



Reference Specification

for

High bit rate Digital Subscriber Line (HDSL) Modems

IDA RS HDSL 1
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CONTENTS

		Page
PART A	INTRODUCTION	
1	SCOPE	3
2	GENERAL REQUIREMENTS	5
3	SAFETY OF TERMINAL EQUIPMENT FOR CONNECTION TO TELECOMMUNICATION NETWORKS	6
PART B	HIGH BIT RATE DIGITAL SUBSCRIBER LINE (HDSL) TRANSCEIVERS (ITU-T Recommendation G.991.1, October 1998)	
Table		
1	HDSL CORE SPECIFICATION – FUNCTIONS	7
2	HDSL CORE SPECIFICATION – TRANSMISSION MEDIUM	7
3	HDSL CORE SPECIFICATION – TRANSMISSION METHOD	8
4	HDSL CORE SPECIFICATION – FRAME STRUCTURE	8
5	HDSL CORE SPECIFICATION – HDSL EMBEDDED OPERATIONS CHANNEL (EOC)	9
6	HDSL CORE SPECIFICATION – START-UP PROCEDURE	9
7	HDSL CORE SPECIFICATION – OPERATION AND MAINTENANCE	11
8	HDSL CORE SPECIFICATION – ELECTRICAL CHARACTERISTICS OF A SINGLE 2B1Q TRANSCEIVER	11
9	HDSL CORE SPECIFICATION – PERFORMANCE OF INDIVIDUAL HDSL TRANSCEIVERS	12
10	COMMON CIRCUITRY SPECIFICATION	12
11	POWER FEEDING	13
12	ENVIRONMENTAL REQUIREMENTS	13
13	ANNEXES & APPENDICES	14

NOTICE

This Reference Specification is subject to review and revision.

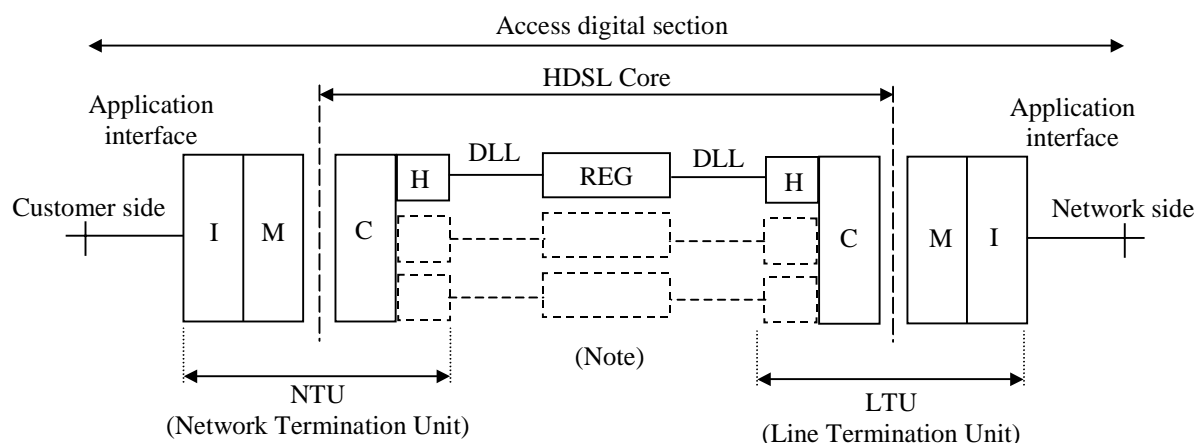
Reference Specifications and Guides are informative documents, and are not used for type approval of customer equipment. They are either one of the following types of documents:

- i. Informative and interim documents on customer equipment standards which are yet to be adopted by the network operators and where standardisation is still in progress.**
- ii. Informative documents describing the network standards adopted by the Public Telecommunication Networks in Singapore.**

PART A INTRODUCTION

1 SCOPE

- 1.1** Part A of this Specification outlines the purpose of the High bit rate Digital Subscriber Line (HDSL) technology, defines the scope and the requirements for power, identification and safety of equipment.
- 1.2** The HDSL is a symmetric Digital Subscriber Line technology that extends the reach of the E1 (2048 kbit/s) and T1 (1544 kbit/s) transmission three to four times without the need for repeaters. HDSL provides advanced digital services to local loop customers and corporate users cost effectively over the existing copper wires, and is suitable for LAN-to-LAN connectivity, for remote data centre access, video-teleconferencing and Internet access. It is also used for system redundancy and disaster recovery.
- 1.3** Part B of this Specification describes the HDSL core. References are taken from the ITU-T Recommendation G.991.1 (Oct 1998) and the ETSI ETR 152 (Feb 1995). The HDSL core specification is independent of applications (refer to Figure 1). HDSL transmission systems for E1 (2048 kbit/s) based applications can be implemented over three pairs, two pairs or one pair of twisted copper wires, at transmission rate of 784 kbit/s, 1168 kbit/s or 2320 kbit/s correspondingly. Each comprises a HDSL transceiver pair connected by a digital local line (DLL) and linked by some common circuitry. HDSL transmission systems for T1 (1544 kbit/s) based applications can be implemented over two pairs of twisted copper wires at transmission rate of 784 kbit/s per line. The transmission system for 1544 kbit/s two-pair system application is described in Annex A/G.991.1.



Description of functional blocks:

C	Common circuitry
H	HDSL transceiver
I	Interface
M	Mapping
REG	Regenerator
DLL	Digital Local Line

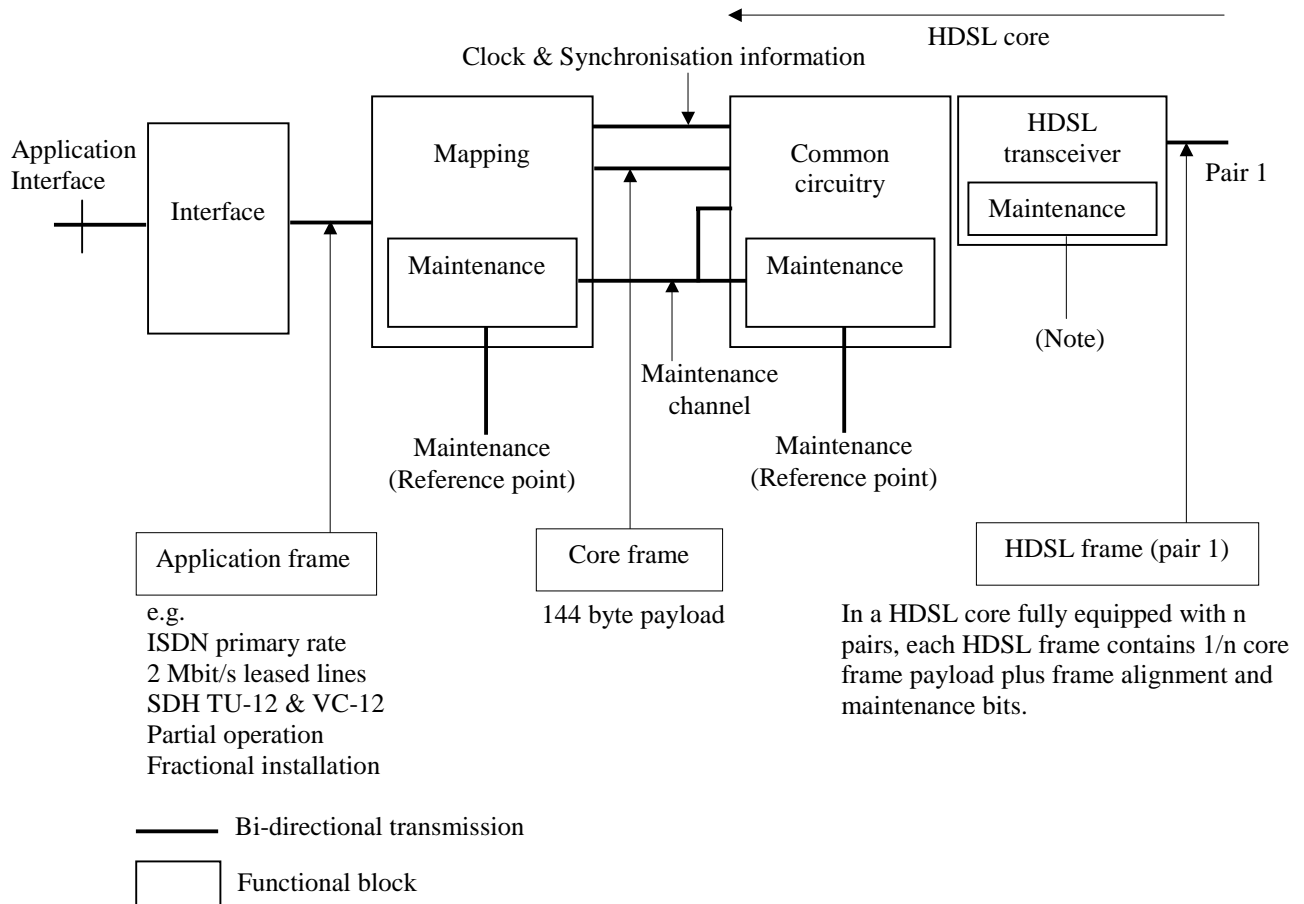
Note: A fully equipped HDSL core consists of one, two or three H, REG and DLL combinations depending on HDSL transceiver data transmission rate. REGs are optional.

Figure 1 (Figure 1 of G.991.1/ETR 152):
Access digital section employing HDSL technology
(Simplified configuration)

- 1.4** Within the HDSL core as shown in Figure 1, Part B of this Specification defines the requirements for the individual HDSL transceiver, the transmission performance, the HDSL maintenance requirements and procedures. An individual HDSL transceiver system is a two-wire bi-directional transceiver for metallic wires using the echo cancellation method. The line encoding specified is 2B1Q (two binary, one quaternary). CAP (Carrierless Amplitude/Phase modulation) may also be used in a transmission system. The detailed description of CAP is given in Annex B/G.991.1.

- 1.5 The HDSL core also includes the common circuitry for combining and controlling one, two or three HDSL transceiver systems, depending on the bit rate of the transceiver system used. The common circuitry and the necessary number of HDSL transceiver systems form the HDSL core, which is independent from the possible applications.
- 1.6 This Specification does not specify all the requirements for the implementation of Network Termination Unit (NTU), Line Termination Unit (LTU) or regenerator (REG). It serves only to describe the functionality needed.
- 1.7 This Specification describes the HDSL transmission technique as a means for transporting several types of applications. Application specific examples are described in Appendix I/G.991.1. They are:
 - a) ISDN Primary Rate Access with 2048 kbit/s
 - b) European 2048 kbit/s digital unstructured leased line (D2048U)
 - c) European 2048 kbit/s digital structured leased line (D2048S)
 - d) Fractional installation (n x 64 kbit/s)
 - e) Partial operation
 - f) 2048 kbit/s mapped into TU-12 structure (HDSL transmission for SDH access)

An overview of the different framing procedures is as shown in Figure 2.



Note: A fully equipped HDSL core consists of one, two or three H, REG and DLL combinations depending on HDSL transceiver data transmission rate. REGs are optional.

Figure 2 (Figure 3 of G.991.1/ETR 152):
An overview of framing procedures

1.8 References

- | | |
|--|---|
| ITU-T Recommendation G.991.1
(October 1998) | High bit rate Digital Subscriber Line (HDSL) transceivers |
| ETSI Technical Report – ETR 152
(February 1995) | High bit rate Digital Subscriber Line (HDSL) transmission on metallic local lines |

2 GENERAL REQUIREMENTS

2.1 Power Supply

The equipment may be a.c. powered or d.c. powered. For an a.c. powered equipment, the Specification shall be complied with when operating from an a.c. mains supply of voltage, $230V \pm 10\%$ and frequency, $50 \text{ Hz} \pm 2\%$. Where external power supply is used, e.g. AC adaptor, it shall not affect the capability of the equipment to meet the Specification.

2.2 Identification of Equipment

The equipment shall be marked with the supplier or manufacturer's name or identification mark, and the supplier or manufacturer's model or type reference. The markings required shall be legible, indelible and readily visible.

NOTE

The following notations are used in the Specification:

- | | |
|-----|--|
| CR | Conformance requirement defines features and functions that must be supported at minimum. |
| M | Mandatory requirement is where the equipment implementation shall conform to those clauses in that section relating to the operation of the equipment. |
| O | Optional requirement means it is optional whether equipment implements that function but if function is implemented, it shall conform to the clauses in that section relating to the operation of the equipment. |
| NA | Not Applicable is where the requirements specified in that section on the equipment shall not be applicable for attachment. |
| GID | The section provides General Information and Definitions. |

3	SAFETY OF TERMINAL EQUIPMENT FOR CONNECTION TO TELECOMMUNICATION NETWORKS	CR	REMARKS
3.1	General	–	
3.1.1	<p>Equipment (mains or battery powered) shall be designed to comply with the principles of Singapore Standards (SS), International Electrotechnical Commission (IEC) or other safety standards e.g. IEC 60950, EN60950, BS EN41003, SS 337.</p> <p>Requirements applicable to the equipment (e.g. class of equipment, type of TNV circuit and types of components) covered in the following sections of IEC 60950¹ shall be identified and complied with:</p> <p>Scope (1.1 of IEC 60950)</p> <p>Definitions (1.2 of IEC 60950)</p> <p>General requirements (1.3 of IEC 60950)</p> <p>General conditions for test (1.4 of IEC 60950)</p> <p>Components (1.5 of IEC 60950)</p> <p>Power interface (1.6 of IEC 60950)</p> <p>Marking and instructions (1.7 of IEC 60950)</p> <p>Protection from hazards (2 of IEC 60950)</p> <p>Wiring, connections and supply (3 of IEC 60950)</p> <p>Physical requirements (4 of IEC 60950)</p> <p>Electrical requirements and simulated abnormal conditions (5 of IEC 60950)</p> <p>Connection to telecommunication networks (6 of IEC 60950)</p>	M	
3.2	Protection of telecommunication network service personnel, and users of other equipment connected to the network, from hazards in the equipment	–	
3.2.1	Circuitry intended to be directly connected to a telecommunication network shall comply with the requirements for an SELV ² circuit or a TNV-1 ³ circuit (refer to 6.1.1 of IEC 60950).	M	
3.2.2	There shall be insulation between circuitry intended to be connected to a telecommunication network and any parts or circuitry that will be earthed (refer to 6.1.2 of IEC 60950).	M	
3.3	Protection of equipment users from over voltages on telecommunication networks	–	
3.3.1	Equipment shall provide adequate electrical separation between TNV-1 circuit and certain parts of the equipment (refer to 6.2.1 of IEC 60950).	M	
3.3.2	Compliance with 3.3.1 is checked by the electric strength test procedure of 6.2.2 of IEC 60950.	M	
3.4	Protection of the telecommunication wiring system from overheating	–	
3.4.1	Equipment intended to provide power over the telecommunication wiring system to remote equipment shall limit the output current to a value that does not cause damage to the telecommunication wiring system (refer to 6.3 of IEC 60950).	Note 1	
Note 1 – Requirements are mandatory if clause is applicable.			

¹ IEC 60950:1999

² Safety Extra Low Voltage (SELV) circuit is so designed and protected that under normal and single fault conditions, its voltages do not exceed a safe value of 42.4 V peak or 60 Vd.c. under normal operating conditions.

³ Only TNV-1 circuits are permitted for connection to the Singapore telecommunication network whose normal operating voltages do not exceed the limits for an SELV circuit (refer to 1.2.8.10 of IEC 60950)

PART B HIGH BIT RATE DIGITAL SUBSCRIBER LINE (HDSL) TRANSCEIVERS

(ITU-T Recommendation G.991.1, October 1998)

TABLE 1: HDSL CORE SPECIFICATION – FUNCTIONS				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Functions	5.1	5.1	M	
Transparent transport of core frames	5.1.1	5.1.1	M	
Stuffing and destuffing	5.1.2	5.1.2	M	
CRC-6 procedures and transmission error detection	5.1.3	5.1.3	M	
Error reporting	5.1.4	5.1.4	M	
Failure detection	5.1.5	5.1.5	M	
Failure reporting	5.1.6	5.1.6	M	
Bit timing	5.1.7	5.1.7	M	
Frame alignment	5.1.8	5.1.8	M	
HDSL transceiver autonomous start-up control	5.1.9	5.1.9	M	
Loopback control and coordination	5.1.10	5.1.10	M	
Mapping between core frames and HDSL frames	5.1.11	5.1.11	M	
Control of the maintenance channel	5.1.12	5.1.12	M	
Synchronization and coordination of HDSL transceivers	5.1.13	5.1.13	M	
Identification of pairs	5.1.14	5.1.14	M	
Correction of pair identification	5.1.15	5.1.15	M	
Remote power feeding	5.1.16	5.1.16	O	
Wetting current	5.1.17	5.1.17	O	

TABLE 2: HDSL CORE SPECIFICATION – TRANSMISSION MEDIUM				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Transmission medium	5.2	5.2	–	Heading
Description	5.2.1	5.2.1	GID	
Minimum Digital Local Line (DLL) requirements for HDSL applications	5.2.2	5.2.2	GID	
DLL physical characteristics	5.2.3	5.2.3	GID	
DLL electrical characteristics	5.2.4	5.2.4	GID	
Principal characteristics	5.2.4.1	5.2.4.1	GID	
Differences in physical transmission characteristics between pairs in the DLL	5.2.4.2	5.2.4.2	GID	
Crosstalk characteristics	5.2.4.3	5.2.4.3	GID	
Unbalance about earth	5.2.4.4	5.2.4.4	GID	
Impulse noise	5.2.4.5	5.2.4.5	GID	
Micro interruptions	5.2.4.6	5.2.4.6	GID	

TABLE 3: HDSL CORE SPECIFICATION – TRANSMISSION METHOD				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Transmission method	5.3	5.3	–	Heading
General	5.3.1	5.3.1	M	Duplex transmission on 2-wire metallic local lines, achieved through the use of echo cancellation method.
Transmission on three-pairs	5.3.2	5.3.2	Note 1	Each operates at 784 kbit/s using 2B1Q line code.
Transmission on two-pairs	5.3.3	5.3.3	Note 1	Each operates at 1168 kbit/s using 2B1Q or CAP line code for 2048 kbit/s applications or 784 kbit/s using 2B1Q line code for 1544 kbit/s applications.
Transmission on one-pair	5.3.4	–	Note 1	Transceiver operates at 2320 kbit/s using 2B1Q or CAP line code.
Transmission on four-pairs	5.3.5	–	NA	
Transmission on one or four pairs	–	5.3.4	NA	
Line code	5.3.6	5.3.5	M	The line encoding specified in § 5/G.991.1 is 2B1Q. Alternatively, CAP as described in Annex B/G.991.1 may also be used.
Line symbol rate	5.3.7	5.3.7	GID	392 kbaud ± 32 ppm for a three-pair system 584 kbaud ± 32 ppm for a two-pair system 1160 kbaud ± 32 ppm for a one-pair system
Note 1 Duplex transmission should be implemented either on three-pair, two-pair or one-pair system. Only one of these options is implemented, and the requirements thereof are “M”.				

TABLE 4: HDSL CORE SPECIFICATION - FRAME STRUCTURE				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Frame structure	5.4	5.4	–	Heading
Core frame	5.4.1	5.4.1	M	Figure 6/G.991.1 a)
2B1Q HDSL frame	5.4.2	5.4.2	Note 1	Table 3/G.991.1, Table 4/G.991.1 or Table 5/G.991.1
2B1Q HDSL frame structure	5.4.2.1	5.4.2.1	–	Heading
Frame structure of the three-pair system	5.4.2.1.1	5.4.2.1.1	Note 2	
Frame structure of the two-pair system	5.4.2.1.2	5.4.2.1.2	Note 2	
Frame structure of the one-pair system	5.4.2.1.3	–	Note 2	
Frame bit assignments	5.4.2.2	5.4.2.2	M	
Scrambling method	5.4.3	5.4.3	M	Annex A/G.960
Note 1 “M” if 2B1Q line code is employed.				
Note 2 Either three-pair, two-pair or one-pair system is implemented. and the requirements thereof are “M”.				

TABLE 5: HDSL CORE SPECIFICATION - HDSL EMBEDDED OPERATIONS CHANNEL (EOC)				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
HDSL embedded operations channel (eoc)	5.5	5.5	M	
Functions of the HDSL eoc	5.5.1	5.5.1	M	
HDSL eoc acknowledgement protocol	5.5.2	5.5.2	M	
Message/echo-response protocol state	5.5.2.1	5.5.2.1	M	
Command/response mode of operation for HDSL core	–	5.5.2.2		
Unable to comply mode of operation	5.5.2.2	5.5.2.3	M	
The HDSL eoc data read/write mode	5.5.3	5.5.3	M	
Data read protocol	5.5.3.1	5.5.3.1	M	
HDSL eoc data read mode requirements	5.5.3.2	5.5.3.2	M	
Data write protocol	5.5.3.3	5.5.3.3	M	
HDSL eoc data write mode requirements	5.5.3.4	5.5.3.4	M	
HDSL eoc-message list	5.5.4	5.5.4	M	
HDSL eoc-message set requirements	5.5.5	5.5.5	M	
Data registers in the NTU and in regenerators	5.5.6	5.5.6	M	
Noise margin	5.5.7	5.5.7	–	Heading
General	5.5.7.1	5.5.7.1	M	
Coding of the noise margin values	5.5.7.2	5.5.7.2	M	

TABLE 6: HDSL CORE SPECIFICATION - START-UP PROCEDURE				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Start-up procedure	5.6	5.6	–	Heading
General	5.6.1	5.6.1	–	Heading
Start-up	5.6.1.1	5.6.1.1	M	
Activation of HDSL transceiver pairs	5.6.1.2	5.6.1.2	M	
Transparency	5.6.1.3	5.6.1.3	M	
Noise margin	5.6.1.4	5.6.1.4	M	
Control and status signals	5.6.2	5.6.2	GID	
Control signals	5.6.2.1	5.6.2.1	–	Heading
QUIET	5.6.2.1.1	5.6.2.1.1	M	
ACTREQ	5.6.2.1.2	5.6.2.1.2	M	
Status signals	5.6.2.2	5.6.2.2	GID	
LOSW	5.6.2.2.1	5.6.2.2.1	M	
LOSWT	5.6.2.2.2	5.6.2.2.2	M	
LOS	5.6.2.2.3	5.6.2.2.3	M	
LOST	5.6.2.2.4	5.6.2.2.4	M	
INDC	5.6.2.2.5	5.6.2.2.5	M	
INDR	5.6.2.2.6	5.6.2.2.6	M	
PID	–	5.6.2.2.7	M	

TABLE 6: HDSL CORE SPECIFICATION - START-UP PROCEDURE (CONTINUED)				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Transmitted signals	5.6.3	5.6.3	GID	
Silent	5.6.3.1	5.6.3.1	M	
S0 signal	5.6.3.2	5.6.3.2	M	
S1 signal	5.6.3.3	5.6.3.3	M	
2B1Q data	5.6.3.4	5.6.3.4	M	
Timers	5.6.4	5.6.4	GID	
T1	5.6.4.1	5.6.4.1	M	
T2	5.6.4.2	5.6.4.2	M	
T3	5.6.4.3	5.6.4.3	M	
T4	5.6.4.4	5.6.4.4	M	
T5	–	5.6.4.5	M	
T6	–	5.6.4.6	M	
T-Act	5.6.4.5	5.6.4.7	M	
Timer values	5.6.4.6	5.6.4.8	M	Table 13/G.991.1
Activation state diagrams	5.6.5	5.6.5	M	
HDSL transceiver status at the NTU	5.6.5.1	5.6.5.1	M	
HDSL transceiver status at the LTU	5.6.5.2	5.6.5.2	GID	
The HDSL synchronization state machine	5.6.5.3	5.6.5.3	M	
Regenerator related procedures	5.6.6	5.6.6	Note 1	
Activation state diagrams for the REG	5.6.6.1	–	Note 1	
HDSL transceiver states at the REG-R	5.6.6.1.1	–	Note 1	
HDSL transceiver states at the REG-C	5.6.6.1.2	–	Note 1	
The pair identification mechanism	–	5.6.7	–	
Pair identification initial values	–	5.6.7.1	–	
Pair identification at the NTU	–	5.6.7.2	–	
Pair identification at the LTU	–	5.6.7.3	–	
Redefinition of pair sequence	–	5.6.7.4	–	
Note 1 “M”, if regenerator is used.				

TABLE 7: HDSL CORE SPECIFICATION - OPERATION AND MAINTENANCE				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Operation and maintenance	5.7	5.7	GID	
Functions at the LTU external OAM reference point	5.7.1	5.7.1	GID	
Functions at the NTU external OAM reference point	5.7.2	5.7.2	O	
OAM messages and functions supported by the HDSL core	5.7.3	5.7.3	M	
Power feeding related OAM functions	5.7.4	5.7.4	M	
Regenerator behaviour	5.7.5	5.7.5	–	Heading
Response to LOS/LFA	5.7.5.1	5.7.5.1	Note 1	
Operation of loopback 1A	5.7.5.2	5.7.5.2	Note 1	
Note 1 “M”, if regenerator is used.				

TABLE 8: HDSL CORE SPECIFICATION - ELECTRICAL CHARACTERISTICS OF A SINGLE 2B1Q TRANSCEIVER				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Electrical characteristics of a single 2B1Q transceiver	5.8	5.8	–	Heading
General	5.8.1	5.8.1	M	
Transmitter/receiver impedance and return loss	5.8.2	5.8.2	M	
Transceiver reference clock	5.8.3	5.8.3	M	
Transmitter output characteristics	5.8.4	5.8.4	GID	
Pulse amplitude	5.8.4.1	5.8.4.1	M	
Pulse shape	5.8.4.2	5.8.4.2	M	
Power spectral density	5.8.4.3	5.8.4.3	–	Heading
Power spectral density for 392 kbaud systems	5.8.4.3.1	5.8.4.3.1	Note 1	
Power spectral density for 584 kbaud systems	5.8.4.3.2	5.8.4.3.2	Note 1	
Power spectral density for 1160 kbaud systems	5.8.4.3.3	–	Note 1	
Total power	5.8.4.4	5.8.4.4	M	
Unbalance about earth	5.8.5	5.8.5	–	Heading
Longitudinal conversion loss	5.8.5.1	5.8.5.1	M	
Longitudinal output voltage	5.8.5.2	5.8.5.2	M	
Note 1 Depending on the baud rate of the system, the requirements thereof are mandatory.				

TABLE 9: HDSL CORE SPECIFICATION - PERFORMANCE OF INDIVIDUAL HDSL TRANSCEIVERS				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Performance of individual HDSL transceivers	5.9	5.9	–	Heading
Performance requirements	5.9.1	5.9.1	GID	
DLL physical models (test loops)	5.9.2	5.9.2	GID	
Jitter and wander	5.9.3	5.9.3	–	Heading
General	5.9.3.1	5.9.3.1	GID	
Input jitter tolerance at the HDSL transceiver at the NTU	5.9.3.2	5.9.3.2	M	
Output jitter tolerance at the HDSL transceiver at the NTU	5.9.3.3	5.9.3.3	M	
Input jitter tolerance at the HDSL transceiver at the LTU	5.9.3.4	5.9.3.4	GID	
Output jitter tolerance at the HDSL transceiver at the LTU	5.9.3.5	5.9.3.5	GID	

TABLE 10 : COMMON CIRCUITRY SPECIFICATION				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Delay difference buffer	6.1	6.1	M	
The pair identification mechanism	6.2	–	GID	Only available for 2048 kbit/s applications
Pair identification initial values	6.2.1	–	GID	
Pair identification at the NTU	6.2.2	–	GID	
Pair identification at the LTU	6.2.3	–	GID	
Laboratory performance measurements	6.3	7.1.3.3	–	Heading
General	6.3.1	7.1.3.3.1	GID	
Test configuration	6.3.2	7.1.3.3.2	GID	
Test procedure with shaped noise	6.3.3	7.1.3.3.3	GID	
Test procedure for impulse noise	6.3.4	7.1.3.3.4	GID	
Common mode rejection test	6.3.5	7.1.3.3.5	GID	
Micro interruption test	6.3.6	7.1.3.3.6	GID	

TABLE 11 : POWER FEEDING				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
General	7.1	8.1	O	
Wetting current	7.2	8.2	O	
Remote power feeding aspects	7.3	8.3	O	
Remote power feeding aspects at the LTU	7.3.1	8.3.3	O	
Remote power feeding aspects at the NTU	7.3.2	8.3.1	O	
Remote power feeding aspects at the regenerator	7.3.3	8.3.2	O	

TABLE 12 : ENVIRONMENTAL REQUIREMENTS				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Climatic conditions	8.1	9.1	GID	
Safety	8.2	9.2	GID	Part A, section 3 of this Specification applies.
Overvoltage protection	8.3	9.3	GID	
Electromagnetic compatibility (EMC)	8.4	9.4	GID	IDA TS EMC applies.

TABLE 13 : ANNEXES & APPENDICES				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Transmission system for 1544 kbit/s two-pair system application	Annex A	–	GID	
Frame structure of the two-pair system for 784 kbit/s	A.1	–	GID	
High bit rate Digital Subscriber Line (HDSL) CAP based system	Annex B	–	–	Heading
Scope and general information	B.1	–	GID	
References	B.2	–	GID	
Abbreviations	B.3	–	GID	
Reference configuration and functional description	B.4	–	GID	
HDSL core specification	B.5	–	–	Heading
Functions	B.5.1	–	O	
Transmission medium	B.5.2	–	O	
Transmission method	B.5.3	–	O	
Frame structure	B.5.4	–	O	
HDSL embedded operations channel (eoc)	B.5.5	–	O	
Start-up procedure	B.5.6	–	O	
Operation and maintenance	B.5.7	–	O	
Electrical characteristics of CAP-based transceivers	B.5.8	–	O	
Performance of individual HDSL transceivers	B.5.9	–	O	
Common circuitry specification	B.6	–	O	
Power feeding	B.7	–	O	
Environmental requirements	B.8	–	GID	

TABLE 13 : ANNEXES & APPENDICES (CONTINUED)				
TITLE	ITU-T REC G.991.1	ETSI ETR 152	CR	REMARKS
Application specific examples	Appendix I	–	–	Heading
Application specific requirements for ISDN PRA with 2048 kbit/s	I.1	7.1.3	O	
Application specific requirements for the European 2048 kbit/s digital unstructured leased line (D2048U)	I.2	–	O	
Application specific requirements for the European 2048 kbit/s digital structured leased line (D2048S)	I.3	–	O	
Application specific requirements for fractional installation	I.4	–	O	
Application specific requirements for partial operation	I.5	–	O	
Application specific requirements for the 2048 kbit/s mapped into TU-12 structure	I.6	–	O	
Detailed definition of cable characteristics and test loops	Appendix II	Annex A	GID	
Bibliography	Appendix III	–	GID	