecting Digital Services

Considerable service flexibility is available through interconnection to other U S WEST digital services. SVDS end links (customer premises to serving central office) and mid-links (control leg) may be connected to U S WEST Digital Data Service, U S WEST DS1 Service or U S WEST DS3 Service. The multiplexed substrate data aggregate output may be delivered on 64 kbit/s Digital Data Service, DS1 or DS3 Service.

An in depth description of U S WEST Digital Data Service may be gained from U S WEST Technical Publication 77312, for DS1 service refer to 77200 and for DS3 service 77324.

2.2 Voice Channel

2.2.1 Description

The SVDS operates in conjunction with single line analog switched voice services, such as single line residential, single line business , Centrex, WATS, Foreign Exchange or Foreign Central Office, etc.

Each companion voice service has specific transmission loss objectives. As a result, allowable cable loss and length for the SVDS may be restricted to comply with the companion voice service transmission parameters.

Refer to Appendix A for information on acceptable companion services types. Maximum cable length and loss for the cable gauge noted is provided for the corresponding service type as a guideline.

2.2.2 Foreign Dial Tone

When SVDS is provided on a Foreign Exchange or Foreign Central Office type service, the derived data channel is separated from the voice channel at the serving wire center, not at the dial tone office.

3. NC and NCI Code Sets

3.1 Purpose

The interface to U S WEST SVDS is described by a combination of a Network Channel Code and a Network Channel Interface Code. This chapter addresses channel codes and interface codes, that apply specifically to U S WEST SVDS service. These codes should be specified by the customer when ordering service. ANSI T1.223-1991 identifies the structure and the coded representation of the NC and NCI codes.

3.2 Network Channel Codes

The Network Channel (NC) code is a four character code that identifies the channel service, parameters and available feature options.

NC codes in Table 3-1 define the SVDS channel configurations offered by U S WEST.

Table 3-1 NC Codes – SVDS

Service Type	Inter-state/Inter-LATA NC Code	Intra-state/Intra-LATA NC Code
Point-to-Point	LV-M	HV-M
Multipoint	LV-Q	HV-Q
Subrate Multiplexed	LV-R	HV-R

The NC codes in Table 3-2 describe a 64 kbit/s subrate multiplexed channel equipped with a central office located subrate multiplexer. This arrangement multiplexes individual data channel into a DS0-B signal and delivers this signal from the subrate multiplexer to a customer designated premises as a 64 kbit/s DS0-B channel.

Table 3-2 NC Codes – 64 kbit/s Subrate Multiplexed (DS0-B) Channel

Data Rate	NC Code	Description
2.4 kbit/s	HS-A	64 kbit/s DS0-B channel multiplexed with up to 20 individual 2.4 kbit/s subrate channels.
4.8 kbit/s	HS-C	64 kbit/s DS0-B channel multiplexed with up to 10 individual 4.8 kbit/s subrate channels.
9.6 kbit/s	HS-D	64 kbit/s DS0-B channel multiplexed with up to 5 individual 9.6 kbit/s subrate channels.

3.3 Network Channel Interface Codes

The Network Channel Interface (NCI) code identifies interface specifications associated with a particular channel. The NCI code provides the means to define the physical and electrical/optical characteristics at the channel interface, thus ensuring compatibility between the network channel and the associated end-user CPE.

Table 3-3 characterizes the NCI codes for SVDS. Table 3-4 identifies applicable NCI codes for those digital services that may be combined with, or interconnected to SVDS.

Table 3-3 NCI Codes – SVDS

Service	Data Rate	NCI Code	Description
SVDS	2.4 kbit/s	02DV5.BA	Simultaneous Digital Data Over Voice Channel
	4.8 kbit/s	02DV5.BB	
	9.6 kbit/s	02DV5.BC	
	19.2 kbit/s	02DV5.BL	

Table 3-4 NCI Codes – Digital Services

Service	Data Rate	NCI Code	Description
DDS	2.4 kbit/s	04DU5.24	Single (DS0-A) Digital Data Channel
	4.8 kbit/s	04DU5.48	
	9.6 kbit/s	04DU5.96	
	19.2 kbit/s	04DU5.19	
DDS	64 kbit/s	04DU5.64	64 kbit/s Subrate Multiplexed (DS0-B) Digital Data Channel
DS1	DS1	04DJ9.++	1.544 Mbit/s Digital Transport Channel
		04DS9.++	
		04DU9.++	
DS3	DS3	04DS6.++	Digital Transport Channel
		02FCF.++	

"++" represents available frame and format options.

Refer to the appropriate U S WEST Technical Publication 77312 for U S WEST Digital Data Service, 77200 for U S WEST DS1 Service or 77324 for U S WEST DS3 Service.

4. Data Channel Service Objectives

U S WEST SVDS is a high quality and reliable service; to ensure this quality and reliability, service limit and objectives have been established. These parameters and their objectives are characterized below.

4.1 Parameters

4.1.1 Error-Free Seconds

Error-Free Seconds (EFS) are one-second intervals that do not contain any bit-errors, usually expressed as a percentage over a consecutive 24-hour period. EFS is used as a parameter for digital services since these errors tend to occur in bursts.

4.1.2 Errored-Second

An Errored-Second is a one second interval with one or more bit errors. A reciprocal of Error-Free-Seconds.

4.2 Objectives

4.2.1 End-User to Carrier

End-User to Carrier service (NI to Point Of Presents) EFS objective, while in service, will perform at a monthly average level equal to or greater than 99.8 percent EFS, and not more than 173 errored seconds (ES) per day.

4.2.2 End-User to End-User

End-User to End-User service (NI to NI) EFS objective, while in service, will perform at a monthly average level equal to or greater than 99.5 percent EFS, and not more than 432 ES per day. This is based on two derived data end links and one mid-link.

Data Channel Objective Summary

Segment	Parameter and Objective	
End-User to Carrier	EFS =99.8%	<ES 173 per day
End-User to End-User	EFS =99.5%	<ES 432 per day

4.2.3 Service Acceptance Limit

Service Acceptance Limit – SVDS will be considered to be acceptable for turn-up when there are no errors within a 15-minutes period while performing a data channel loopback test. If one error occurs within this 15-minutes period, the test will continued for an addition 15-minutes period and there may be no more than two errors in the total time of 30 minutes, while performing a data channel loopback test.

4.2.4 Immediate Action Limit

Immediate Action Limit – SVDS will be considered to be operating at an unacceptable level of error performance, and corrective action will commence when the performance of a 15-minute channel loopback test results in the observation of more than one bit errors.

5. System Description

5.1 System Architecture

The SVDS system consists of two principle units as shown in Figure 5-1:

1. A Central Office Data Voice Multiplexer (CDVM), located in a U S WEST serving dial tone central office. The CDVM provides for interconnection to other services via a standard DS0 interface, as described in ANSI T1.107b-1991 or, via a EIA-232-D interface as described in ANSI/EIA-232-D-1986.
2. A Remote Voice Multiplexer (RDVM) normally collocated with the subscriber Data Terminal Equipment (DTE). The RDVM interfaces the SVDS channel and is *Customer Provided Equipment (CPE)*. Typically, the RDVM provides an EIA-232-D or an equivalent interface for interconnect to DTE.

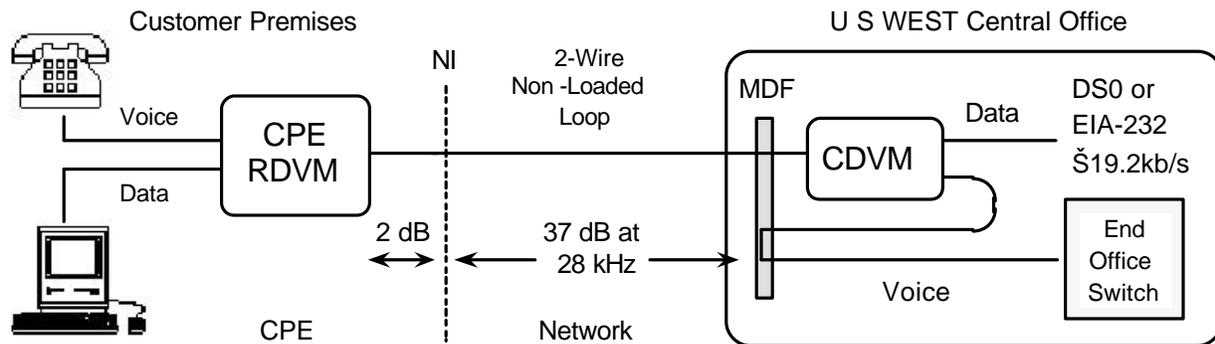


Figure 5-1 SVDS System Architecture

5.2 Overview

The SVDS system, as depicted in Figure 5-1, is a transparent transmission system that provides simultaneous voice and data transmission over a single, non-loaded copper, or and equivalent subscriber cable pair.

The voice section of the SVDS system provides a voice frequency channel (bandwidth approximately 4 kHz) that connects to the subscriber line side of end office switches presently deployed in U S WEST central offices. Signaling on the voice channel is by switch hook, dial pulses, dual tone multifrequency, loop start, ground start, and ringing generator. Failure of or loss of power to the CDVM or RDVM will not interrupt the voice connectivity or call processing.

The data section of the service provides a transparent synchronous transmission channel (bit-in, bit-out) for digital pulses with rates up to and including 19.2 kbit/s. The data channel is multiplexed above the 0 Hz to 4 kHz band of the voice channel employing a technique of Time Compression Multiplexing that operates independent of the voice channel. The CDVM and RDVM receivers use a lowpass filter in the voice frequency path to isolate the energy in the voice channel from energy at higher frequencies, including energy resulting from transmission on the data channels.

5.3 Transmission

A full-duplex asynchronous or synchronous protocol transparent data transmission, concurrent with full-duplex baseband voice operation over a non-loaded cable facility is provided. The data path supports synchronous and asynchronous serial data rates up to and including 19.2 kbit/s, and provides a transmit and receive clock for synchronous transmission at all standard rates of 2.4, 4.8, 9.6 and 19.2 kbit/s.

5.4 Operation

The SVDS system operates over a non-loaded telephone subscriber cable pair, which may be mixed of gauge copper wire or equivalent, and up to 18,000 feet in length. The practical operating cable length is limited to about 16,800 feet to maintain voice and data transmission quality. See Appendix A for additional information.

SVDS channel service is activated when power is applied to the RDVM. No additional signaling is required to establish the data transmission path. The SVDS subscriber line carries synchronous baseband digital information and the RDVM is synchronized onto the network clock of the incoming data (looped-timed).

The RDVM must disable its transmit carrier if it cannot detect incoming data from the CDVM. When no incoming data is detected, the RDVM free runs until the incoming data clock is available.

5.5 Maintenance and Testing

5.5.1 Customer Responsibilities

The customer is responsible for all equipment and cable on the customer side of the Network Interface at their location. The customer or their agent should sectionalize trouble to verify it is not in the customer's owned equipment or cable before reporting the trouble conditions U S WEST. Joint testing between U S WEST and the customer may be necessary to effectuate fault location.

5.5.2 U S WEST Responsibilities

U S WEST is responsible for all equipment and facilities on the network side of the NI at the customer locations and for maintaining U S WEST provided transmission facilities between serving central offices.

5.5.3 Data Loopback - Remote Test Capability

The SVDS system is capable of remote testing by way of three data loopback arrangements:

- One is an Office Channel Unit (OCU) loopback that is located at the closest point to the customer's loop within the CDVM and is used to determine the "well-being" of the CDVM.
- The second is a Channel Service Unit (CSU) loopback that is located at the closest point to the customer's loop within the RDVM and is used to determine the "well-being" of the loop.
- The third is a Data Service Unit (DSU) loopback that is located at the closest point to the Customer's DTE within the RDVM and is intended to determine the "well-being" of the RDVM itself.

All three loopbacks can be invoked from the network by sending appropriate loopback code. The loopback schemes and code patterns are defined in ANSI T1.107b-1991.

5.6 Summary of System Characteristics

5.6.1 Voice Channel

Frequency Band	200 to 4000 Hz	
Impedance at the NI	600 ohms + 2.15 μ F	
Added Insertion Loss	Less than 0.9 dB at 1004 Hz	
Added Message Noise	Less than 8 dBmnc	
Added DC Resistance	Less than 100 ohms	
Attenuation Distortion	400 to 2800 Hz: within 0.5 dB of loss at 1004 Hz 2800 to 3300 Hz: within 1.0 dB of loss at 1004 Hz	
Longitudinal Balance (through CDVM & RDVM)	200 Hz = = 74 dB 500 Hz = = 71 dB	1000 Hz = = 65 dB 3000 Hz = = 58 dB
Echo Return Loss (through CDVM & RDVM)	ERL 500 to SRL 200 to SRL 2500 to	2500 = 14 dB 500 = 10 dB 3200 = 10 dB
Ringer Equivalent Number	Less than 2	
Signaling	Loop or ground start (see ANSI T1.401-1993)	
Call Processing	Same as the public switched network (see ANSI T1.401-1993)	
Network Interface	Miniature 6-position RJ11C or 50-position RJ21X jack	

5.6.2 Data Channel

Central Office Electrical Interface	DS0 or EIA-232-D
Payload Data Rates	2.4, 4.8, 9.6 and 19.2 kbit/s Asynchronous or Synchronous
Impedance at the NI	135 – 146 ohms + 0.039 μ F at 28 kbit/s
Signal Level	12.5 \pm 1 dBm into 135 ohms, 3.5 V peak voltage
System Range	43 dB at 28 kHz
Operating Range	39 dB at 28 kHz
System Transmission Rate	56 kbit/s synchronous
Loop Transmission Format	2-wire baseband Time Compression Multiplexing
System Transmission Format	Digital, bipolar-shaped pulse, burst-mode transmission, 2.5 ms burst
Frequency Band	10 kHz to 112 kHz
Clock Source	Composite clock traceable to a Primary Reference Source (Ref.: ANSI T1.101-1987)
Line Equalization	Automatic

6. Subscriber Loop Characteristics

6.1 Operational Requirements

The RDVM should be designed to operate over a non-loaded, twisted cable pair, with a minimum wire size of 26 gauge copper or equivalent and a maximum length of 18,000 feet. The following subscriber loop characteristics must be supported:

- The non-loaded loop may be 26, 24, 22, or 19 gauge wire, or a mix of those gauges, with a length range of 0 to 18,000 feet.
- Cumulative bridged tap of up to 6000 feet with a random configuration. Any single bridged tap may not exceed 2000 feet.
- A loop loss may not exceed 43 dB at 28 kHz into a 135 ohms termination.

6.2 Provisioning Requirements

The dynamic operating range of the SVDS access line is limited to a loss of 39 dB at 28 kHz between the CDVM and RDVM. This is to ensure reliable error performance and spectrum compatibility with other services. Hence, SVDS system provisioning requirements are as follows:

- The non-loaded loop loss, plus bridged tap loss between the CDVM and Network Interface [NI], is limited to 37 dB at 28 kHz into a 135 ohms termination.
- Two decibels (2 dB) of the system operating range is allocated to the customer between the NI and the customer provided RDVM for their cabling losses.
- The maximum allowable cumulative bridged tap is limited to 6000 feet. Any single bridged tap may not exceed 2000 feet.

As a reference, a loop loss of 37 dBm at 28 kHz equates to 15,400 feet of 26 single gauge cable, or 16,800 feet of mixed gauge cable (11,600 feet of 26 plus 5,200 of 24 gauge).

6.3 Line Impedance

The nominal impedance of the line, at the Nyquist frequency of 28 kHz, is considered to be 135 ohms resistive. All sections in this publication which reference loop loss, receiver sensitivity, etc., require that measurements and calculations use this nominal value.

6.4 Transmission Path Characteristics

Network transmission characteristics, considerations and performance are addressed in Technical Publication 41005 and TR-TSY-000507. Transmission characteristics at the network interface for the voice service are addressed in TA-NPL-000912.

6.5 Test Voltages

Voltages applied to the loop at the central office for testing with the station equipment on-hook, may reach a maximum of ± 200 volts DC between the tip and ring, or between either conductor and ground. AC maintenance testing signals of up to 10 volts rms may also be applied from either tip-to-ring, tip-to-ground or ring-to-ground, in the frequency range of 5 to 1000 Hz. This does not include ringing voltage which could be as high as 150 volts rms at frequencies of 15 to 68 Hz. See ANSI T1.401-1993 for a detailed description of test voltages.

6.6 Physical Interface

The subscriber cable pair terminate on a miniature 6-position RJ11C jack or 50-position RJ21X jack located on the subscriber premises. Specifications for these jacks are defined in Technical Publication 47102 or Federal Communication Commission (FCC) Rules and Regulations, Part 68, Subpart F, Section 68.500.

The miniature 6-position jack is shown schematically in Figure 6-1. This jack is equipped with six contacts, the center two contacts (positions 4 and 3) are used for the Tip and Ring.

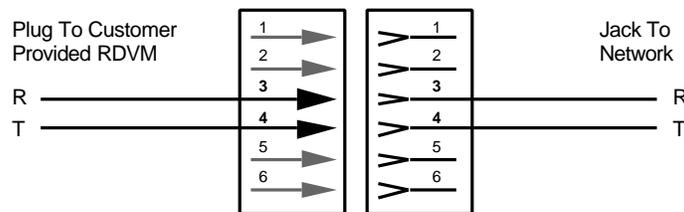


Figure 6-1 Network Interface - Miniature 6-Position Jack

7. RDVM Requirements

7.1 FCC Compliance

Criteria appearing in this publication which are requirements under Part 68 of the FCC's Rules and Regulations are not verbatim reproductions but may excerpt or paraphrase the relevant section(s). In the event that requirements more stringent than those in this Technical Publication are part of or adopted in Part 68, the latter must take precedence.

7.2 Maintenance and Network Affecting Requirements

The RDVM shall not impair, or interfere with the operation of and existing network systems. These include, but are not limited to:

- Mechanized Loop Testing
- Digital Subscriber Loop Carrier
- Digital Subscriber Line using 2B1Q line code (Bellcore TR-NWT-000393)
- DDS and TI transport system
- All central office switching systems (e.g., analog or digital stored program control and electro-mechanical type switching system)

Information on these transports and switching systems may be obtained through customer information letters and technical publications available from the manufacture. Relevant technical information may also be available from Bellcore and U S WEST.

7.3 Interconnect Specifications - RDVM to Telephone Set

The connecting terminals shall meet the specifications for miniature plugs and jacks stated in Technical Publication 47102. Connection to the network must be made in accordance with the applicable state tariffs. The manufacturer should be capable of providing a length of cable equipped with a plug consistent with these tariffs. It is the responsibility of the RDVM manufacturer to specify the appropriate jack and plug.

7.4 Voice Channel Requirements

The RDVM is connected to the tip and ring of the physical voice circuit and interposed between the network and voice communication equipment as illustrated in Figure 5-1. When connected the RDVM it must not degrade the voice frequency transmission or interfere with signaling and supervision. Voice frequency transmission objectives stipulated in U S WEST and state requirements, must be maintained in concert with employing SVDS and inter-positioning the RDVM in the voice path.

Effectuating the criteria advocated following will lessen the degree in which the RDVM will impact voice frequency transmission, signaling and supervision.

7.4.1 Switched Network Characteristics

The voice channel shall meet all current requirements under ANSI T1.401-1993 for switched voice service. This document addresses network signals, call-processing, disconnect and connect procedures at the network interface.

7.4.2 Added Insertion Loss and Loop Resistance

The added insertion loss to the voice path caused by the RDVM should be less than 0.45 dB at 1004 Hz. The added series DC loop resistance should not exceed 50 ohms.

7.4.3 Attenuation Distortion

The insertion loss of the RDVM at 400 Hz and at 2800 Hz should be within -0.2 dB to +0.8 dB of the loss at 1004 Hz.

These measurements are made with a signal level of 0 dBm and with a source impedance of 900 ohms and meter impedance of 600 ohms.

7.4.4 Return Loss

To prevent "singing" and to minimize the voice service degradation due to echo, the RDVM input impedance should be equal to the reference impedance of either a 600 ohms resistor or 600 ohms resistor in series with a 2.16 μ F capacitor.

The deviation of input impedance from the reference impedance is measured in terms of return loss.

Requirements: 200 to 3200 greater than 3.5 dB
 500 to 2500 greater than 7.0 dB

7.4.5 Longitudinal Balance

Compliance with longitudinal balance requirements and objectives is necessary for protection against excessive metallic circuit noise caused by the conversion of longitudinal voltages.

Requirements: 200 Hz = = 74 dB 1000 Hz = = 65 dB
 500 Hz = = 71 dB 3000 Hz = = 58 dB

When measurements are performed in accordance with ANSI/IEEE Std 455-1985.

7.4.6 Idle Channel Noise

The overall voice idle channel noise may not exceed 20 dB_{BrnC}, therefore it is important the RDVM contribute limited additional noise.

Requirements: Additional idle channel noise should not exceed 5 dB_{BrnC}.

7.4.7 DC Current

At the Network Interface during addressing and communication call-processing states, the network provides a minimum of 20 ma Direct Current (DC) loop current into a 430 ohm termination under "Normal Power Available" condition and a minimum of 18 ma under "Commercial Power Outage" condition. Reference for the preceding is ANSI T1.401-1993.

7.4.8 DC Voltage

The idle-state network tip-to-ring DC voltage at the network interface shall be in the range from 0 to 105 volts. Minimum tip-to-ring voltage should be no less than 21 volts DC at the network interface with 5 M Ω across the tip and ring.

Network abnormalities may result in switch-initiated maintenance conditions that remove the line voltage until the abnormal condition is corrected and the line restored by the network. Consequently, network voltage shall not be used to power the RDVM.

7.4.9 Failure Mode and Power

The failure mode refers to state when the RDVM is not operational due to a fault condition or power loss in the RDVM. The RDVM when in a failure mode must not affect normal telephone operation. The RDVM must be powered locally; power is *not* provided via the network interface.

7.4.10 Physical Interface

The RDVM connects to the Tip and Ring leads of the subscriber loop pair through a miniature 6-position RJ11C jack or 50-position RJ21X. Specifications for these jacks are defined in the FCC Rules for Regulations, Part 68, Subpart F, Section 68.500.

7.5 Data Channel Requirements

7.5.1 Active State

When either the RDVM or CDVM is transmitting customer payload data, the digital stream will be considered to be in the active state. The RDVM must be designed to be a Layer 1 type device, hence, all data codes must be transmitted during this state.

7.5.2 Idle State

The RDVM must transmit a control code during the idle state and data codes during the data mode state. Normally, a Control Mode Idle (CMI) code is transmitted during the idle state. These control codes relative to the particular state of the RDVM to DTE interchange circuits, as well as network requirements, are defined in Section 8.6.

7.5.3 Line Rate

The local loop runs as a full-duplex 19.2 kbit/s synchronous data link using Time Compression Multiple (TCM) technology with a line bit rate of 56 kbit/s. The data is transmitted constantly with a control mode idle code normally transmitted during the idle state.

7.5.4 Synchronization

The transmit data of the RDVM must be synchronized to the incoming data from the CDVM located in the central office. The CDVM is synchronized to composite clock traceable to a primary reference source. The CDVM acts as the master and initiates synchronization to the RDVM, which is optioned for Receiver Timing.

7.5.5 Data Terminal Equipment (DTE) Disruption

Should the connection between the RDVM and the user's DTE be disrupted, or the user's DTE not be powered, the RDVM shall send within 200 milliseconds after detection of the disruption of the DTE, a steady Control Model Idle (CMI) code to the CDVM for the duration of that situation.

7.5.6 Anti-Streaming Feature

An option for enabling an anti-streaming feature is recommended. This option limits data transmission from the DTE to 27-seconds after assertion of Request To Send (RTS). After 27-seconds, the RDVM transmits CMI until the DTE toggles RTS OFF then ON. This feature is normally used in multipoint circuits to prevent a faulty DTE from monopolizing the network, and as a result, disabling the entire multipoint network.

7.5.7 Channel Polarity

Should a tip and ring reversal between the RDVM and CDVM occur, the RDVM transceiver must be capable of automatically detecting and correcting this situation. This will allow the RDVM to begin its burst with the first mark, having the same polarity as the first mark coming from the CDVM.

7.5.8 Data Only Mode

The Data Only option provides for data channel operation without providing the voice channel operation. When activated, the DC path must be terminated in a manner to allow a range of 10 to 30 milliamperes of sealing current with -48 volts applied to the loop from the serving US WEST central office. In the Data and Voice mode of operation, the DC termination is provided by the voice channel station equipment.

7.5.9 Data Throughput

Based on the structure of the TCM Burst Rate of 400 times per second and associated Data Word structure of eight data words per burst and six data bits (not counting control bits), the effective throughput capability of the SVDS data channel is 19.2 kbit/s. When operating at less than 19.2 kbit/s, Data Words are concatenated to match the desired rate as noted below.

7.5.10 Synchronous Data Rate Support

The RDVM shall be capable of supporting four possible synchronous data rates within the TCM transmission. These include: 2.4, 4.8, 9.6 and 19.2, kbit/s. The transmission of data rates less than 19.2 kbit/s shall be accomplished by concatenating the data in the following manner:

- 2.4 kbit/s – Each Data Word shall be sent eight times
- 4.8 kbit/s – Each Data Word shall be sent four times
- 9.6 kbit/s – Each Data Word shall be sent two times

7.5.11 Asynchronous Data Rate Support

The RDVM shall be capable of supporting four asynchronous data rates within the TCM transmission. These include:

- 2.4 kbit/s
- 4.8 kbit/s
- 9.6 kbit/s
- 19.2 kbit/s

To support these rates, the RDVM must be capable of stripping/inserting the start and stop data bits, and mapping/demapping the data bits to/from the synchronous data rates described above. In all cases, the synchronous rate used must be greater than or equal to the asynchronous rate to ensure proper framing.

7.6 Receiver Requirements

The receiver must be able to equalize the frequency dependent attenuation caused by the cable loop, frame the incoming bursts from the CDVM, perform timing recovery and perform data recovery. The source impedance of the transmitter shown in Figure 7-1 acts as the load impedance of the receiver.

7.6.1 Equalization Requirements

The receiver must equalize for non-loaded cable with a nominal shunt capacitance of 0.083 micro-Farad per mile. Cables of 19, 22, 24, or 26 gauge may be mixed in any given loop. The equalizer must be able to accommodate a practical range of 26 gauge cable or the equivalent loss of 39 dB at 28 kHz. Cable having nominal DC resistance of up to 1300 ohms will be encountered. Since the system supports single line residential or business, Centrex, etc. and other switched voice services, and the cable must be non-loaded, cable length will not exceed 18,000 feet.

Bridged taps up to 6,000 feet in length (total of all taps) with no single bridged tap exceeding 2000 feet may be encountered, and must be supported by the equalization circuit. The system shall be expected to equalize cable with loss up to 8.0 dB at 1004 Hz or 39 dB at 28 kHz.

7.6.2 Framing Requirements

The RDVM must frame the incoming burst from the CDVM. Frame synchronization shall occur in less than 500 milliseconds. During the time synchronization takes place, the RDVM shall refrain from sending any transmit bursts. Once synchronization is established, the RDVM may initiate its transmit bursts. The synchronization algorithm must minimally be sufficiently robust to maintain synchronization under the worst case subscriber loop conditions.

7.6.3 Timing Recovery

In synchronous operation, the RDVM must supply timing to the Data Terminal Equipment (DTE) through the EIA interface. In this mode, the RDVM's recovered clock must meet the requirements specified in ANSI T1.410-1992.

7.7 Digital Signal at the Network Interface

7.7.1 Scope

This section specifies the digital transmission requirements at the network interface. Both the transmit and receive signal are specified. Data transmission in SVDS uses baseband Pulse Amplitude Modulation (PAM) signaling in conjunction with Alternate Mark Inversion (AMI) encoding. In this sense, the transmission scheme is similar to digital data services transmission outlined in ANSI T1.410-1992.

Also addressed in this section is how full-duplex data transmission is achieved on a single wire pair through a Time Compression Multiplexing (TCM) scheme running 400 frames per second. Finally, to eliminate data signal energy in the voice frequency (VF) band, the shape used for data transmission is coded as specified later in this chapter.

7.7.2 PAM Transmission

Figure 7-1 shows the model of the transmitter to be used with the PAM transmission. Both the CDVM and RDVM transmit PAM burst at the rate of 400 Hz (referenced to the serving office clock). The transmission is fully symmetric, that is, each direction uses the same pulse shape and an identical format (explained later in this section). $V(t)$ represents the spectrum of the signal when the data is random.

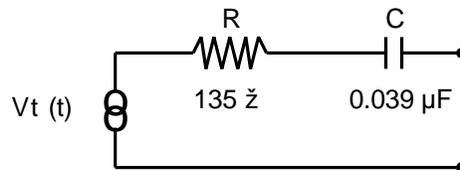


Figure 7-1 PAM Transmitter Model

7.7.3 AMI Symbol Encoding

If the AMI data burst to be transmitted is $[a_0, a_1, a_2, a_3, \dots, a_N]$, where a_i is either -1 , 0 or $+1$ in accordance with the rules of AMI and if the raw data burst to be transmitted is $[|a_0|, |a_1|, |a_2|, |a_3|, \dots, |a_N|]$, and if the bit rate is $1/T$ Hz (nominally 56 kbit/s), then the transmit signal must be:

Where: $p(t)$ is the single pulse as shown in Figure 7-2

$$V_t(t) = \sum_{i=0}^N a_i \cdot p(t-iT)$$

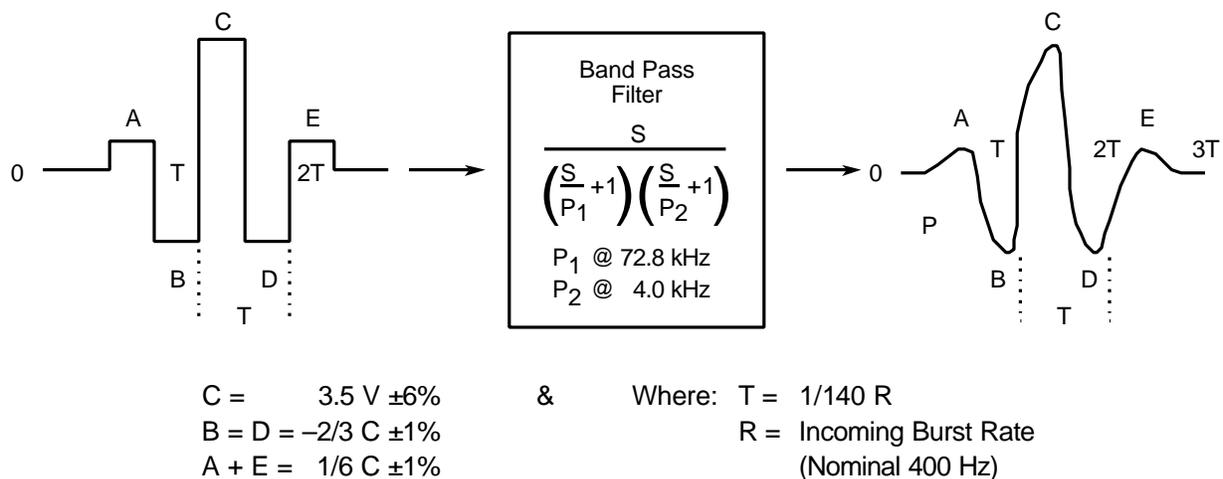


Figure 7-2 Single Transmitted Pulse Into a 135 Ω + 0.039 μF Load

7.8 TCM Requirements

7.8.1 TCM Frame

The RDVM must support a TCM frame that is composed of two TCM bursts:

1. a transmitted burst, and
2. a received burst.

Each TCM frame must be 2.5 milliseconds long with a frame rate of 400 Hz. It is required that during normal operation, (i.e., when both ends of a data circuit are synchronized), one TCM burst is received and transmitted every frame. The RDVM must transmit its burst within 4 to 10 bit periods (approximately 71 to 178 microseconds) after receipt of an incoming burst from the CDVM.

7.8.2 TCM Burst

The bit rate of a TCM burst is 56 kbit/s and must be synchronized with the network composite clock. Each TCM burst or frame is sent as shown below and is composed of three basic parts:

1. The Headershown as "**H**"
2. The Data Wordshown as "**DW**"
3. The Tail.....shown as "**T**"

| H | DW1 | DW2 | DW3 | DW4 | DW5 | DW6 | DW7 | DW8 | T |

- **TCM Burst Header** – The TCM burst header is two bits long and both bits are always set to a "1" (mark).
- **TCM Burst Data Word** – The TCM data portion carries customer data and is 56 bits long. The 56 bits are grouped into eight seven-bit words. Each word is composed of six data bits and a control bit with the first bit being the most significant and the control bit being the least significant bit within each Data Word. Therefore, the structure for each eight Data Words within a TCM Burst would be:

| dddddd | Where: d = a single bit of customer data, and
 c = the control bit

- **TCM Burst Tail** – The TCM burst tail is composed of two bits:
 1. The first bit is a parity bit, used to produce even parity;
 2. The second bit is the last bit of the frame which is always set to "1" (mark).

The even parity ensures that the whole burst (including header and tail) has an even number of marks. This guarantees zero DC per burst.

```
|.....TCM Burst.....|  
11 | dddddd | P1
```

- **Control Bit** – The seventh bit of every Data Word must correspond functionally to the network control bit described in ANSI document T1.107b-1991. The structure of the received and transmitted bursts must be the same. The bit rate of a TCM signal is 56 kbit/s and is synchronous to the network clock.

7.9 Fault Isolation Loopbacks

7.9.1 Required Loopbacks

The RDVM shall be capable of supporting CSU and DSU *non*-latching loopbacks described in ANSI document T1.107b-1991. These loopbacks shall be activated when either a CSU or DSU loopback code, as applicable, is received from the network. Network control codes for *non*-latching loopbacks are:

CSU code	0101000	DSU code	0101100
----------	---------	----------	---------

7.9.2 Recommended Loopbacks

It is strongly recommended that the RDVM be equipped with both a Latching Local Loopback (toward the DTE) and a Network Digital Loopback (toward the network), capable of being activated manually. These latching loopbacks are often desired by our service users.

7.9.3 Other Loopbacks

Support for other digital in-band and network control arrangements are permitted as long as their operation is non-interfering, and/or compatible with the 64 network controls described in ANSI document T1.107b-1991 or Bellcore Technical Reference TR-TSY-000476.

8. RDVM Data Terminal Equipment Interface

8.1 Interface Recommendations

It is the vendor responsibility to select the type of Data Terminal Equipment (DTE) interface to be supported by the RDVM. However, the SVDS system access is designed to support the end-to-end American National Standards Institute (ANSI) Electronics Industries Association (EIA) ANSI/EIA-232-D data interchange functions. The RDVM should support an ANSI/EIA-232-D and subset RS-232-C interface where the RDVM is Data Communication Equipment (DCE) and the customer's data terminal is DTE. The recommended physical interface and mechanical characteristics for the RDVM is also addressed in the ANSI/EIA-232-D standard.

The functionality noted in this chapter is primarily based on the ANSI/EIA-232-D requirements necessary to provide single channel dedicated, channel switched and packet switched data communication links. This chapter also defines the bit format for supporting this functionality on an end-to-end basis for asynchronous and synchronous applications via the SVDS data channel.

8.2 Recommended Data Interchange Circuits - DCE (RDVM) Source Signals

The RDVM, functioning as DCE, should be capable of generating the following data interchange signals:

8.2.1 Circuit AB – Signal Ground

Circuit AB establishes a common ground reference potential for all interchange circuits. Proper operation of interchange circuits requires the presents of a signal ground path between the circuits grounds of the equipment at each end of the interconnection. The signal ground interchange circuit shall be connected to the circuit ground which shall be connected to protective ground in accordance with EIA-422-A requirements.

8.2.2 Circuit BB – Received Data

Signals on circuit BB are generated by the RDVM in response to data received from the remote DTE via the SVDS data channel, or by the RDVM in response to maintenance or control signals from the local DTE.

8.2.3 Circuit CB – Clear To Send

Signals on this circuit are generated by the RDVM to indicate that the RDVM is ready to transmit data to the CDVM via the SVDS channel. When required criteria has been met, the (CTS) function must be held active unless the TCM link loses synchronization, a CSU or DSU loopback is received from the network, or one of the following control codes is received from the network: 111lx0; where "x" can be either a 0 or 1 bit.

8.2.4 Circuit CC – DCE Ready

Signals on circuit CC indicate the status of the RDVM to the DTE. That is, an ON state indicates the RDVM is connected to the data channel, is powered up, and is not in loopback. When required criteria has been met, circuit CC must be held ON unless the TCM link loses synchronization or a CSU or DSU loopback is received from the network.

8.2.5 Circuit CF – Received Line Signal Detector

Circuit CF signals the DTE that the RDVM is receiving a suitable TCM signal as established by the manufacture. When required criteria is met, circuit CF must be held ON unless the TCM link loses synchronization, a CSU or DSU loopback is received from the network, or one of the following control codes is received from the network; 1111xx0; where "x" can be either a 0 or 1 bit.

8.2.6 Circuit DB – Transmitter Signal Element Timing

Circuit DB provides the DTE with transmit signal element timing information from the network. The recovered clock presented on circuit CC must meet the requirements specified in ANSI T1.410-1992.

8.2.7 Circuit DD – Receiver Signal Element Timing

Circuit DD provides the DTE with receive signal element timing information from the network. The recovered clock presented on circuit DD must meet the requirements specified in ANSI T1.410-1992.

8.2.8 Circuit SCB – Secondary Clear to Send as a Receive Channel

Circuit SCB functions as a Receive Channel interchange circuit to provide an inband channel for unique system implementations requiring an additional end-to-end control signal to signal the DTE that the remote DTE is ready to transmit data. The state of circuit SCB follows the state of the Transmit Channel interchange circuit SCA at the remote end.

When implement and required criteria has been met, circuit SCB must be held ON unless the TCM link loses synchronization, a CSU or DSU loopback is received from the network, or one of the following control codes is received from the network; 111xx10; where "x" can be either a 0 or 1 bit.

8.2.9 Circuit TM – Test Mode

The ON state of Circuit TM indicates to the DTE that the RDVM is in a test condition. Circuit TM must be in the ON state during a local loopback, digital loopback, remote digital loopback, CSU or DSU loopback (initiated from the network).

8.3 Recommended Data Interchange Circuits - DTE Source Signals

The RDVM should be capable of receiving and reacting to the following data interchange signals from the DTE:

8.3.1 Circuit BA – Transmitted Data

Circuit BA accepts serial binary data from the DTE and is processed by the RDVM for transmission on the SVDS channel to the CDVM and remote DTE.

8.3.2 Circuit CA – Request To Send

Signals on circuit CA are generated by the DTE to indicate the DTE is ready to transmit data. A transition from OFF to ON instructs the RDVM to enter the transmit mode for sending data over the SVDS channel. The capability to synthesize RTS or apply a permanent signal to RTS circuit is necessary for situations where the DTE does not provide a RTS signal.

8.3.3 Circuit CD – DTE Ready

Signals on circuit CD are transmitted by the DTE to prepare the RDVM for data transmission over the SVDS channel and maintains the connection established by external means. The capability to synthesize DTE Ready or apply a permanent signal to DTE Ready circuit is necessary for situations where the DTE does not provide a DTE Ready signal.

8.3.4. Circuit LL – Local Loopback

Signals on circuit LL are generated by the DTE to initiate or control the local loopback condition. When circuit LL is ON, the RDVM should disconnect from the loop and perform a local loopback at the network interface toward the DTE.

8.3.5 Circuit SCA – Secondary Request To Send as a Transmit Channel

Circuit SCA functions as a Transmit Channel interchange circuit to provide an inband channel for unique system implementations requiring an additional end-to-end control signal, to signal the remote DTE that data is ready to be transmit. The state of circuit SCA is mirrored by the Receive Channel interchange circuit SCB at the remote end. Circuit SCA must be held ON by the DTE , when implemented, before data can be transmitted.

8.4 Network Controls

As noted in section 7.8.2, the TCM burst must contain eight words of seven bits each. These seven bits consist of six data bits followed by a network control bit. When the control bit is set to one, the six data bits contain customer data. When the control bit is set to zero, the six data bits represent one of 64 network control codes. Additional information on these controls can be found in ANSI document T1.107b-1991.

8.5 Request To Send – Clear To Send

The transition from idle to data mode may replace a number of initial data bits with bits from the idle sequence. To prevent losing customer data due to this transition, the RDVM should have an option for RTS to CTS operation and delay. When this option is selected, the EIA-232 CTS circuit changes state in response to change of state of the RTS circuit. When the RTS circuit is turned on, there shall be a delay before the CTS circuit turns on to prevent the customer from transmitting data until after the transition interval. The delay shall be long enough for the RDVM to transmit a start-up pad of at least 6 bits of data at the customer data rate into the network before the customer starts to transmit actual data. This will allow for a sufficient idle to data mode transition interval.

8.6 End-to-End Data Interchange

The DTE must hold, or the RDVM must force, DTE Ready, Request-To-Send and Transmit Channel if implemented, states active (ON) in order to transmit data. If any of these leads are inactive (OFF), a DCE-to-DCE control code indicating the status of these leads must be sent to the CDVM. The DCE-to-DCE control codes are as follows:

Table 8-1 DCE to DCE Control Codes

DTR	RTS	TRMT CH	Code
off	off	off	1111110
off	off	on	1111100
off	on	off	1111010
off	on	on	1111000
on	off	off	1110110
on	off	on	1110100
on	on	off	1110010

Control Mode Idle (CMI) code is required in certain applications such as multipoint circuits where it is used for supervisory control purpose. The RDVM shall have an option that causes the RDVM to transmit the CMI code (1111110) towards the network, in lieu of those noted in Table 8-1, when the EIA-232 Request-To-Send (RTS) circuit is OFF, independent of the state of the DTE Ready (DTR) and Transmit Channel (SCA) interchange circuits.

8.7 Synchronous Operation

The RDVM operates at four synchronous bit rates: 2400, 4800, 9600 and 19200 bit/s. It must generate a clock element at the bit rate that is frequency-locked to the TCM burst rate. This clock element is placed on EIA circuits DB and DD.

The RDVM accepts data from the DTE on the BA circuit (Transmitted Data) aligned with clock DB. The RDVM should arbitrarily split the data into six-bit chunks that are packed into the first six bits of the seven-bit TCM words described in Chapter 7 of this publication.

The RDVM must hold the BB circuit (Received Data) to a mark condition if a control code is received from the CDVM. Otherwise, the six data bits from the received seven-bit word are sequentially placed on the BB circuit aligned to clock circuit DD.

8.8 Asynchronous Operation

The RDVM operates at four asynchronous bit rates: 2400, 4800, 9600 and 19200 bit/s. It does this by converting the asynchronous data to/from synchronous data operating at one of the four rates described above. During asynchronous operation, the signal element timing circuits DD and DB should be set to a mark condition.

The asynchronous data must have the following format:

- one start bit (space)
- an eight-bit byte
- one stop bit (mark)

The CDVM or RDVM places no interpretation on the eight-bit byte, thus, these bits may be used for parity bits and/or additional stop bits-with the remaining bits containing customer data. When no customer data is available for transmission, an eight-bit synchronization character must be repeatedly sent on the synchronized SVDS channel. This character is B1111110, where: the "B" bit is used to signal a break condition by setting the "B" bit to a one when a break is received on circuit BA (Transmitted Data).

When a synchronous character with a "B" bit set to one is received, the circuit BB (Received Data) should be set to space until a data character is received or a synchronous character with the "B" bit set to zero is received.

When data bytes received from the BA circuit and sent to the CDVM are concatenated, a zero must be inserted after every group of five ones in order to avoid sending a synchronization character. In the reverse direction, the zero which appears after every five ones must be discarded before dividing the bits up into the eight-bit bytes. Received synchronization characters are used to identify byte boundaries.

9. Definitions

9.1 Acronyms

AMI	Alternate Mark Inversion
ANSI	American National Standards Institute
CDVM	Central Office Data/Voice Multiplexer
CMI	Control Mode Idle
CPE	Customer Provided Equipment
CSU	Channel Service Unit
CTS	Clear-To-Send
DC	Direct Current
DCE	Data Circuit-Terminating Equipment
DDS	Digital Data Services
DDOV	Digital Data Over Voice
DS0	Digital Signal Zero
DSR	DCE Ready
DSU	Data Service Unit
DTE	Data Terminal Equipment
DTR	DTE Ready
EFS	Error-Free Seconds
EIA	Electronic Industries Association
ERL	Echo Return Loss
ES	Errored Seconds
EU	End-User
FDX	Full Duplex
IAL	Immediate Action Limit
INC	Integrated Network Corporation
LATA	Local Access and Transport Area
LL	Local Loopback
MDF	Main Distributing Frame
MLT	Mechanized Loop Testing
NC	Network Channel
NCI	Network Channel Interface
NI	Network Interface
OCU	Office Channel Unit

PAD	Packet Assembler/Disassembler
PAM	Pulse Amplitude Modulation
POS	Point of Sale
RDVM	Remote Data/Voice Multiplexer
RTS	Request-To-Send
SAL	Service Acceptance Limit
SRL	Singing Return Loss
SCA	Secondary Request-To-Send (Received Channel)
SCB	Secondary Clear-To-Send (Transmitted Channel)
SVDS	Simultaneous Voice Data Service
TCM	Time Compression Multiplexing
VF	Voice Frequency

9.2 Glossary

Alternate Mark Inversion (AMI)

A one (mark) pulse which is the opposite polarity as its predecessor.

American National Standards Institute (ANSI)

An organization supported by the telecommunications industry to establish performance and interface standards.

Asynchronous Transmission

Not synchronous: Data transmission in which the time of occurrence of specified significant instant of a data bit (usually the leading edge) is arbitrary, and occurs without necessarily having a fixed time relationship to preceding comparable instants.

Attenuation Distortion

The change in attenuation with frequency relative to the attenuation at a reference frequency; the reference frequency is 1004 Hz unless otherwise specified.

Bandwidth

The range of frequencies that contain most of the energy or power of a signal; also, the range of frequencies over which a circuit or system is designed to operate.

Bit (Binary Digit)

A binary unit of information. It is represented by one of two possible conditions, such as the value 0 or 1, on or off, high potential or low potential, conducting or not conducting, magnetized or demagnetized. A Bit is the smallest unit of information, by definition.

Byte

A consecutive number of bits usually constituting a complete character or symbol. If the length of the byte is not specified, it is conventionally assumed to have a length of 8-bits. In the Digital Data System, a byte refers to an arbitrary group of 8 consecutive bits; it does not correspond to a byte of customer data.

Carrier

An organization whose function is to provide telecommunications services. Examples are: Local Exchange Carriers, Interexchange Carriers, Cellular Carriers, etc.

Central Office (CO)

A local switching system (or a portion thereof) and its associated equipment located at a wire center.

CCITT

An abbreviation for Consultative Committee on International Telephone and Telegraph; an international standards group now known as the International Telecommunications Union.

CDVM

An abbreviation for the data/voice multiplexer located in the central office.

Channel

An electrical or photonic, in the case of fiber optic based transmission systems, communications path between two or more points of termination.

Channel Service Unit (CSU)

This unit provides regeneration of the signal received from the network, controls the pulse shape and amplitude for transmission of the signal into the network, and possibly provides loop-back. The CSU function is frequently found within a Data Service Unit (DSU).

Control Mode Idle (CMI)

A bipolar violation sequence used to indicate that a terminal does not have data to transmit.

Customer

Denotes any individual, partnership or corporation who subscribes to the services provided by U S WEST Communications, Inc. Customers are divided into two distinct and separate categories: (1) carriers, who provide interexchange services for hire for others, and (2) end-users, who request services only for their own use.

Customer Premises

Denotes a building or portion(s) of a building occupied by a single customer or end-user either as a place of business or residence. Adjacent buildings and the buildings on the same continuous property occupied by the customer and not separated by a public thoroughfare, are also considered the customer's premises.

Customer Provided Equipment (CPE)

Equipment owned and maintained by the customer and located on their side of the End-User Point of Termination (EU-POT) network interface.

dBm

A decibel in which the reference power is one milliwatt.

dBmC

Weighted noise power in dBm measured by a noise measuring set with C-Message weighting.

DS0-A

A DS0 signal that carries data for only one signal.

DS0-B

A DS0 signal that carries data multiplexed from several subrate signals.

Data Circuit-Terminating Equipment (DCE)

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

Data Service Unit (DSU)

Digital, customer premises equipment used to recover timing from a baseband BPRZ signal, and which converts from BPRZ line signals to a business machine interface signal such as V.35. The DSU usually contains circuitry to recognize, and respond to, loop-back commands from the serving test center.

Data Terminal Equipment (DTE)

A generic term for customer terminal equipment that connects to the network through a modem or through digital Network Channel Terminating Equipment (NTCE), i.e., a computer or a PBX.

Decibel (dB)

A unit measurement of transmission loss, gain, or relative level. It is the logarithmic unit of signal power ratio most commonly used in telephony. It is used to express the relationship between two signal powers, usually between two acoustic, electrical, or optical signals; it is equal to ten times the common logarithm of the ratio of the two signal powers.

Digital Data Hub

A U S WEST designated serving wire center at which bridging, multiplexing, test access, cross-connecting functions are performed.

Digital Data Service (DDS)

Generically describes digital data service offering at 64 kbit/s and below.

End Office Switch

The term "End Office Switch" denotes a U S WEST switching system where local exchange services are terminated for purposes of interconnection to other exchange services or trunks. Included are Remote Switching modules and Remote Switching Systems served by a host office in a different wire center.

End-User (EU)

The term "end-user" denotes any customer of telecommunications service that is not a carrier, except that a carrier shall be deemed to be an "end-user" to the extent that such carrier uses a telecommunications service for administrative purposes without making such service available to others, directly or indirectly. The term is frequently used to denote the difference between a Carrier interface and an interface subject to unique regulatory requirements at non-Carrier customer premises (FCC Part 68, etc.).

Error Free Second (EFS)

A one-second interval which does not contain any bit-errors; usually expressed as a percentage over a consecutive 24-hour period.

Full Duplex (FDX)

Simultaneous transmission in both directions between two points.

Immediate Action Limit (IAL)

The bound of acceptable performance and the threshold beyond which U S WEST Communications, Inc. will accept a customer's trouble report and take immediate corrective action.

Insertion Loss

Insertion loss is the ratio (expressed in dB) of the power delivered to a specified load at the receiving interface by a specified source at the transmitting interface to the power delivered by the same source directly to an identical load.

Line

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

Line-Side Connection

Denotes a connection of a transmission path to the dial tone side of a switching system.

Local Access and Transport Area (LATA)

A geographic area for the provision and administration of communications service. It encompasses designated exchanges that are grouped to serve common social, economic and other purposes.

Longitudinal Balance (Longitudinal-to-Metallic)

The Longitudinal balance of any circuit is an expression, in dB, of the ratio of the longitudinal voltage (E_1) to the metallic voltage (E_m): $\text{Balance (dB)} = 20\log (E_1/E_m)$ where E_1 is the voltage measured "tip and ring to ground", and E_m is the voltage measured across the tip and ring.

Loopback

An out-of-service test procedure applied to a full duplex channel that causes a received signal to be returned to the source.

Map

Map or mapped is to establish a correspondence between the elements of one set and the elements of another set.

Multiplexer (Mux)

An equipment unit that performs multiplexing which is a technique of modulating (analog) or interleaving (digital) multiple, relatively narrow bandwidth channels into a single channel having a wider bandwidth (analog) or higher bit-rate (digital). The term Multiplexer implies the demultiplexing function is present to reverse the process.

Network Channel (NC) Code

The Network Channel (NC) code is an encoded representation used to identify both switched and non-switched channel services. Included in this code set are customer options associated with individual channel services, or feature groups and other switched services.

Network Channel Interface (NCI) Code

The Network Channel Interface (NCI) code is an encoded representation used to identify five (5) interface elements located at a Point of Termination (POT) at a central office or at the Network Interface at a customer location. The Interface code elements are: Total Conductors, Protocol, Impedance, Protocol Options, and Transmission Level Points (TLP). (At a digital interface, the TLP element is not used.)

Network Interface (NI)

The point of demarcation on the customer's premises at which U S WEST's responsibility for the provision of service ends.

Off-Hook

The supervisory state indicative of the active (in use) condition.

On-Hook

The supervisory state indicative of the idle condition.

Packet Switched Network

A switched network that provides connection for forwarding standard data packets between user parties.

Parity

Parity is a coding scheme that adds a bit so that the total of all "one" or "mark" bits in an array will always be either even (even parity) or odd (odd parity). This permits detection of bit groups that contain single errors. It may be applied to characters or blocks.

Parity Check

The process of checking received data to determine if the correct parity has been received. If the total of "one" or "mark" bits is not odd or even depending on the system being used, an error has occurred.

Premises

Denotes a building or portion(s) of a building occupied by a single customer or end-user either as a place of business or residence.

Pulse Amplitude Modulation (PAM)

Modulation in which the modulating wave is caused to amplitude modulate a pulse carrier.

Return Loss

Denotes a measure of the similarity between the two impedances at the junction of two transmission paths. The higher the return loss, the higher the similarity.

Ringer Equivalence

A numeric indicator which is an inverse function of on-hook impedance and resistance, called the Ringer Equivalence Number (REN). All registered terminal equipment which can affect on-hook impedance and resistance is assigned a REN. The sum of all such REN's on a given telephone line shall not exceed 5, but may be fewer depending on the ringer voltage source and the facility serving the line. (FCC Part 68.321)

Service Acceptance Limit (SAL)

The maximum deviation from a design parameter that is allowed at service turn-up or customer acceptance.

Serving Wire Center

The term "Serving Wire Center" denotes a U S WEST Communications, Inc. Central Office from which dial tone for the local Exchange Service would normally be provided to the demarcation point on the property at which the customer is served.

Signaling

The transmission of information to establish, monitor, or release connections and/or provide Network Control.

Start Bit

In asynchronous transmission, the first bit in a 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 of character, normally a mark condition, which serves to return the line to its idle or rest state.

Synchronous Transmission

A transmission process such that between any two significant instants in the overall bit-stream there is always an integral number of unit intervals.

Time Compression Multiplexing (TCM)

A process of interleaving two or more bit streams. As defined for the SVDS application, the TCM is used to transfer the signaling plus data information by alternately time interleaving bursts of data in the transmit and receive directions (sometimes called Ping-Pong scheme).

10. References

10.1 ANSI IEEE/EIA/T1 Documents

ANSI T1.101-1987 American National Standards Institute (ANSI) *Telecommunications – Synchronization Interface Standards for Digital Networks*

ANSI T1.107b-1991 American National Standards Institute (ANSI) *Digital Hierarchy – Supplement to Formats Specifications (synchronous digital data format)* A supplement to ANSI T1.107-1988

ANSI T1.223-1991 American National Standards Institute (ANSI) *Information Interchange - Structure and Representation of Network Channel (NC) and Network Channel Interface (NCI) Codes for the North American Telecommunications System*

ANSI T1.401-1993 American National Standards Institute (ANSI) *Interface Between Carriers and Customers Installations – Analog Voice Grade Switched Access Lines Using Loop-start and Ground-start Signaling*

ANSI T1.410-1992 American National Standards Institute (ANSI) *Carrier-to Customer Metallic Interface – Digital Data at 64 kbit/s and Subrates*

ANSI/IEEE
of
Std 455-1985 *IEEE Standard Test Procedure for Measuring Longitudinal Balance of Telephone Equipment Operating in the Voice Band*

ANSI/EIA-
232-D-1986 *Interface Between Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange*
November 1986

ANSI/EIA-
Circuits
422-A-1978 *Electrical Characteristics of Balanced Voltage Digital Interface*

10.2 Bellcore Technical Publications

PUB 41005 *Data Communications Using The Switched Telecommunications Network*, May 1971.

PUB 47102 *Miniature Plugs and Jacks*, December 1982.

10.3 Bellcore Technical Advisories

Technical Advisories (TA) are documents that describe preliminary view of proposed generic requirements. These preliminary views are subject to change and are likely to be superseded by revised versions known as Technical References (TRs).

TA-NPL-000912 *Compatibility Information for Telephone Exchange Service*
Issue 1, February 1989

10.4 Bellcore Technical References

- TR-TSY-000189 *Generic Requirements For The Subrate Multiplexer*, Issue 1, April 1986
- TR-NWT-000393 *Generic Requirements for ISDN Basic Access Digital Subscriber Lines*
Issue 2, January 1991.
- TR-TSY-000458 *Digital Signal Zero, "A" (DS-0A 64 kb/s) Systems Interconnection*
Issue 1, December 1989
- TR-TSY-000476 *Network Maintenance: Access and Testing OTGR: Section 6.5*
Issue 1, May 1992
- TR-TSY-000507 *Transmission LSSGR - Section 7*, Issue 4, June 1990.

10.5 U S WEST Technical Publication

- 77200 *U S WEST DS1 Service, Network Channel and Network Channel Interface Code Combinations*, Issue B, August 1993
- 77312 *U S WEST Digital Data Services, Technical Product Description, Transmission Parameters Limits, and Interface Combinations*
Issue C, March 1992
- 77324 *U S WEST DS3 Services*, Issue C, April 1993

10.6 Other Publications

Federal Communications Commission *Code of Federal Regulations 47, Part 68*

10.7 Document 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.

ANSI/EIA and T1 documents may be obtained from:

American National Standards Institute
Attention: Customer Service
11 West 42nd Street
New York, NY 10036
Phone: (212) 642-4900
Fax: (212) 302-1286

ANSI/IEEE documents may be obtained from:

Global Engineering Documents
2805 McGraw Avenue
Irvine, CA 92714
Phone: (800) 854-7179
Fax: (714) 261-7892

Bellcore Technical Advisory (TA), Technical Publications (PUB) and Technical Reference (TR) documents may be obtained from:

Bellcore Customer Service
8 Corporate Place
Piscataway, NJ 08854-4156
Phone: (800) 521-2673 (within U.S.A. & Canada)
(908) 699-5800 (for other calls)
Fax: (908) 336-2559

FCC "Rules and Regulations" may be purchased from:

Superintendent of Documents
Government Printing Office
Washington, D.C. 20402
Phone: (202)738-3238

U S WEST Technical Publications may be obtained from:

Faison Office Products Company
3251 Revere Street, Suite 200
Aurora, CO 80011
Phone: (800) 777-3672
Fax: (303) 340-1905

Ordering Information for Employees of U S WEST Communications, Inc.

Manager - IRM
1801 California St., Rm. 1340
Denver, CO 80202
Phone: (303) 297-7620

A. SVDS Companion Voice Frequency Service Type

Listed in Table A-1 are the Service Types, and there associated cable limits, suitable for deployment of digital data over voice technology.

Loop Facility Requirements

- A single, non-loaded, twisted cable pair, single or mixed 26, 24, 22 or 19 gauge wire.
- Maximum allowable cumulative bridged tap: 6000 feet. A single bridged tap may not exceed 2000 feet.

Voice Frequency (VF) Service Requirements

- Maximum cable loss is based on intra-exchange service except for foreign exchange service.
- Maximum cable loss reduced by 0.5 dB to compensate for the data/voice multiplexer loss.
- Expected loss objective for each Service Type not exceeded.
- VF service code and first modifier is LVS, when interconnected to a *inter*-state tariffed access service.
- VF service code and first modifier is HVS, when interconnected to a *intra*-state tariffed service.

Simultaneous Voice and Data Service (SVDS) Requirements

- Maximum non-load cable loss, plus bridged tap between the Central Office data/voice multiplexer and the Network Interface (NI): 37 dB at 28 kHz into 135 Ω.
- Two decibels at 28 kHz are allocated to our customer between the NI and the customer's provided data/voice multiplexer.

NOTES for Table A-1 :

- ι Maximum allowable non-loaded cable loss including bridged tap, between the Network Interface and Serving Central Office, measured at 1004 Hz into a 900 ohm termination. Indicated value reflects compensation for switching system and data/voice multiplexer loss, as appropriate.
- ι Non-loaded loop design limits: 18 kft, 1300 ohms and 8.0 dB at 1004 Hz.
- ↪ A prototypical 2-gauge (26 & 24) 1300 ohm loop design.
- ∨ Improved or enhanced transmission performance identified by the following USOCs:
USOC: THPVD applies to Service Codes: DO, LS & TK
USOC: VGA applies to Service Codes: DO, LS & TK
USOC: TEN applies to Service Code: CL
- f Service Code available in specific state tariffs as Basic Exchange Service.
- ~ Circuit design limited to D4 or D5 FXS channel unit. SVDS loop connects to FXS channel unit.
- ? Service code "LS" describes a 1FB, 1MB, 1FR or 1MR with improved or enhanced transmission performance.

- « Allowable NCI code: 02LS2. Equivalent Service Codes: CL, FX, WO, WX.
- » Allowable NCI code: 02GS2. Equivalent Service Codes: DO, TK, WI, WS.

Table A-1 SVDS Companion Switched Voice Frequency Services Cable Length & Loss Guidelines

Service Type & Service Code		Maximum Cable Loss (dB) @ 1004 Hz ζ	28kHz Loss	Equivalent NL Cable Length (Ft)		
				26 ga	24 ga \jmath	26+24ga \rceil
Flat Business Line	1FB	7.5	37.0	15,400	20,300	11,600+5,200
Measured Business Line	1MB	7.5	37.0	15,400	20,300	11,600+5,200
Flat Residence Line	1FR	7.5	37.0	15,400	20,300	11,600+5,200
Measured Residence Line	1MR	7.5	37.0	15,400	20,300	11,600+5,200
Centrex Central Office Line	CL	4.5 Improved v	24.8	10,400	13,500	n/a
		7.5 Basic f	37.0	15,400	20,300	11,600+5,200
Direct Out Dial	DO	3.5 Improved v	19.7	8,300	11,000	n/a
		7.5 Basic f	37.0	15,400	20,300	11,600+5,200
Foreign Exchange Line	FX	3.5 ~ (ICL:5.0)	19.7	8,300	11,000	n/a
Local Service	LS	3.5 Improved v ?	19.7	8,300	11,000	n/a
Feature Group A (Oregon)	SB	3.5 ~ (ICL:5.0)	19.7	8,300	11,000	n/a
WATS Access Line-Standard	SE	7.5	37.0	15,400	20,300	11,600+5,200
WATS Access Line-Improved	SF	3.5	19.7	8,300	11,000	n/a
Local PBX Trunk	TK	3.5 Improved v	19.7	8,300	11,000	n/a
		7.5 f	37.0	15,400	20,300	11,600+5,200
Voice Line-Switched (VG32)	UC	3.5 ~ « Fex	19.7	8,300	11,000	n/a
		5.0 «	27.0	11,300	14,600	n/a
Voice Trunk-Switched (VG33)	UD	5.0 »	27.0	11,300	14,600	n/a
800 Service Trunk	WI	7.5	37.0	15,400	20,300	11,600+5,200
WATS Line (Out)	WO	7.5	37.0	15,400	20,300	11,600+5,200
WATS Trunk (Out)	WS	7.5	37.0	15,400	20,300	11,600+5,200
800 Service Line	WX	7.5	37.0	15,400	20,300	11,600+5,200
WATS Trunk (Two-Way)	WY	7.5	37.0	15,400	20,300	11,600+5,200
WATS Line (Two-Way)	WZ	7.5	37.0	15,400	20,300	11,600+5,200