iDA SINGAPORE

Telecommunications Standards Advisory Committee (TSAC)

Draft Technical Specification

Asymmetrical Digital Subscriber Line Modems

Draft IDA TS ADSL
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IDA TS ADSL Issue 2, XXX 2013 [Revision: 0]	Technical Specification for Asymmetrical Digital Subscriber Line Modems
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Content

Technical Specification for
Asymmetrical Digital Subscriber Line (ADSL)
Modems

1   Scope

1.1   This Specification defines the physical layer characteristics of the Asymmetrical Digital Subscriber Line (ADSL) interface for the second generation ADSL modems. The purpose of the Specification is to ensure proper inter-working of ADSL modems at the customer end (ATU-R) and network operator end (ATU-C) in terms of interaction and electrical characteristics. It defines a variety of frame bearers in connection with or without an underlying service. For example:

(a)   ADSL transmission simultaneously on the same metallic twisted pair with voice band services;

(b)   ADSL transmission without any underlying service, optimised for deployment with ADSL over voice band services in the same binder cable;

(c)   ADSL transmission with specific requirements for Reach Extended ADSL2, simultaneously on the same metallic twisted pair with voice band services; and

(d)   ADSL transmission with extended upstream bandwidth, simultaneously on the same pair with voice band services.

1.2   This Specification outlines the second generation ADSL (ADSL2 and ADSL2plus) in accordance with the ITU-T Rec. G.992.3 for "Asymmetric digital subscriber line transceivers 2 (ADSL2)", and the ITU-T Rec. G.992.5 for "Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2+)", which have been developed with reference to the first generation ADSL defined in the ITU-T Rec. G.992.1. More features have been added, which include the support of data rates exceeding 8 Mbit/s downstream and 800 kbit/s upstream, the enhanced on-line reconfiguration capabilities, the new line diagnostics procedures and conformance testing, and so on.

1.3   The use of the Broadband Forum's ADSL2/ADSL2plus Functionality Test Plan (TR-105) is recommended for verifying implementation of the transceiver functional requirements in the ADSL modems, for conformity with the ITU-T Rec. G.992.3 and G.992.5. The TR-105 has been developed in relation to the physical layer management for ADSL defined in the ITU-T Rec. G.997.1, for operations, administration and maintenance (OAM) configuration, and performance monitoring, which enables the deployment of interoperable ADSL2/ADSL2+ services.

1.4   It is intended that ADSL modems are designed for multi-mode operation, capable of supporting ADSL2 and/or ADSL2+ standards that provide for backward compatibility, for interworking with network equipment of the first generation ADSL standards.

1.5   The application models for ITU-T Rec. G.992.3/G.992.5 are based on the generic reference configurations as shown in Figures 1 and 2 (Figures 5-4 and 5-5/G.992.3). The application models for ADSL data service only and ADSL data service with underlying POTS services shall be applicable.
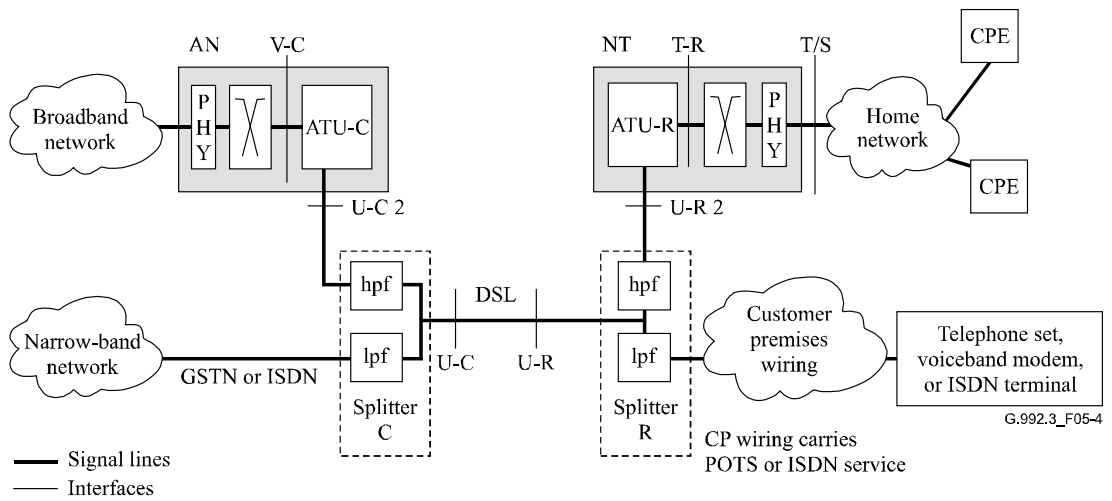
Figure 1 (Figure 5-4/G.992.3): Generic application reference model for
remote deployment with splitter
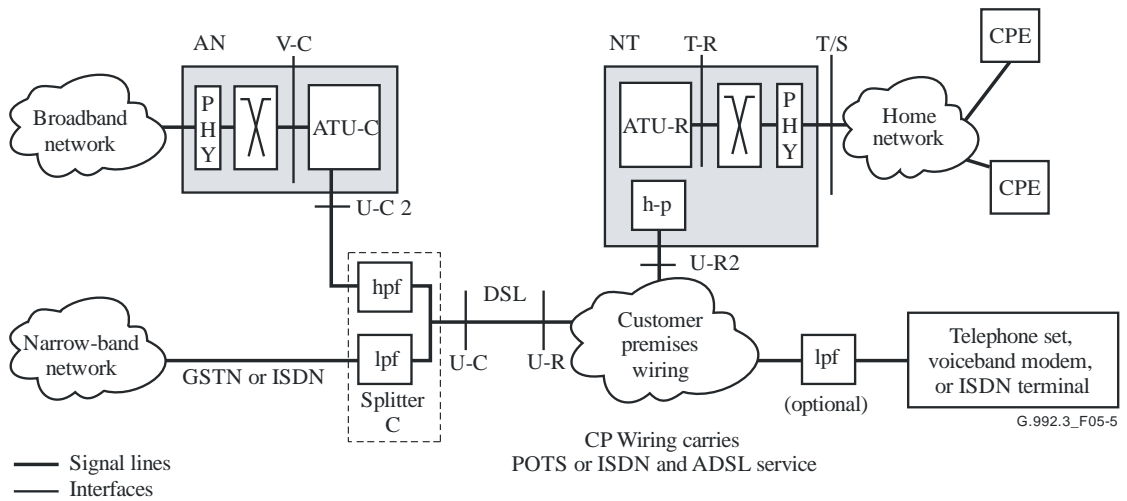
Figure 2 (Figure 5-5/G.992.3): Generic application reference model for
splitterless remote deployment

2   General Requirements

2.1   Power Supply

The equipment may be AC powered or DC powered. For AC powered equipment, the Specification shall be complied with when operating from an AC mains supply of voltage, 230V ± 10% and frequency, 50 Hz ± 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 TE 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.

2.3   Safety Requirements

The equipment shall be tested for compliance with the International Electrotechnical Commission IEC 60950-1 safety standard[1]. The requirements in IEC 60950-1 that are applicable to the equipment [e.g. class of equipment, type of telecommunication network voltage (TNV) circuit and types of components] shall be identified and complied with.

2.4   Electromagnetic Compatibility (EMC) Requirement

The equipment shall comply with the EMC requirements defined in IEC CISPR 22.

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[1] The safety standard includes, among others, protection of telecommunications network service personnel and users of other equipment connected to the network from hazards in the equipment.

3   Abbreviations

3.1   The following abbreviations are used:

AC   Alternating Current
AN   Access Node
ATM   Asynchronous Transfer Mode
ATU-C   Asymmetric digital subscriber line Transceiver Unit at the central office end (i.e., network operator)
ATU-R   Asymmetric digital subscriber line Transceiver Unit at the remote terminal end (i.e., customer premises)
CP   Customer Premises
CPE   Customer Premises Equipment
DC   Direct Current
DSL   Digital Subscriber Line
GSTN   General Switched Telephone Network
HPF   High-Pass Filter
ISDN   Integrated Services Digital Network
LPF   Low-Pass Filter
MPS   Management Protocol Specific
NT   Network Termination
NTR   Network timing reference: 8 kHz reference to be transmitted downstream
PHY   Physical layer
PMD   Physical Media Dependent (sublayer)
PMS-TC   Physical Media-Specific Transmission Convergence
POTS   Plain Old Telephone Service (one of the services using the voice band; sometimes used as a descriptor for all voice band services)
PSD   Power Spectral Density
PTS   Packet Transport Specific
STM   Synchronous Transfer Mode
T/S   Interface(s) between asynchronous digital subscriber line network termination and customer premises equipment or home network
TC   Transmission Convergence (sublayer)
TPS-TC   Transmission Protocol-Specific Transmission Convergence layer
T-R   Interface(s) between ATU-R and switching layer (ATM or STM or Packet)
U-C   Loop interface – Central office end
U-R   Loop interface – Remote terminal end
V-C   Logical interface between ATU-C and a digital network element such as one or more switching systems

4 Asymmetric Digital Subscriber Line Transceivers 2 (ADSL2) & ADSL Transceivers – Extended Bandwidth (ADSL2+)

4.1 ADSL modems shall comply with mandatory requirements set out in the ITU-T Rec. G.992.3/ G.992.5.

Title	§	ITU-T Rec. G.992.3	ITU-T Rec. G.992.5
Scope	1		
References	2		
Definitions	3		
Abbreviations	4		
Reference models	5	Application models for data service application model, and data with POTS service application model are with reference to Figures 1 and 2 (Figures 5-4 and 5-5/G.992.3).	See § 5 of G.992.3, adding "G.992.5 provides tools for the operator of the access network to control the ADSL transmit PSD and aggregate power in the downstream and upstream directions."
Transport Protocol Specific Transmission Convergence (TPS-TC) function	6	Heading	ADSL modem shall support the TPS-TC transport capabilities and functions, interfaces and procedures as defined in § 6/G.992.3 and the relevant clauses in Annex K/G.992.3.
Transport capabilities	6.1	ADSL modem (ATU-R) shall support the procedures for transport of the output frame bearers of one to four unidirectional TPS-TC functions in both the upstream and downstream directions. ADSL modem shall support at least one combination of a TPS-TC function (of a type defined in Annex K/G.992.3 and Annex K/G.992.5). STM-TC (K.1/G.992.3) is not applicable. ATM-TC (K.2/G.992.3) is supported. PTM-TC (K.3/G.992.3) is optional.	
Interface signals and primitives	6.2		
Control parameters	6.3	Control parameters of the TPS-TC function as defined in Table 6-1/G.992.3, shall be supported. All the mandatory control parameters for the ATM-TC type described in K.2/G.992.3 shall also be supported.	
Data plane procedures	6.4		
Management plane procedures	6.5	Each TPS-TC function may provide local management primitives as defined in Annex K/G.992.3.	
Initialization procedure	6.6		
On-line reconfiguration	6.7	On-line reconfiguration procedures are defined uniquely for each TPS-TC type in Annex K/G.992.3.	
Power management mode	6.8		

Title	§	ITU-T Rec. G.992.3	ITU-T Rec. G.992.5
Physical Media Specific Transmission Convergence (PMS-TC) function	**7**	Heading	Heading
Transport capabilities	7.1	ADSL modem shall support the PMS-TC function for multiplexing and transporting several channels of information.	See § 7.1 of G.992.3.
Additional functions	7.2		See § 7.2 of G.992.3.
Block interface signals and primitives	7.3		See § 7.3 of G.992.3.
Block diagram and internal reference point signals	7.4		See § 7.4 of G.992.3.
Control parameters	7.5	All mandatory control parameter configurations described in § 7.6.3 of ITU-T Rec. G.992.3 shall be supported by each ATU.	See § 7.5 of G.992.3.
Frame structure	7.6		See § 7.6 of G.992.3, except for modifications shown in § 7.6.2 of G.992.5, and Tables 7-8 and 7-9/G.992.5.
Data plane procedures	7.7		See § 7.7 of G.992.3.
Control plane procedures	7.8	An ATU-C may optionally transport an 8-kHz timing marker as NTR to support the transport of a timing reference from a voice PSTN access network to equipment located with the ATU-R.	See § 7.8 of G.992.3.
Management plane procedures	7.9		See § 7.9 of G.992.3.
Initialization procedures	7.10		See § 7.10 of G.992.3, except for modifications shown in § 7.10 of G.992.5 and Table 7-18/G.992.5.
On-line reconfiguration	7.11		See § 7.11 of G.992.3.
Power management mode	7.12		See § 7.12 of G.992.3.

Title	§	ITU-T Rec. G.992.3	ITU-T Rec. G.992.5
Physical media dependent function	**8**	Heading	Heading
Transport capabilities	8.1	ADSL modem shall support the PMD function for transporting a bitstream over the physical medium (i.e. over the copper pairs) in both the upstream and downstream directions.	See § 8.1 of G.992.3.
Additional functions	8.2		See § 8.2 of G.992.3.
Block interface signals and primitives	8.3		See § 8.3 of G.992.3.
Block diagram and internal reference point signals	8.4		See § 8.4 of G.992.3.
Control parameters	8.5	The valid control parameter settings for the transmit PMD function are shown in Tables 8-7 and 8-9 of ITU-T Rec. G.992.3 for the ATU-C and ATU-R, respectively. The mandatory control parameter settings for the transmit PMD function are shown in Tables 8-8 and 8-10 of ITU-T Rec. G.992.3 for the ATU-C and ATU-R, respectively.	See § 8.5 of G.992.3, and additional text given in § 8.5.1 and § 8.5.3 of G.992.5.
Constellation encoder for data symbols	8.6		See § 8.6 of G.992.3.
Constellation encoder for synchronization and L2 exit symbols	8.7		See § 8.7 of G.992.3.
Modulation	8.8		See § 8.8 of G.992.3, and modifications shown in § 8.8.3, § 8.8.4 and § 8.8.5 of G.992.5.
Transmitter dynamic range	8.9		See § 8.9 of G.992.3, and additional text given in § 8.9 of G.992.5.
Transmitter spectral masks	8.10	ADSL modem shall operate within the spectral mask(s) for the service option(s) it is supporting, as defined in the corresponding Annexes to the ITU-T Rec. G.992.3.	See § 8.10 of G.992.3, and modifications shown in § 8.10 of G.992.5. Annex L is not defined in G.992.5.
Control plane procedures	8.11		See § 8.11 of G.992.3.
Management plane procedures	8.12		See § 8.12 of G.992.3, and modifications shown in § 8.12.5.1 of G.992.5.
Initialization procedures	8.13	ADSL modem may implement FDM or EC to separate upstream and downstream signals.	See § 8.13 of G.992.3, and additional text given in § 8.13 of G.992.5.
Short initialization procedures	8.14	Short Initialization Sequence shall be optional. If the Short Initialization Sequence is supported, the ADSL modem should also support unbalanced bitswap.	See § 8.14 of G.992.3, replacing Figure 8-34/G.992.3 with Figure 8-34/G.992.5.
Loop diagnostics mode procedures	8.15		See § 8.15 of G.992.3, and modifications shown in § 8.15 of G.992.5 for Tables 8-43, 8-46 and 8-47, § 8.15.5.2 of G.992.5 and Tables 8-55 to8-63.
On-line reconfiguration of the PMD function	8.16		See § 8.16 of G.992.3.
Power management in the PMD function	8.17		See § 8.17 of G.992.3.

Title	§	ITU-T Rec. G.992.3	ITU-T Rec. G.992.5
Management Protocol Specific Transmission Convergence (MPS-TC) functions	**9**	ADSL modem (ATU-R) provides procedures to facilitate management of the ATUs. The MPS-TC functions communicate with the physical layer management functions as described the ITU-T Rec. G.997.1.	See § 9 of G.992.3.
Transport functions	9.1	As a management plane element, the MPS-TC provides transport of the clear eoc and command messages and ATU-R management defects and anomalies.	See § 9.1 of G.992.3.
Additional functions	9.2		See § 9.2 of G.992.3.
Block interface signals and primitives	9.3		See § 9.3 of G.992.3.
Management plane procedures	9.4		See § 9.4 of G.992.3, and modifications shown in § 9.4.1 of G.992.5.
Power management	9.5		-
Dynamic behaviour	**10**	ATUs contain dynamic behaviours, which include features for initialization, on-line reconfigurations and power management transitions.	See § 10 of G.992.3.
Initialization	10.1		
On-line Reconfiguration (OLR)	10.2		
Power management	10.3		

Title	§	ITU-T Rec. G.992.3	ITU-T Rec. G.992.5
Specific requirements for an ADSL system operating in the frequency band above POTS	**Annex A**	Heading (See Notes 1 and 2, for splitterless ADSL2 modems based on G.992.4.)	Heading
ATU-C functional characteristics (pertains to § 8)	**A.1**	For the ATU-C downstream, with overlapped spectrum, the widest possible band used is 25.875 to 1104 kHz, and with non-overlapped spectrum, the widest possible band used is 138 to 1104 kHz.	For the ATU-C downstream, with overlapped spectrum, the widest possible band used is 25.875 to 2208 kHz, and with non-overlapped spectrum, the widest possible band used is 138 to 2208 kHz.
ATU-R functional characteristics (pertains to § 8)	**A.2**	ADSL modem shall comply with the ATU-R upstream transmit spectral mask specified in Figure A.3/G.992.3. The widest possible band used is 25.875 to 138 kHz. The PSD template nominal passband transmit PSD level is −38 dBm/Hz, and aggregate transmit power is 12.5 dBm.	ADSL modem shall comply with the ATU-R upstream transmit spectral mask specified in Figure A.3/G.992.5. The widest possible band used is 25.875 to 138 kHz. The PSD template nominal passband aggregate transmit power is 12.5 dBm.
Initialization	**A.3**		See A.3 of G.992.3.
Electrical characteristics	**A.4**		See A.4 of G.992.3, and modifications shown in A.4.3.3.1 of G.992.5: "The ATU-R shall have a longitudinal conversion loss (LCL) of at least 40 dB in the frequency range from 1104 kHz to 2208 kHz".
Specific requirements for an ADSL system operating in the frequency band above ISDN as defined in ITU-T Rec. G.961 Appendices I and II	**Annex B**	Not applicable	Not applicable
Specific requirements for an ADSL system operating in the same cable as ISDN as defined in ITU-T Rec. G.961 Appendix III	**Annex C**	Not applicable	Not applicable
ATU-C and ATU-R state diagrams	**Annex D**	General information and description	General information and description (See Annex D of G.992.3.)
POTS and ISDN Basic Access Splitters	**Annex E**	Optional requirement (See Note 3, for splitterless ADSL2 modems based on G.992.4.)	See Annex E of G.992.3. Where applicable, operation according to Annexes A and I, the G.992.3 requirements applying over frequency band up to 1104 kHz, shall be met by frequency band up to 2208 kHz.
Type 1 – POTS splitter – Europe	**E.1**	Where applicable, ADSL/POTS splitters shall comply with ETSI TS 101 952-1 (see Annex L of IDA TS PSTN Issue 2), and the total (across tip and ring at the POTS port) impedance in the 2 to 10 MHz frequency band should be at least 160 Ω.	

Title	§	ITU-T Rec. G.992.3	ITU-T Rec. G.992.5
Type 2 – POTS splitter – North America	**E.2**	Where applicable, the customer premises POTS splitter shall comply with ATIS-0600016, and the total (across tip and ring at the POTS port) impedance in the 2 to 10 MHz frequency band should be at least 160 Ω.	
Type 3 – ISDN (ITU-T Rec. G.961 Appendix I or II) Splitter – Europe	**E.3**	Not applicable	Not applicable
Type 4 – POTS splitter – Japan	**E.4**	Optional requirement	Optional requirement
ATU-x performance requirements for region A (North America)	**Annex F**	Optional requirement	Further study by ITU-T
ATU-x performance requirements for region B (Europe)	**Annex G**	Optional requirement	Further study by ITU-T
Specific requirements for a synchronized symmetrical DSL (SSDSL) system operating in the same cable binder as ISDN as defined in ITU-T Rec. G.961 Appendix III	**Annex H**	Not applicable	Further study by ITU-T
All digital mode ADSL with improved spectral compatibility with ADSL over POTS	**Annex I**	Optional requirement (See Note 4, for splitterless ADSL2 modems based on G.992.4.) Where applicable, for ATU-C downstream with overlapped spectrum, the widest possible band used is 3 to 1104 kHz, and with non-overlapped spectrum, the widest possible band used is 138 to 1104 kHz. Where applicable, the ADSL modem shall comply with the ATU-R upstream transmit spectral mask specified in Figure I.2/G.992.3. The widest possible band used is 3 to 138 kHz. The PSD template nominal passband transmit PSD level is −38 dBm/Hz, and aggregate transmit power is 13.3 dBm.	Optional requirement Where applicable, for ATU-C downstream with overlapped spectrum, the widest possible band used is 3 to 2208 kHz, and with non-overlapped spectrum, the widest possible band used is 138 to 2208 kHz. Where applicable, the ADSL modem shall comply with the ATU-R upstream transmit spectral mask specified in Figure I.2/G.992.5. The widest possible band used is 3 to 138 kHz. The PSD template nominal passband transmit PSD level is −38 dBm/Hz, and aggregate transmit power is 13.3 dBm.

Note 1: The requirements defined for splitterless ADSL2 modems in ITU-T Rec. G.992.4, are largely the same as those defined for ADSL2 modems in ITU-T Rec. G.992.3, except for the specific requirements set out in Annexes A, E and I of G.992.4.

Note 2: Where applicable, for the ATU-C downstream (A.1.2 and A.1.3 of G.992.4), with overlapped spectrum, the widest possible band used is 25.875 to 552 kHz, and with non-overlapped spectrum, the widest possible band used is 138 to 552 kHz.

Note 3: G.992.4 is intended for installation without splitters. However, if splitters are provided for operation with POTS they shall be as described in Annex E/G.992.3.

Note 4: Where applicable, for the ATU-C downstream with overlapped spectrum, the widest possible band used is 3 to 552 kHz, and with non-overlapped spectrum, the widest possible band used is 138 to 552 kHz.

Title	§	ITU-T Rec. G.992.3	ITU-T Rec. G.992.5
All Digital Mode ADSL with improved spectral compatibility with ADSL over ISDN	**Annex J**	Not applicable	Not applicable
TPS-TC functional descriptions	**Annex K**	General information and description (For splitterless ADSL2 modems based on G.992.4, see Annex K of G.992.3, and exceptions given in § 6 of G.992.4.)	General information and description See Annex K of G.992.3, and changes given in Annex K of G.992.5.
STM Transmission Convergence (STM-TC) function	**K.1**	Not applicable	Not applicable
ATM Transmission Convergence (ATM-TC) function	**K.2**	Mandatory requirement	Mandatory requirement
Packet transmission convergence function (PTM-TC)	**K.3**	Optional requirement	Optional requirement
Specific requirements for a Reach Extended ADSL2 (READSL2) system operating in the frequency band above POTS	**Annex L**	Optional requirement For an ATU supporting Annex L, support of Annex A is mandatory. For an ATU supporting Annex A, support of Annex L is optional.	Intentionally left blank
Specific requirements for an ADSL system with extended upstream bandwidth, operating in the frequency band above POTS	**Annex M**	Optional requirement	Optional requirement
64/65-octet PTM-TC sublayer functional specifications	**Annex N**	Optional requirement	Intentionally left blank
-	**Annex O**	Intentionally left blank.	Intentionally left blank
Reduced downstream aggregate transmit power requirements	**Annex P**	Optional requirement	See Annex P of G.992.3.
Note 5: Annexes L to P of G.992.3 are not applicable to splitterless ADSL2 modems.			

Title	§	ITU-T Rec. G.992.3	ITU-T Rec. G.992.5
ATM layer to physical layer logical interface	**Appendix I**	General information and description	See Appendix I of G.992.3.
Compatibility with other customer premises equipment	**Appendix II**	General information and description	See Appendix II of G.992.3.
The impact of primary protection devices on line balance	**Appendix III**	General information and description	See Appendix III of G.992.3.
Example overlapped PSD masks for use in a TCM-ISDN crosstalk environment	**Appendix IV of G.992.3**	General information and description	-
PSD template to be used in capacity calculations with in-band transmit spectrum shaping	**Appendix IV of G.992.5**	-	General information and description
Constraints on delay, impulse noise protection, overhead rate, and net data rate when bonding	**Appendix V**	General information and description	General information and description
Packet layer to physical layer logical interface	**Appendix VI**	General information and description	See Appendix VI of G.992.3.
ADSL2 automoding	**Appendix VII**	General information and description	See Appendix VII of G.992.3.
Impact of loop and ATU impedance mismatch on the Hlog accuracy	**Appendix VIII**	General information and description	See Appendix VIII of G.992.3.

5   References

5.1   For the technical requirements captured in this Specification, reference has been made to the following documents:

ITU-T Rec. G.992.3 (04/09)   Asymmetric Digital Subscriber Line Transceivers 2 (ADSL2)

ITU-T Rec. G.992.4 (07/02)   Splitterless Digital Subscriber Line Transceivers 2 (Splitterless ADSL2)

ITU-T Rec. G.992.5 (01/09)   Asymmetric Digital Subscriber Line (ADSL) Transceivers – Extended Bandwidth (ADSL2+)

ITU-T Rec. G.997.1 (06/12)   Physical layer management for digital subscriber line transceivers

IEC 60950-1 (2005)   Information Technology Equipment – Safety

IEC CISPR 22 (2008)   Information Technology Equipment – Radio disturbance characteristics – Limits and methods of measurement

Draft IDA TS PSTN (2013)   Technical Specification for Terminal Equipment connected to the Network Terminating Equipment (NTE) or the Public Switched Telephone Network (PSTN) for access to voice band services

BBF TR-105 (Nov 2011)   ADSL2/ADSL2plus Functionality Test Plan

Annex A
Corrigendum / Addendum

Changes to IDA TS ADSL Issue 1 Rev 2 (May 11)			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
—	—	This Specification has been streamlined for the second generation ADSL modems – ADSL2/ADSL2+, based on ITU-T Rec. G.992.3/G.992.5 (2009). Implementation of the functional requirements conforming to G.992.3/G.992.5 may be verified, using the BBF TR-105 (2011). It is intended that ADSL modems are designed for multi-mode operation, capable of supporting ADSL2 and/or ADSL2+ standards that provide for backward compatibility, for interworking with network equipment of the first generation ADSL standards (based on the ITU-T Rec. G.992.1). References to the first generation ADSL standards are no longer required, as G.992.3 has been developed in relation to G.992.1. This Specification has been re-issued as the IDA Technical Specification for ADSL modems (IDA TS ADSL Issue 2).	XX 13

Changes to IDA TS ADSL Issue 1 Rev 1 (Apr 06)			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
—	—	Change of IDA's address at cover page to Mapletree Business City.	1 May 11

Changes to IDA TS ADSL Issue 1 (Jul 05)			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
—	—	The Specification has included the technical requirements for the second generation ADSL modems (G.992.3 and G.992.4) as well as for the ADSL 2+ modems (G.992.5).	Apr 06

Changes to IDA TS ADSL 1 and TS ADSL 2			
Page	**TS Ref.**	**Items Changed**	**Date of Issue**
—	—	The IDA TS ADSL Issue 1 (Jul 05) has superseded the IDA TS ADSL 1 Issue 1 Rev 1 (Jun 2000) and TS ADSL 2 Issue 1 (Sep 2000).	21 Jul 05
—	—	Title of Specification has been renamed as "Technical Specification for Asymmetric Digital Subscriber Line Modems" (IDA TS ADSL Issue 1). There are no changes to the technical requirements for the first generation ADSL modems (G.992.1 and G.992.2).	21 Mar 05