ETSI TS 101 524 V1.4.1 (2006-02)

Technical Specification

Transmission and Multiplexing (TM); Access transmission system on metallic access cables; Symmetric single pair high bitrate Digital Subscriber Line (SDSL)

[ITU-T Recommendation G.991.2 (2005), modified]

Reference
RTS/TM-06041

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access, adaption, basic, coding, digital, HDSL, IP, ISDN, local loop, PSTN, rate, SDSL, subscriber, transmission, xDSL

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The present document is partly based on the T1E1 HDSL2 specification. In turn, the ITU-T Recommendation G.991.2 (G.shdsl) annex B text was largely based on earlier versions of the present document. Efforts have been made to ensure that the ITU G.shdsl and ETSI SDSL work items were kept in line. To facilitate this alignment this revision of the present document was produced as an endorsement of ITU-T Recommendation G.991.2 (2005) with modifications and additions.

Endorsement Notice

The present document, in conjunction with ITU-T Recommendation G.991.2 (2005) provides the specification for Symmetric single pair high bitrate Digital Subscriber Line (SDSL):

NOTE: The current revision of ITU-T Recommendation G.991.2 consists of four documents:

- ITU-T !
- Recommendation G.991.2, December 2003.
- ITU-T Recommendation G.991.2, Amendment 1, July 2004.
- ITU-T Recommendation G.991.2, Amendment 2, December 2004.
- ITU-T Recommendation G.991.2, Amendment 3, September 2005.

Global modifications to G.991.2

Replace throughout the entire document G.991.2 the terms and abbreviations as shown in the table below

Terminology and Nomenclature in G.991.2	Terminology and Nomenclature as Modified by ETSI TS 101 524
Central Office	Network Side
SHDSL	SDSL
Single-Pair High-bit-rate DSL	Symmetric single pair high bit rate Digital Subscriber Line
STU	TU
SHDSL Transceiver Unit	SDSL Termination Unit
STU-C	LTU
STU at the Central Office	Line Termination Unit
STU-R	NTU
STU at the Remote End	Network Termination Unit
TC-PAM	UC-PAM
Trellis Coded Pulse Amplitude Modulation	Ungerboeck Coded Pulse Amplitude Modulation
TCM	UCM
Trellis Coded Modulation	Ungerboeck Coded Modulation

Clause 2 "References"

Add the following references:

[15] ETSI TS 101 135: "Transmission and Multiplexing (TM); High bit-rate Digital Subscriber Line (HDSL) transmission systems on metallic local lines; HDSL core specification and applications for combined ISDN-BA and 2 048 kbit/s transmission".

[16] ETSI TS 102 080: "Transmission and Multiplexing (TM); Integrated Services Digital Network (ISDN) basic rate access; Digital transmission system on metallic local lines".

[17] ETSI EN 300 012-1: "Integrated Services Digital Network (ISDN); Basic User-Network Interface (UNI); Part 1: Layer 1 specification".

[18] ETSI EN 300 001: "Attachments to the Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN".

[19] ETSI EN 300 019 (all parts): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

[20] ETSI EN 300 386: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements".

[21] ITU-T Recommendation K.20 (2003): "Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents".

[22] ITU-T Recommendation K.21 (2003): "Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents".

[23] ITU-T Recommendation O.9 (1999): "Measuring arrangements to assess the degree of unbalance about earth".

[24] ETSI EG 201 185: "Terminal support interface for harmonized analogue PSTN terminals".

[25] ANSI/INCITS 4-1986: "Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)".

[26] ETSI TS 101 012: "Transmission and Multiplexing (TM); Broadband Access Digital Section and NT functional requirements".

[27] ITU-T Recommendation G.704 (1998): "Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels".

[28] IETF RFC 2495: "Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types".

[29] ETSI TBR 021: "Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling".

[30] ATM Forum Specification, AF-PHY-0086.001: "Inverse Multiplexing for ATM (IMA) Specification".

[31] ETSI EN 300 347-1: "V interfaces at the digital Local Exchange (LE); V5.2 interface for the support of Access Network (AN); Part 1: V5.2 interface specification".

[32] ETSI ETS 300 297: "Integrated Services Digital Network (ISDN); Access digital section for ISDN basic access".

[33] ISO/IEC 13239 (2002): "Information technology; Telecommunications and information exchange between systems; High-level data link control (HDLC) procedures".

[34] ITU-T Recommendation K.44 (2003): "Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents - Basic Recommendation".

[35] ITU-T Recommendation K.45 (2003): "Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents".

Clause 4 "Reference models"

Append to this clause the new clauses 4.4 and 4.5.

4.4 Physical reference configuration

Figure 4.4 shows the reference configuration of an SDSL transmission system.

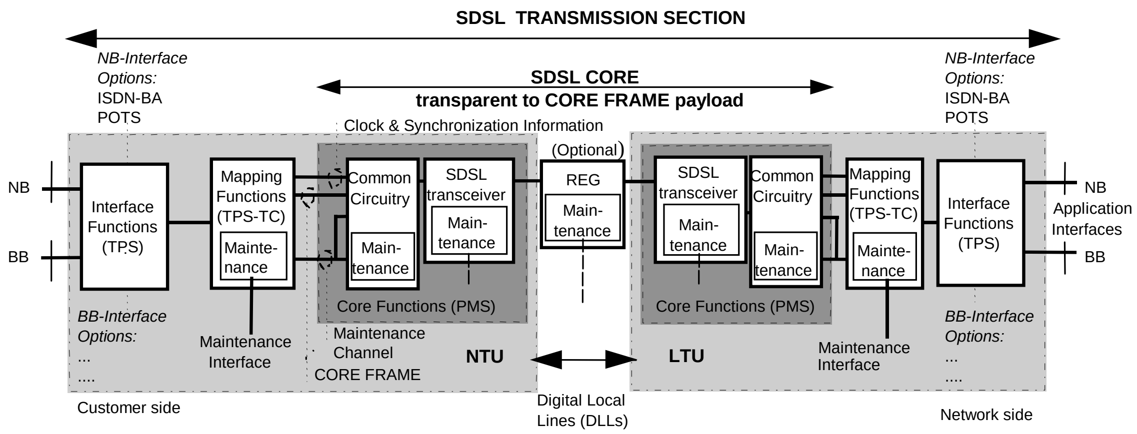

Figure 4-4: Protocol reference model

The reference configuration provides for a bi-directional symmetrical channel with a variable bit rate that is under the control of the network management system of the operator. In the optional M-pair mode the distribution of the aggregate bitstream to the M SDSL core systems is carried out by the TPS-TC functionality of the mapping functions which are specified for the different applications in annex E. An option is provided for transporting an independent narrowband channel. The narrowband channel shall be able to carry an ISDN-BA whose clock domain is not necessarily the same as that of the rest of the channel. The narrowband channel shall alternatively be capable of supporting analogue telephone channels. Remote power feeding shall be provided by the central office. In this case, a reduced power mode (for lifeline service in case of local power failure) may be provided for the ISDN-BA or one analogue telephone connection.

The multiplexing of additional narrowband channels into the data channel is not precluded. Lifeline service is not required for these channels.

The SDSL transmission system consists of the following functional blocks:

- interface functions;
- mapping functions;
- common circuitry;
- SDSL transceiver;
- optional regenerators.

The functions at the central office side constitute the Line Termination Unit (LTU) and act as master to the customer side functions, which constitute the Network Termination Unit (NTU), and to a regenerator where applicable.

The common circuitry providing for Physical Medium Specific Transmission Convergence (PMS-TC) Layer and the SDSL transceivers comprise the core functions of the NTU and the LTU which, along with the Digital Local Line (DLL), make up the SDSL core. The DLL is commonly a metallic twisted pair and may contain regenerators if an enhanced transmission range is required. In optional configurations, the DLL can be M copper twisted pairs (M-pair mode). In that case, each SDSL Termination Unit contains M separate PMD layers, interfacing to a common PMS-TC layer.

A regenerator may be inserted at any convenient intermediate point in the SDSL core with appropriate insertion loss consideration. Power feeding and lifeline service may restrict the maximum achievable loop reach. In the optional M-pair mode, M-pair regenerators may be used when this reach extension is required.

The SDSL core is application independent. It transparently transports the SDSL frames that it receives at its internal interfaces.

The mapping functions and the interface functions are application dependent and Transmission Protocol Specific (TPS). The mapping function handles the Transmission Convergence (TC) Layer of the specific application including the maintenance and the mapping of the application frames into the SDSL frame. The TC-functions contain:

- channel multiplexing and demultiplexing;
- framing;
- frame synchronization;
- error detection;
- justification;
- maintenance.

The interface functional block provides interfaces to the data channel and the optional narrowband subchannel. The physical characteristics of the interfaces are application dependent. Implementation details are defined in the application descriptions.

The interfaces between the functional blocks are only logical separations and are not required to be physically accessible.

A clear embedded operations channel (eoc) is provided for within the system frame structure. The SDSL core is specified so as to promote interoperability of equipment from different vendors.

4.5 Functions

The functions listed in table 4.1 are necessary for the correct operation of the SDSL core.

Table 4-1: Necessary functions

Functions related to the SDSL core	LTU	NTU/ REG
Transparent transport of SDSL frames	<---->	
Stuffing and destuffing	<---->	
Transmission error detection	<---->	
Error reporting	<---->	
Failure detection	<---->	
Failure reporting	<---->	
Bit timing	<---->	
Frame alignment	<---->	
Power back-off	<---->	
Transceiver start-up control	----->	
Loopback control and co-ordination	<---->	
Synchronization of SDSL transceivers	----->	
Remote power feeding	----->	
Wetting current	----->	

4.5.1 Transparent transport of SDSL frames

This function provides for the bi-directional transmission of the SDSL frames.

4.5.2 Stuffing and destuffing

This function, when used, provides for the synchronization of the application data clock to the SDSL transceiver system clock, by means of adding zero or four stuffing bits per SDSL frame.

4.5.3 Transmission error detection

This function provides for error performance monitoring of the SDSL transceiver systems in each SDSL frame.

4.5.4 Error reporting

This function provides for the reporting of errors detected.

4.5.5 Failure detection.

This function provides for the detection of failures in the SDSL transceiver system.

4.5.6 Failure reporting

This function provides for the reporting of failures detected in the SDSL transceiver systems.

4.5.7 Bit timing

This function provides bit timing to enable the SDSL transceiver systems to recover information from the aggregate bit stream.

4.5.8 Frame alignment

This function provides information to enable the SDSL transceiver systems to recover the SDSL frame.

4.5.9 Power Back-Off (PBO)

The transmitter shall have the ability to reduce its transmitted power in order to reduce crosstalk with transmission systems operating in the same multi pair cable. The power back-off function shall be provided in both directions of transmission. The reduction of power shall be controlled by the management system. The assignment of power back-off values in 4-wire/M-pair mode shall be as specified in clause 9.2.6.

4.5.10 Transceiver start-up control

This function provides for the activation to reach the operational state. It may contain a preactivation procedure.

4.5.11 Loopback control and co-ordination

This function provides for the activation and deactivation of loopbacks in the LTU, the REG and the NTU.

4.5.12 Synchronization of SDSL transceivers

This function provides for the synchronization of the SDSL transceiver systems.

4.5.13 Remote power feeding

This function provides for remote power feeding of the NTU and/or the regenerators from the LTU.

4.5.14 Wetting current

This optional function provides for feeding of a low current on the pair to mitigate the effect of corrosion of contacts.

Clause 7 "PMS-TC Layer Functional Characteristics"

Modify clause 7.1.2.1 and add the following text:

7.1.2.1 *sw1 - sw14* (Frame Sync Word)

The frame synchronization word (FSW) enables SHDSL receivers to acquire frame alignment. The FSW (bits *sw1 - sw14*) is present in every frame. The synchronization word consists of the following 14-bit sequence: 11111100001100. This sequence shall be passed as a parameter for both upstream and downstream directions during the pre-activation; The SW is present in every frame and is the same in both the upstream and downstream directions.

Clause 9 "Management"

Add the following text to clause 9.2:

9.2.8 Loss of local power

The STU-R shall indicate loss of local power to the STU-C through *ps*-bit. The STU-R shall be able to send the ps-bit in at least 1 and preferably 3 consecutive frames after losing local power. If the ps-bit is set for less than three frames, it is up to the application at the STU-C layer to determine the validity of the message.

9.2.9 Loss of Signal (LOS)

The Loss Of Signal flag (LOS = ONE) indicates that no signal is detected on the line. LOS = ZERO indicates that a signal has been detected. The LOS at the STU-R side is set to zero as soon as the S_c signal is detected. The LOS at the STU-C side is set to zero as soon as the S_r signal is detected. LOS at the line side of the STU-C, STU-R or REG leads to a deactivation of the respective path after 2 s and therefore always results in an LOS message from the SDSL core to the Operation & Maintenance (O&M) functional block in the STU-C. The STU-C O&M unit cannot determine however the location of the fault.

Annex A "Regional Requirements - Region 1"

Delete annex A. It is not applicable.

Annex C "Regional Requirements - Region 3"

Delete annex C. It is not applicable

Annex E "Application-specific TPS-TC Framing"

Delete clause E.3 (TPS-TC for Unaligned DS1 Transport).

Delete clause E.4 (TPS-TC for Aligned DS1/Fractional DS1 Transport).

Delete clause E.12 (TPS-TC for STM with a Dedicated Signalling Channel (DSC)).

These TPS-TCs are not applicable.

E.10.2 Dual Bearer Mode Types

Modify table E-22 as follows:

Table E-22: Supported TPS-TCs in Dual Bearer Mode

Type	Description	$TPS\text{-}TC_a$	$TPS\text{-}TC_b$
1	STM + Broadband	Synchronous ISDN BRA (clause E.8) LAPV5 Enveloped POTS or ISDN (clause E.13) (see note) TU-12 (E.14)	Clear Channel (clause E.1) Clear Channel Byte-Oriented (clause E.2) Unaligned D2048U (clause E.5) (see note) Unaligned D2048S (clause E.6) (see note) Aligned D2048S/Fractional D2048S (clause E.7) (see note) ATM (clause E.9) PTM (HDLC based) (clause E.11) PTM (64/65-Octet based) (clause E.15)
2	STM + Cell / Packet	Unaligned D2048U (clause E.5) (see note) Unaligned D2048S (clause E.6) (see note) Aligned D2048S/Fractional D2048S (clause E.7) (see note) TU-12 (E.14)	ATM (Annex clause E.9) PTM (HDLC based) (clause E.11) PTM (64/65-Octet based) (clause E.15)
3	STM + Clear Channel	Unaligned D2048U (clause E.5) (see note) Unaligned D2048S (clause E.6) (see note) Aligned D2048S/Fractional D2048S (clause E.7) TU-12 (clause E.14)	Clear Channel (clause E.1) Clear Channel Byte-Oriented (clause E.2)
NOTE: Denotes TPS-TC modes that typically apply only in European networks. $TPS\text{-}TC_a$ has to be used for services, which require 8 kbit/s granularity.			

Annex F "Region 1 Requirements for Data Rates between 192 and 5 696 kbit/s"

Delete annex F. It is not applicable.

Add the following references to clause "Bibliography":

[B21] ETSI TS 101 272: "Transmission and Multiplexing (TM); Optical Access Networks (OANs) for evolving services; ATM Passive Optical Networks (PONs) and the transport of ATM over digital subscriber lines".

[B22] ETSI ES 201 970: "Access and Terminals (AT); Public Switched Telephone Network (PSTN); Harmonized specification of physical and electrical characteristics at a 2-wire analogue presented Network Termination Point (NTP)".

[B23] ETSI EN 300 659-1: "Access and Terminals (AT); Analogue access to the Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 1: On-hook data transmission".

[B24] ETSI EN 300 659-2: "Access and Terminals (AT); Analogue access to the Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services; Part 2: Off-hook data transmission".

[B25] ETSI ES 200 778 (all parts): "Access and Terminals (AT); Analogue access to the Public Switched Telephone Network (PSTN); Protocol over the local loop for display and related services; Terminal Equipment requirements".

[B26] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility.

[B27] ITU-T Recommendation Q.552 (2001): "Transmission characteristics at 2-wire analogue interfaces of digital exchanges".

[B28] ATM Forum specification, AF-VMOA-0145.000: "Loop Emulation Service using AAL2".

Annex ZA Transmission medium

ZA.1 Description

The transmission medium over which the digital transmission system is expected to operate is the local line distribution network, known as the Digital Local Line (DLL). A digital local line distribution network employs cables comprising multiple twisted pairs to provide services to customers. In a local line distribution network, customers are connected to the local exchange via local lines. To simplify the provision of SDSL, a digital transmission system must be capable of satisfactory operation over the majority of metallic local lines without requirement of any special conditioning. In order to permit the use of SDSL transmission systems on the maximum possible number of digital local lines, the restrictions imposed by SDSL requirements are kept to the minimum necessary to guarantee acceptable operation.

ZA.2 Physical characteristics of a Digital Local Line (DLL)

A Digital Local Line (DLL) is constructed of one or more cable sections that are spliced or interconnected together.

The distribution or main cable is structured as follows:

- cascade of cable sections of different diameters and lengths;
- up to two Bridged Taps (BTs) may exist at various points in installation and distribution cables.

A general description of the DLL physical model is shown in figure ZA.1 and typical examples of cable characteristics are given in table ZA.1.

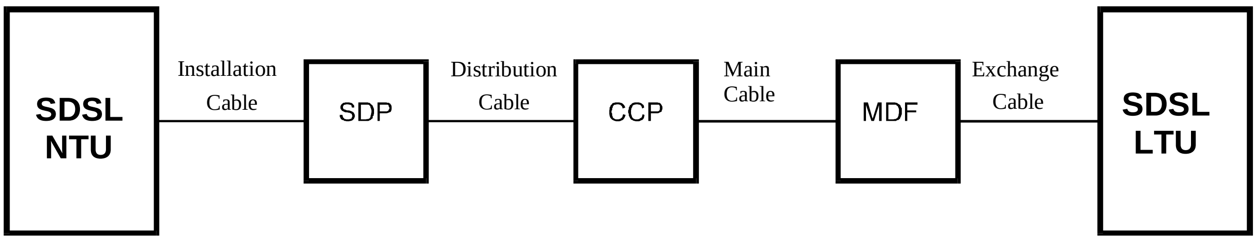

Figure ZA.1: DLL physical model

Table ZA.1: Typical cable characteristics

	Exchange cable	Main cable	Distribution cable	Installation cable
Wire diameter (mm)	0,5; 0,6; 0,32; 0,4	0,3 to 1,4	0,3 to 1,4	0,4; 0,5; 0,6; 0,8; 0,9; 0,63
Structure	SQ (B) or TP (L)	SQ (B) or TP (L)	SQ (B) or TP (L)	SQ or TP or UP
Maximum number of pairs	1 200	4 800	600	2 (aerial) 600 (in house)
Installation		underground in ducts	underground or aerial	aerial (drop) or in ducts (in house)
Capacitance (nF/km at 800 Hz)	55 to 120	25 to 60	25 to 60	35 to 120
Wire insulation	PVC, FRPE	PE, paper pulp	paper, PE, Cell PE	PE, PVC

TP:	Twisted Pairs	PE:	Polyethylene
SQ:	Star Quads	PVC:	Polyvinylchloride
UP:	Untwisted Pairs	Pulp:	Pulp of paper
L:	Layer	Cell PE:	Cellular Foam Polyethylene
B:	Bundles (units)	FRPE:	Fire Resistant PE

NOTE: This table is intended to describe the cables presently installed in the local loop. Not all of the above cable types are suitable for SDSL systems.

ZA.3 Electrical characteristics of a Digital Local Line (DLL)

The transmitted signal will suffer from impairments due to crosstalk, impulsive noise and the non-linear variation with frequency of DLL characteristics. These impairments are described in more detail in the following clauses.

ZA.3.1 Principal Transmission characteristics

The principal electrical characteristics varying nonlinearly with frequency are:

- insertion loss;
- group delay;
- characteristic impedance, comprising real and imaginary parts.

ZA.3.2 Crosstalk characteristics

Crosstalk noise in general is the result of finite coupling loss between pairs sharing the same cable, especially those pairs that are physically adjacent. Finite coupling loss between pairs causes a vestige of the signal flowing on one DLL (disturber DLL) to be coupled into an adjacent DLL (disturbed DLL). This vestige is known as crosstalk noise. Near-end crosstalk (NEXT) is assumed to be the dominant type of crosstalk for SDSL.

Intersystem NEXT results when pairs carrying different digital transmission systems interfere with each other.

Intrasystem NEXT or self-NEXT results when all pairs interfering with each other in a cable are carrying the same digital transmission system. Intrasystem NEXT noise coupled into a disturbed DLL from a number of DLL disturbers can be represented as being due to an equivalent single disturber DLL with a coupling loss versus frequency characteristics known as Power Sum Loss (PSL). Values for 1 % worst case NEXT loss vary from 40 dB to 70 dB at 150 kHz depending upon the cable type, number of disturbers and environment.

ZA.3.3 Unbalance about earth

The DLL will have finite balance about earth. Unbalance about earth is described in terms of Longitudinal Conversion Loss (LCL). The expected worst case value is 42,5 dB at 150 kHz decreasing with frequency by 5 dB/decade.

ZA.3.4 Impulse noise

The DLL will have impulse noise resulting from other systems sharing the same cables as well as from other extrinsic sources.

ZA.3.5 Micro interruptions

A micro interruption is a temporary line interruption due to external mechanical action on the copper wires constituting the transmission path, for example, at a cable splice.

ZA.4 Minimum Digital Local Line (DLL) requirements for SDSL applications- no loading coils;

- only twisted pair or quad cable;
- no additional shielding necessary;
- when bridged taps are present, the maximum number shall be limited to 2 and the length of each to 500 m.

Annex ZB Environmental requirements

ZB.1 Climatic conditions

Climatograms applicable to the operation of SDSL equipment can be found in ETS 300 019 [19]. The choice of classes is under national responsibility.

ZB.2 Safety

Safety requirements are mentioned in clause B.5.3 "Span Powering".

ZB.3 Over-voltage protection

No over-voltage protection requirements are specified under the present document.

NOTE: Depending on the equipment NTU, LTU or REG, the ITU-T Recommendations K.21 [22], K.20 [21], K.44 [34] or K.45[35] should be applied.

ZB.4 Electromagnetic compatibility

The EMC requirements are defined according to the equipment type and as described in EN 300 386 [20].

NOTE: Additional EMC requirements may be imposed under EMC Directive (89/336/EEC) (see bibliography).

Annex ZC (informative): Transmission and reflection of cable sections

ZC.1 Definition of transfer function and insertion loss

Transfer function and insertion loss are quantities that are related to the values of the (complex) source and load impedance. Within the context of the present document, a simplified definition is used in which source and load are the same and equal to a real value R_V. The transfer function and insertion loss associated with a two-port network, normalized to a chosen reference resistance $R_{V,}$ are defined as the following voltage ratios (see figures ZC.1 and ZC.2):

$$\text{Transfer Function} = \frac{U_2}{U_1}$$

$$\text{Insertion Loss} = \frac{U_1}{U_2}$$

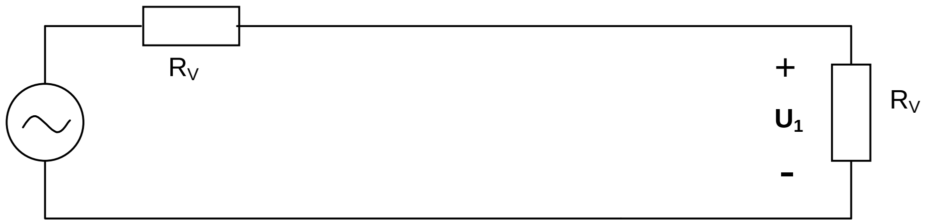

Figure ZC.1: Voltage across the load

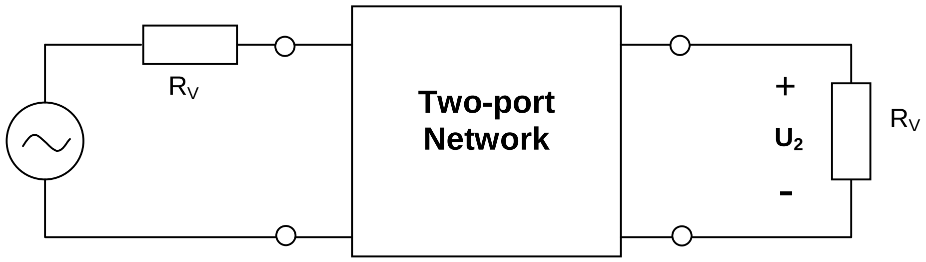

Figure ZC.2: Voltage across the load with a two-port network inserted

These quantities are directly related to the scattering parameters associated with the two-port network as defined in clause G.2:

Transfer Function (TF)	$= s_{21}$	Magnitude of TF (in dB) = 20 $\log_{10}(\lvert s_{21}\rvert)$
Insertion Loss (IL)	$= 1/s_{21}$	Magnitude of IL (in dB) = -20 $\log_{10}(\lvert s_{21}\rvert)$

ZC.2 Derivation of s-parameters from primary cable parameters

The test loops are defined by one or a cascade of cable sections. The characteristics of each section are specified by means of primary cable parameters $\{Z_s, Y_p\}$ per unit length (L_0). This clause gives the equations to evaluate the relevant characteristics of cable sections (s-parameters) from the primary parameters and to handle cascade of cable sections.

Insertion loss and return loss of a cable section, for SDSL, can be calculated from the primary parameters $\{Z_s, Y_p\}$ per unit length (L_0) by evaluating the two-port s-parameters, normalized to $\mathbf{R_V}$ = 135 Ω.

$Z_{sx} = (L/L_0) \cdot Z_s$	$\gamma_x = \sqrt{Z_{sx} \cdot Y_{px}}$	$\alpha_x = real(\gamma_x)$	$R_{sx} = real(Z_{sx})$	$G_{px} = real(Y_{px})$
$Y_{px} = (L/L_0) \cdot Y_p$	$Z_0 = \sqrt{Z_{sx} / Y_{px}}$	$\beta_x = imag(\gamma_x)$	$L_{sx} = imag(Z_{sx}/\omega)$	$C_{px} = imag(Y_{px}/\omega)$

$$S = \begin{bmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{bmatrix} = \frac{1}{(Z_0/R_v + R_v/Z_0)\cdot\tanh(\gamma_x) + 2} \times \begin{bmatrix} (Z_0/R_v - R_v/Z_0)\cdot\tanh(\gamma_x) & 2/\cosh(\gamma_x) \\ 2/\cosh(\gamma_x) & (Z_0/R_v - R_v/Z_0)\cdot\tanh(\gamma_x) \end{bmatrix}$$

Insertion Loss: $1/s_{21}$

Return Loss: $1/s_{11}$

The s-parameters of two cable sections (a and b) in cascade, $\mathbf{S}_{ab}$, can be calculated from the s-parameters $\mathbf{S}_a$ and $\mathbf{S}_b$ as described below:

$$S_{\mathbf{ab}} = \begin{bmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{bmatrix} = \frac{1}{1 - s_{22a}\cdot s_{11b}} \cdot \begin{bmatrix} s_{11a} - \Delta_{sa}\cdot s_{11b} & s_{12b}\cdot s_{12a} \\ s_{21a}\cdot s_{21b} & s_{22b} - \Delta_{sb}\cdot s_{22a} \end{bmatrix} \qquad \Delta_{si} = s_{11i}\cdot s_{22i} - s_{12i}\cdot s_{21i}$$

Annex ZD (informative): Guideline for the narrowband interfaces implementation in the SDSL NTUThis annex provides information needed for the implementation of power efficient narrowband interfaces (at the SDSL NTU) when lifeline service has to be guaranteed.

Narrowband interfaces and conditions that were taken into account are:

- ISDN user-network interface (S-interface);
- Analogue interface (PSTN) in the following conditions:
  - "On Hook" with ringing applied;
  - "On Hook" with no transmission and normal battery applied;
  - "Off Hook", normal talk state;
  - "On Hook", with FSK/DTMF data transfer;
  - "Power denial".

The PSTN interface has been identified as the highest power consuming interface and, in particular, the operational state *"Off Hook", normal talk state.*

Table ZD.1 provides a guideline to the implementation of voice-band analogue interfaces (a/b interfaces) offered to the final user by means of adapter devices terminating various types of digital networks such as xDSL or ISDN. Particular attention is given to the power budget implied by the individual requirements.

The information was derived from EG 201 185 [24] (see bibliography), and experience gained in the use of intelligent ISDN Network Terminations widely used for the ISDN network (NTs providing analogue terminal adapter interfaces to the user). The tables allow a comparison between those two ETSI documents in order to facilitate the harmonization of the network side of the analogue voice band switched interface (PSTN). The suggested values are very close to EG 201 185 [24], however they add important information on parameters affecting the power consumption (vital for the lifeline service) that are lacking in those documents.

Table ZD.1: Implementation guideline of voice-band analogue interfaces

	EG 201 185 [24] (V1.1.1)	ES 201 970 (V1.1.1)	Suggested values	notes
General				
applicability (loop length)	≤ 100 Ω	≤ 750 Ω	≤ 100 Ω	
mechanical aspects	RJ-11 (3 and 4)	RJ-11 (3 and 4)	RJ-11	
Signalling				
on-hook voltage (min, max)	38 V to 78 V @100 kΩ	38 V to 78 V @ 100 MΩ/LF	38 V to 78 V @ 1 mA	1
on-hook voltage @ 2,5 mA	≥ 32 V	≥ 32 V	≥ 32 V	2
off-hook resistance (d.c.)	n.a.	n.a.	≤ 800 Ω	3
non-seizure current	I_{loop} < 3 mA	I_{loop} < 3 mA	I_{loop} < 4 mA	
seize current	I_{loop} ≥ 6 mA	I_{loop} ≥ 10 mA	I_{loop} > 6 mA	4
seize surely recognized	150 ms	150 ms	≥ 250 ms	
seize surely not recognized	≤ 25 ms	≤ 25 ms	≤ 50 ms	
loop current (min-max)	≥ 18 mA	18 mA to 70 mA	≥ 18 mA @ 800 Ω ≥ 25 mA @ 400 Ω	
loop current (recommended)	32 mA ± 7 mA	25 mA to 40 mA	See line above	
clear signal threshold	≤ 1 mA	≤ (seize curr. -0.5 mA)	≤ 6 mA	
clear signal not recognized	≤ 350 ms	≤ 250 ms	≤ 150 ms	
clear signal recognized	≥ 500 ms	≥ 500 ms	≥ 200 ms	
clear signal from the network	release tone	release tone	release tone	5
DTMF recognition level	-5 dBV to -15 dBV	-5 dBV to -15 dBV	-5 dBV to -15 dBV	
DTMF max twist	4 dB	6 dB	4 dB	
DTMF frequency error	±(1,5 % + 2 Hz)	±(1,5 % + 2 Hz)	±(1,5 % + 2 Hz)	

	EG 201 185 [24] (V1.1.1)	ES 201 970 (V1.1.1)	Suggested values	notes
DTMF min duration	40 ms	40 ms	40 ms	
DTMF min pause	40 ms	40 ms	40 ms	
Ringing voltage (required)	≥ 35 V_{rms} @ 4 kΩ (a.c.)	≥ 35 V_{rms} @ 400 kΩ//LF	≥ 40 V_{rms} (2 KΩ, φ ≥ 60°)	6
Ringing frequency	25 Hz (or 50 Hz) ± 2 Hz	25 Hz (or 50 Hz) ± 2 Hz	25 Hz (or 50 Hz) ± 2 Hz	
Distortion	≤ 5 %, symmetric	≤ 5 %, symmetric	10 %, symmetric	
Max ringing current	n.a.	n.a.	80 mA	
Superimposed d.c.	38 V to 78 V (optional)	38 V to 78 V (optional)	38 V to 78 V	7
Ring Trip threshold	dc seize condition or ≤ 700 Ω (@ 25 Hz or 50 Hz)	dc seize condition or < 700 Ω @ 25 Hz	dc seize	
Ring Trip Delay	≤ 100 ms	≤ 200 ms	≤ 200 ms	
Tone level	-18 dBV ± 6 dB	-18 dBV ± 6 dB	-18 dBV ± 6 dB	
Signal quality				
Impedance	270 Ω + (750 Ω//150 nF)	270 Ω + (750 Ω//150 nF)	270 Ω + (750 Ω//150 nF)	
return loss	200 Hz to 500 Hz: 14 dB to 18 dB 500 Hz to 2 500 Hz: > 18 dB 2 000 Hz to 3 800 Hz: 18 dB to 14 dB	200 Hz to 300 Hz: > 8 dB 300 Hz to 500 Hz: 8 dB to 10 dB 500 Hz to 1 250 Hz: 10 dB to14 dB 1 250 Hz to 3 400 Hz: >14 dB 3 400 Hz to 3 800 Hz: 14 dB to 12 dB	200 Hz to 500 Hz:14 dB to18 dB 500 Hz to 2 500 Hz: >18 dB 2 000 Hz to 3 800 Hz: 18 dB to14 dB	8
balance to earth	200 Hz to 3 800 Hz: > 46 dB	50 Hz: >40 dB 200 Hz to 600 Hz: >40 dB 600 Hz to 3 800 Hz: >46 dB	50 Hz: > 20 dB 200 Hz to 600 Hz: > 40 dB 600 Hz to 3 800 Hz: >46 dB	
input relative level	+4 dBr ± 1 dB	+4 dBr ± 2 dB	+4 dBr ± 1 dB	9
output relative level	-11 dBr ± 1 dB	-11 dBr ± 2 dB	-11 dBr ± 1 dB	
Frequency Response	300 Hz: -0,3 to +1,0 dB 400 Hz: -0,3 to +0,75 dB 0,6 ÷ 2 kHz: -0,3 dB to +0,75 dB 2,4 kHz: -0,3 dB to +0,45 dB 3 kHz: -0,3 dB to +0,7 dB 3,4 kHz: -0,3 dB to +1,7 dB	as per	as per ITU-T Recommendation Q. 552	
loss vs. signal level	see table 4	as per ITU-T Recommendation Q.552	as per ITU-T Recommendation Q. 552	
input levels	3,14 dB over nominal level	1,8 V_{rms} (+5,7 dBm)	3,14 dB over nominal level	
receive noise	≤ -67 dBVp	as per Q.552	-64 dBm0p	
transmit noise	≤ -64 dBm0p	as per Q.552	-64 dBm0p	
absolute delay	≤ 2 ms	n.a.	≤ 1,5 ms	
relative delay (relative to the minimum)	500 Hz to 600 Hz: ≤ 1,8 ms 600 Hz to 1 000 Hz: ≤ 0,9 ms 1 000 Hz to 2 600 Hz: ≤ 0,3 ms 2 600 Hz to 2 800 Hz: ≤ 1,5 ms	n.a.	500 Hz to 600 Hz: ≤ 0,9 ms 600 Hz to 1 000 Hz: ≤ 0,45 ms 1 000 Hz to 2 600 Hz: ≤ 0,15 ms 2 600 Hz to 2 800 Hz: ≤ 0,75 ms	
Optional features				
Pulse dialling rate	8 to 12 pulse/s	8 to 12 pulse/s	8 to 12 pulse/s	
break/pulse ratio	50 % to 75 %	50 % to 75 %	50 % to 75 %	
Interdigit Pulse	≥ 240 ms	≥ 240 ms	≥ 240 ms	
Register Recall	50 ms to 130 ms	50 ms to 130 ms	25 ms to 150 ms	
Hook Flash	75 ms to 850 ms	n.a.	n.a.	10

	EG 201 185 [24] (V1.1.1)	ES 201 970 (V1.1.1)	Suggested values	notes
Metering Pulses frequency	12 kHz or 16 kHz	12 kHz or 16 kHz	12 kHz or 16 kHz	
Metering Pulses level	approx. 500 mV_{rms}	approx. 100 mV_{rms}	≥ 200 mV_{rms}	

NOTE 1: A concept present in ES 201 970 is the Loading Factor (LF). The operator must state a single LF number for the Network Termination Point (NTP). Based on this LF information, the user can determine the number or the type of terminals that can be connected at the NTP. The operator must guarantee a minimum LF of 100.
The single LF number stated by the operator is the minimum value among the LF calculated for four key parameters: the resistance to ground, the DC resistance in quiescent conditions, the ringing voltage, and the DC current during ringing. A skilled user may take advantage of the operator providing individual L's for these parameters. As an example, the ringing voltage is specified to be greater than 35 Vrms at a load of 400 kΩ/LF. If the operator specifies a LF of 100, this means that the 35 Vrms are guaranteed across a load of 4 kΩ.

NOTE 2: Meeting this value is an optional feature required to support ALASS services.

NOTE 3: 800 Ω represents the sum of the loop and the terminal resistance (d.c.).

NOTE 4: There is an additional recommendation (mentioned in EG 201 185 [24] and in ES 201 970): during any transient state in the transition from quiescent to loop state, the NTP should be able to supply at least 4 mA over a 5 kΩ load for at least 20 ms. The reason for this requirements is that some TE may expect the full current immediately after going off-hook while some NTP may use high resistance supply to provide quiescent state "high" battery voltage (e.g. 50 V through a 10 kΩ resistance) and will not able to deliver the full current before switching in a lower value DC "battery" voltage. The combination of the two cases may cause problems, and the recommendation for the NTP is paired with a recommendation for the TE to be developed so that they can correctly seize the loop under this limited current transient.

NOTE 5: Polarity reversal or K-break may be required by some operators, additionally to release tones.

NOTE 6: EG 201 185 [24] recommends supplying 35 Vrms over 2 kΩ, ac coupled.

NOTE 7: A note specifies that TBR 21 compliant devices are not guaranteed to operate with ringing sources without a superimposed DC voltage.

NOTE 8: For ES 201 970 (see bibliography), return loss measurements include the loop between the NTP and the "line card". It is also stated than the specified value for the return loss at low-mid frequency may not be achieved for loop resistance ≥ 750 Ω.

NOTE 9: Including loop loss for ES 201 970 (see bibliography).

NOTE 10: As a network option, the hook flash is an alternative to register recall. When hook-flash is used, the minimum recognition time for clear originated from the TE raises to 950 ms to 1 050 ms.

ALASS services

Common ALASS services include provision of Calling Line Identity (CLI) and Message Waiting Indication (MWI).

These services are delivered to the terminal equipment using voice-band data, either during incoming call set-up, while the terminal is in the quiescent state or in the off-hook state (e.g. CLI during a CW offering). See EN 300 659-1, EN 300 659-2 and ES 200 778 (see bibliography).

In order to support ALASS services to the TE, the equipment should be able to support one or more additional features, such as:

a) control of polarity reversal;

b) a single burst of ringing current, with or without polarity reversal;

c) provision of 2,5 mA @ 32 V in the quiescent state;

d) ignore on-line d.c. current pulses not exceeding 25 ms duration;

e) generation of DTMF digits to the TE.

History

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