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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Metallic access networks

Physical layer management for digital subscriber line transceivers

Recommendation ITU-T G.997.1

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Recommendation ITU-T G.997.1

Physical layer management for digital subscriber line transceivers

Summary

Recommendation ITU-T G.997.1 specifies:

– the physical layer management for asymmetric digital subscriber line (ADSL) and very high speed digital subscriber line 2 (VDSL2) transmission systems;

– means of communication on a transport transmission channel defined in the physical layer (see Recommendations ITU-T G.992.1, ITU-T G.992.2, ITU-T G.992.3, ITU-T G.992.4, ITU-T G.992.5 and ITU-T G.993.2;

– network element (NE) content and syntax for configuration, fault and performance management.

This edition of Recommendation ITU-T G.997.1:

• includes the management information base (MIB) elements for the physical layer management of Recommendation ITU-T G.993.2 and additional MIB elements for the physical layer management of Recommendations ITU-T G.992.3 and ITU-T G.992.5;

• adds support for Annex N of ITU-T G.993.2 power spectral density (PSD) masks;

• adds support of maximum error-free throughput (MAXEFTR) and extends the specification of error-free bits counter and minimum error-free throughput (MINEFTR) the parameters to apply to lines with retransmission inactive.

History

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Keywords

VDSL transceivers, ADSL transceivers, management, performance monitoring

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T G.997.1

Physical layer management for digital subscriber line transceivers

1 Scope

This Recommendation specifies the physical layer management for asymmetric digital subscriber line (ADSL) and very high speed digital subscriber line 2 (VDSL2) transmission systems based on the usage of indicator bits and embedded operations channel (EOC) messages specified in the ITU-T G.992.x series of Recommendations and in [ITU-T G.993.2], and the clear EOC specified in this Recommendation.

This Recommendation specifies network management elements content for configuration, fault and performance management.

The mechanisms to provide operations, administration and maintenance (OAM) functions, and to generate OAM flows F1, F2 and F3, depend on the transport mechanism of the physical layer transmission system, as well as on the supervision functions contained within the physical layer termination functions of equipment. This Recommendation specifies only flow F3 – transmission path level.

For interrelationships of this Recommendation with other Recommendations of the ITU-T G.99x-series, see [ITU-T G.995.1].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.992.1] Recommendation ITU-T G.992.1 (1999), *Asymmetric digital subscriber line (ADSL) transceivers*.

[ITU-T G.992.2] Recommendation ITU-T G.992.2 (1999), *Splitterless asymmetric digital subscriber line (ADSL) transceivers*.

[ITU-T G.992.3] Recommendation ITU-T G.992.3 (2009), *Asymmetric digital subscriber line transceivers 2 (ADSL2)*.

[ITU-T G.992.4] Recommendation ITU-T G.992.4 (2002), *Splitterless asymmetric digital subscriber line transceivers 2 (splitterless ADSL2)*.

[ITU-T G.992.5] Recommendation ITU-T G.992.5 (2009), *Asymmetric digital subscriber line 2 (ADSL2) transceivers – Extended bandwidth ADSL2 (ADSL2plus)*.

[ITU-T G.993.2] Recommendation ITU-T G.993.2 (2019), *Very high speed digital subscriber line transceivers 2 (VDSL2)*.

[ITU-T G.993.5] Recommendation ITU-T G.993.5 (2019), *Self-FEXT cancellation (vectoring) for use with VDSL2 transceivers*.

[ITU-T G.994.1] Recommendation ITU-T G.994.1 (2018), *Handshake procedures for digital subscriber line transceivers*.

[ITU-T G.995.1] Recommendation ITU-T G.995.1 (2001), *Overview of digital subscriber line (DSL) Recommendations*.

[ITU-T G.998.4] Recommendation ITU-T G.998.4 (2018), *Improved impulse noise protection for digital subscriber line (DSL) transceivers*.

[ITU-T I.610] Recommendation ITU-T I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

[ITU-T T.35] Recommendation ITU-T T.35 (2000), *Procedure for the allocation of ITU-T defined codes for non-standard facilities*.

[IETF RFC 1157] IETF RFC 1157 (1990), *A simple network management protocol (SNMP).*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 anomaly [ITU-T G.992.1]: A discrepancy between the actual and desired characteristics of an item. The desired characteristic may be expressed in the form of a specification. An anomaly may or may not affect the ability of an item to perform a required function.

3.1.2 bearer channel [ITU-T G.992.1]: A user data stream of a specified data rate that is transported transparently by an ADSL system.

NOTE – Bearer channel is also referred to as frame bearer.

3.1.3 defect [ITU-T G.993.2]: A limited interruption in the ability of an item to perform a required function. It may or may not lead to maintenance action depending on the results of additional analysis. Successive anomalies causing a decrease in the ability of an item to perform a required function are considered a defect.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 accumulation period: Period of time used by the network management system to accumulate sufficient number of parameter samples.

3.2.2 clear embedded operations channel: An octet oriented data channel multiplexed in the physical layer transmission frame structure.

3.2.3 failure: Termination of the ability of an item to perform a required function.

NOTE – After failure, the item has a fault. Analysis of successive anomalies or defects affecting the same item can lead to the item being considered as "failed".

3.2.4 full initialization: Any type of initialization procedure specified in relevant Recommendations, except short initialization.

3.2.5 masked subcarrier: A subcarrier that is not transmitted during initialization and showtime.

3.2.6 MEDLEY set: A set of subcarriers used during the digital subscriber line initialization.

NOTE – This set is defined in the respective Recommendations.

3.2.7 net data rate: As defined in the ITU-T G.992.x-series of Recommendations and in [ITU-T G.993.2].

3.2.8 short initialization: A shortened type of initialization procedure, as specified in clause 7.2.1.3.3 and that includes fast retrain, as specified in [ITU-T G.992.2], and short initialization, as specified in [ITU-T G.992.3] and [ITU-T G.992.4].

3.2.9 showtime:

NOTE – As defined in the respective DSL Recommendation.

3.2.10 x-type digital subscriber line (xDSL): Any of the various types of digital subscriber line technology.

NOTE – Based on [ITU-T G.992.3].

3.2.11 α-interface, β-interface: Interface between the physical media specific-transmission convergence (PMS-TC) and the transport protocol specific-transmission convergence (TPS-TC) sub-layers of the x-type digital subscriber line transceiver unit (xTU), as specified in [ITU-T G.995.1] and the relevant Recommendations.

3.2.12 γ-interface: Application interface of the x-type digital subscriber line transceiver unit (xTU), as specified in [ITU-T G.995.1] and the relevant Recommendations.

3.2.13 VDSL2-LR mode: Operation according to [ITU-T G.993.2] Annex D or [ITU-T G.993.5] Annex B.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ADSL	Asymmetric Digital Subscriber Line
AME	ADSL Management Entity
AN	Access Node
ASCII	American Standard Code for Information Interchange
ATM	Asynchronous Transfer Mode
ATTNDR	Attainable Net Data Rate
ATU	ADSL Transceiver Unit
ATU-C	ADSL Transceiver Unit-Central office end
ATU-R	ADSL Transceiver Unit-Remote side
BER	Bit Error Ratio
CL	Capabilities List
CLR	Capabilities List Request
CO-MIB	Central Office-Management Information Base
CRC	Cyclic Redundancy Check
CV-C	Code Violation-Channel
CV-CFE	Code Violation-Channel Far-End
DMT	Discrete Multitone
DPBO	Downstream Power Back-Off
DTU	Data Transfer Unit
EOC	Embedded Operations Channel
ES	Errored Second
ES-L	Errored Second-Line
ES-LFE	Errored Second-Line Far-End

ETR	Expected Throughput
FEBE	Far-End Block Error
FEC	Forward Error Correction
FEC-C	Forward Error Correction-Channel
FEC-CFE	Forward Error Correction-Channel Far-End
FECS-L	Forward Error Correction Second-Line
FECS-LFE	Forward Error Correction Second-Line Far-End
FEXT	Far-End Crosstalk
FFEC	Far-end Forward Error Correction
HDLC	High-level Data Link Control
HEC	Header Error Control
ID	Identifier
IMA	Inverse Multiplexing over ATM
INM	Impulse Noise Monitoring
INP	Impulse Noise Protection
ISDN	Integrated Services Digital Network
LCD	Loss of Cell Delineation
LCD-FE	Far-End Loss of Cell Delineation
LDR	Loop Diagnostics mode Results
LDS	Loop Diagnostics mode Status
LDSF	Loop Diagnostic mode Status Forced
LINIT	Line Initialization
LOF	Loss of Frame
LOF-FE	Far-End Loss of Frame
LOS	Loss of Signal
LOS-FE	Far-End Loss of Signal
LOSS-L	LOS Second-Line
LPR	Loss of Power
LPR-FE	Far-End Loss of Power
LSB	Least Significant Bit
MAXEFTR	Maximum Error-Free Throughput
MDIO	Management Data Input/Output
ME	Management Entity
MIB	Management Information Base
MINEFTR	Minimum Error-Free Throughput
MSB	Most Significant Bit
MUF	Maximum Usable Frequency

NCD	No Cell Delineation
NCD-FE	Far-End No Cell Delineation
NE	Network Element
NEXT	Near-End Crosstalk
NMS	Network Management System
NT	Network Termination
OAM	Operations, Administration and Maintenance
OLR	On-Line Reconfiguration
ONU	Optical Network Unit
OOS	Out of Sync
OOS-FE	Far-End Out of Sync
PDU	Protocol Data Unit
PM	Performance Monitoring
PMD	Physical Media Dependent
PMSF	Power Management State Forced
PMS-TC	Physical Media Specific-Transmission Convergence
POTS	Plain Old Telephone Service
PSD	Power Spectral Density
PTM	Packet Transfer Mode
RDI	Remote Defect Indication
REIN	Repetitive Electrical Impulse Noise
RFI	Remote Failure Indication
RIPOLICY	Re-Initialization Policy
ROC	Robust Overhead Channel
SEF	Severely Errored Frame
SES	Severely Errored Second
SNMP	Simple Network Management Protocol
SNR	Signal-to-Noise Ratio
SOS	Save Our Showtime
SRA	Seamless Rate Adaptation
STM	Synchronous Transfer Mode
TC	Transmission Convergence
TCM-ISDN	Time Compression Multiplex-Integrated Services Digital Network
TE	Terminal Equipment
TPS-TC	Transport Protocol Specific-Transmission Convergence
TR	Threshold Report
UAS	Unavailable Second

UAS-L	Unavailable Second-Line
VCE	Vectoring Control Entity
VDSL2	Very high speed Digital Subscriber Line 2
VME	VDSL2 Management Entity
VTU	VDSL2 Transceiver Unit
VTU-O	VDSL2 Transceiver Unit-central Office
VTU-R	VTU at the Remote site
xDSL	x-type Digital Subscriber Line
xTU	xDSL Transceiver Unit
xTU-C	xDSL Transceiver Unit-Central office end
xTU-R	xDSL Transceiver Unit at the remote side

5 Overview

Figure 5-1 shows the system reference model for this Recommendation.

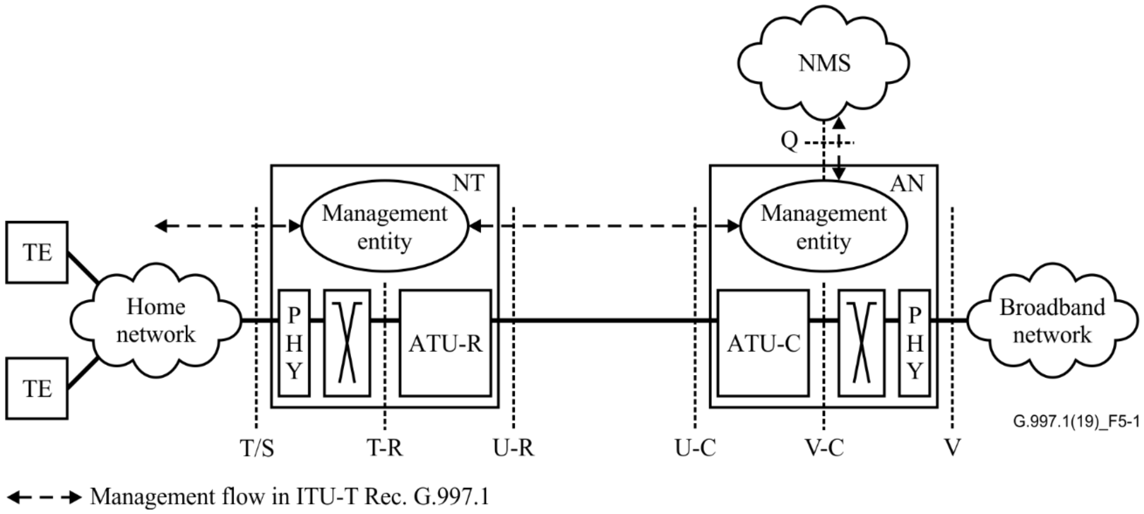

Figure 5-1 – System reference model

There are four management interfaces specified in this Recommendation.

The Q-interface is at the access node (AN) for network management systems (NMSs). All the parameters specified in this Recommendation apply at the Q-interface. The Q-interface provides the interface between the NMS of the operator and the management entity (ME) in the AN.

The near-end parameters supported in the ME at the AN are derived from the xDSL transceiver unit-central office end[1] (i.e., at the network operator) (xTU-C) while the far-end parameters from the xDSL

[1] A generic term referring to both the ADSL transceiver unit-central office end (ATU-C) of the ITU-T G.992.x series of Recommendations and the VDSL2 transceiver unit-central office or NE end (in the optical network unit (ONU) per [ITU-T G.993.2], i.e., network operator (VTU-O) of [ITU-T G.993.2]).

transceiver unit at the remote side[2] (i.e., at the subscriber end of the loop) (xTU-R) can be derived by either of two mechanisms over the U-interface:

- indicator bits and EOC messages can be used to generate the required xTU-R parameters in the ME of the AN;
- the OAM channel and protocol (specified in clause 6) can be used to retrieve the parameters from the xTU-R, when requested by the ME of the AN.

Outside the scope of this Recommendation are: specification of the transport of the management instrumentation over the Q-interface; coding of the management information transferred over the Q-interface.

Two management interfaces, the loop interface-central office end (U-C) at the xTU-C and loop interface-remote side (i.e., subscriber end of the loop) (U-R) at the xTU-R, are specified. Their main purposes are to provide:

- at the xTU-C: the xTU-C near-end parameters for the xTU-R to retrieve over the U-interface;
- at the xTU-R: the xTU-R near-end parameters for the xTU-C to retrieve over the U-interface.

This Recommendation specifies (see clause 6) a method for the communication of the xDSL transceiver unit (xTU) parameters specified in clause 7 over the U-interface.

NOTE 1 – In this Recommendation, U-C and U-R refer to the management interfaces that apply to the appropriate physical reference points specified in corresponding Recommendations. In [ITU-T G.993.2], the reference point U-C is referred to as U-O.

At the T/S-interface, a subset of the parameters specified in this Recommendation may apply. The purpose is to indicate the ADSL or VDSL2 link status to the terminal equipment (TE). These parameters are maintained by the ME of the network termination (NT) and are made available over the T/S-interface.

The G-interface refers to the management flows from the ME on the NT directly to the NMS when that flow crosses the U-C- and U-R-interface, but the management flow is not mediated by the ME on the AN. The specification of the protocols to support flows that cross the G-interface lies outside the scope of this Recommendation. The parameters supported at the G-interface are a superset of those supported at the T/S-interface and they are maintained by the ME of the NT.

The far-end parameters (from the xTU-C) can be derived by either of two mechanisms over the U-interface:

- indicator bits and EOC messages, which are provided at the physical media dependent (PMD) layer, can be used to generate the required xTU-C parameters in the ME of the NT;
- the OAM channel and protocol (specified in clause 6) can be used to retrieve the parameters from the xTU-C, when requested by the ME of the NT.

Outside the scope of this Recommendation are: specification of the transport of this management information over the T/S-interfaces; coding of the management information transferred over the T/S-interface.

Depending on the transceiver Recommendation (e.g., [ITU-T G.992.1] or [ITU-T G.992.2]), some of the parameters may not apply (i.e., fast data stream parameters for [ITU-T G.992.2]).

Specific parameters may be applicable to specific transceiver Recommendations. Tables 7-10 to 7-41 provide the applicability of any specific parameter to any particular Recommendation in the ITU-T G.992.x series of Recommendations or to [ITU-T G.993.2].

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[2] A generic term referring to both the ADSL transceiver unit-remote side (ATU-R; i.e., subscriber end of the loop) of the ITU-T G.992.x series of Recommendations and the VTU at the remote site (i.e., subscriber end of the loop) (VTU-R) of [ITU-T G.993.2].

NOTE 2 – Throughout this Recommendation, the use of the term xTU-C refers to both ATU-C and VTU-O, while the term xTU-R refers to both ATU-R and VTU-R.

5.1 Physical layer management mechanisms

OAM for ATM networks are specified generally in [ITU-T I.610]. This Recommendation uses this model for both ATM and packet transfer mode (PTM). The physical layer contains the three lowest OAM levels, as outlined in Figure 5-2. The allocation of the OAM flows is as follows:

– F1: regenerator section level;

– F2: digital section level;

– F3: transmission path level.

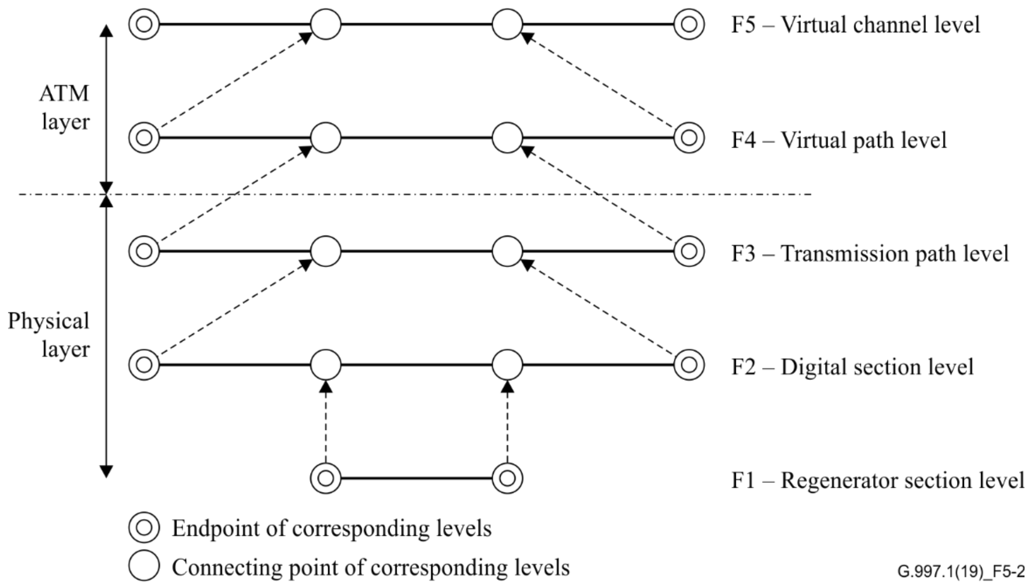


Figure 5-2 – Operations, administration and maintenance hierarchical levels and their relationship with the asynchronous transfer mode layer and physical layer

The physical levels F1 to F3 in this Recommendation are coupled with upper levels F4 and F5 from the fault management perspective. When an F3 fault (e.g., loss of signal (LOS)) is detected, it is reported to the NMS, but an F4/F5, as specified in [ITU-T I.610], fault is generated as well.

The OAM levels F1 to F3 cover the part of the system referred to as xDSL LINE in Figure 5-3. This part includes analogue processing and digital processing for the metallic transmission medium. Levels F1 to F3 provide performance monitoring (PM) of both analogue and digital line-related entities. The x-type digital subscriber line (xDSL) LINE is delimited by the two end points V-D (or α) and T-D (or β) as presented in Figure 5-3. The xDSL LINE is defined between the V-D (or α) and the T-D (or β) reference points.

The xDSL ATM PATH is defined between: a) the logical interface between an ADSL transceiver unit-central office end (ATU-C; i.e., network operator) and a digital network element (NE), such as one or more switching systems (V-C or γ_c); and b) an interface between ATU-R and switching layer (ATM, STM or PTM) (T-R or γ_r) reference points.

The xDSL PTM PATH is defined between the V-C (or γ_c) and T-R (or γ_r) reference points.

The xDSL STM PATH is for further study.

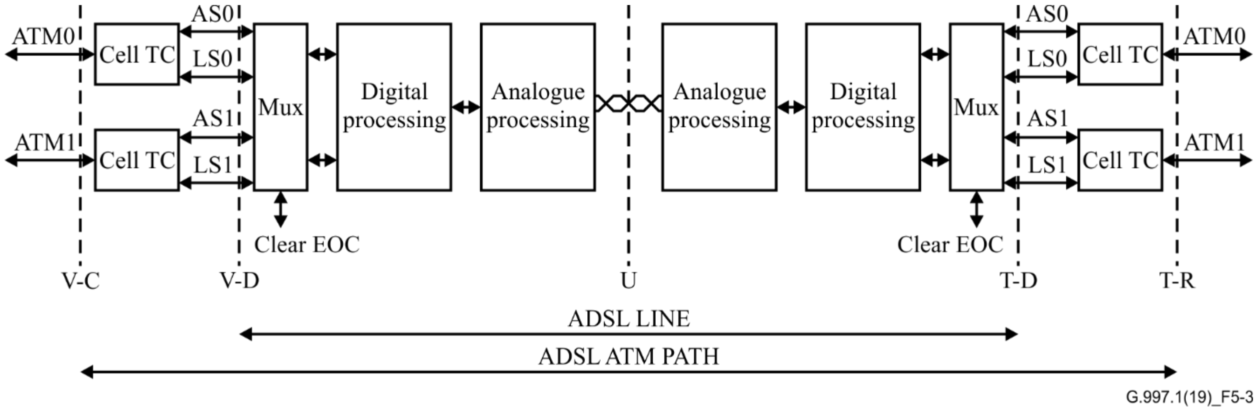


Figure 5-3 – xDSL LINE and xDSL ATM or PTM PATH definition

6 Operations, administration and maintenance communications channel

This clause specifies an optional OAM communication channel across the U-interface (see Figure 6-1). If this channel is implemented, the xTU-C and the xTU-R may use it to transport physical layer OAM messages. If either the xTU-C or the xTU-R does not have the capability of this OAM channel, the far-end parameters, defined in clause 7, at the xTU-C shall be derived from the indicator bits and EOC messages defined in the ITU-T G.992.x-series of Recommendations and in [ITU-T G.993.2]. Support for the OAM communication channel specified in this clause will be indicated during initialization by messages specified in [ITU-T G.994.1] for [ITU-T G.992.1] and [ITU-T G.992.2].

NOTE 1 – In those cases where neither the xTU-R nor the xTU-C implements this communication channel, there are some reduced physical layer OAM capabilities (see clause 7).

The ITU-T G.992.x-series of Recommendations and [ITU-T G.993.2] may provide one of two mechanisms to transport physical layer OAM messages.

– For [ITU-T G.992.1] and [ITU-T G.992.2], the mechanism is a bit-oriented clear EOC and the channel shall meet the requirements specified in clause 6.1. The data link layer shall be as specified in clause 6.3.

– For [ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2], the mechanism is a message-oriented clear EOC and the channel shall meet the requirements specified in clause 6.2. The data link layer shall be as specified in clauses 7.8.2.3, 7.8.2.4 and 9.4.1.8 of [ITU-T G.992.3] for [ITU-T G.992.3], [ITU-T G.992.4] and [ITU-T G.992.5]; and as specified in clauses 8.2 and 11.2.3 of [ITU-T G.993.2] for [ITU-T G.993.2].

See Figure 6-2.

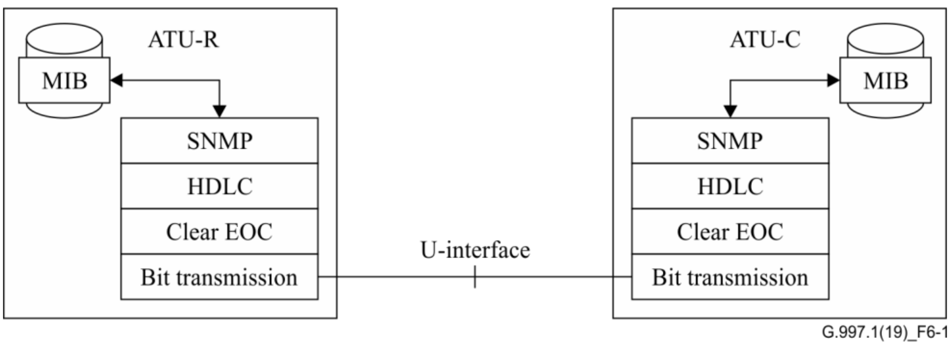


Figure 6-1 – Operations, administration and maintenance communication channel layers for bit-oriented clear embedded operations channel
MIB: management information base

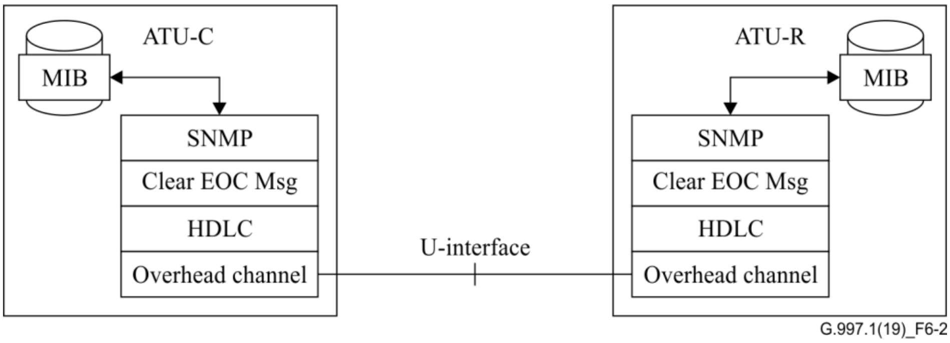


Figure 6-2 – Operations, administration and maintenance communication channel layers for message-oriented clear embedded operations channel
MIB: management information base

NOTE 2 – In Figures 6-1 and 6-2, the MIB is related to the xTU.

6.1 Requirements on the physical media dependent layer for the bit-oriented clear embedded operations channel

In order to support the physical layer OAM protocols defined in this Recommendation, a physical layer Recommendation shall provide a full duplex data channel for support of the data link layer specified in clause 6.3.

The clear EOC serves the function of a physical layer of the protocol stack specified in this Recommendation for [ITU-T G.992.2] and [ITU-T G.992.1].

1) The clear EOC shall be a part of the protocol overhead for the particular xDSL Recommendation.
2) The clear EOC shall be available to carry traffic whenever the xDSL protocol is in a normal transmission mode (e.g., "showtime").
3) The clear EOC shall be available regardless of the specific configuration options or run time adaptation of an ATU-C and ATU-R that are communicating.
4) The clear EOC shall be terminated in the ATU-R and the ATU-C.
5) The clear EOC shall support traffic of at least 4 kbit/s.
6) The clear EOC shall support delineation of individual octets in order to support the link level protocol defined in clause 7.1.
7) The clear EOC should not support error correction or detection, which are rather supported by use of the OAM stack defined in this Recommendation.
8) The clear EOC should not guarantee the delivery of data carried over the channel.
9) The clear EOC should not support retransmission of data upon error.
10) The clear EOC should not acknowledge the receipt of data by the far end of the link.
11) The clear EOC should not require a specific initialization procedure. It can be assumed to be operational whenever the two modems are in synchronization for "showtime" transport of data.

6.2 Requirements on the physical media dependent layer for the message-oriented clear embedded operations channel

In order to support the physical layer OAM protocols defined in this Recommendation, a physical layer Recommendation shall provide a full duplex data channel for support of the simple network management protocol (SNMP) defined in clause 6.4.

1) The clear EOC shall be a part of the protocol overhead for the particular xDSL Recommendation.

2) The clear EOC shall be available to carry traffic whenever the xDSL protocol is in a normal transmission mode (e.g., "showtime", specified in the relevant Recommendations).

3) The clear EOC shall be available regardless of the specific configuration of an xTU-C and xTU-R that are communicating.

4) The clear EOC shall be terminated in the xTU-R and the xTU-C.

5) The clear EOC shall support a bit rate of at least 4 kbit/s.

6) The clear EOC shall support delineation of messages through high-level data link control (HDLC) in order to support the link level protocol defined in clause 7.1.

7) The clear EOC should not support retransmission of data upon error.

8) The clear EOC should not require a specific initialization procedure. It can be assumed to be operational whenever the two modems are in synchronization for "showtime" transport of data.

6.3 Data link layer

For the transport mechanism, an HDLC-like mechanism is specified with the characteristics detailed in clauses 6.3.1 to 6.3.7. The specified method is based on [b-ISO/IEC 13239]. The requirements in clauses 6.3.1 to 6.3.7 apply only to the bit-oriented clear EOC.

NOTE – For [ITU-T G.992.3], [ITU-T G.992.4] and [ITU-T G.992.5], the data link layer uses the clear EOC messages embedded in the overhead channel as specified in clauses 7.8.2.3, 7.8.2.4 and 9.4.1.8 of [ITU-T G.992.3]. For [ITU-T G.993.2], the data link layer uses the clear EOC messages embedded in the overhead channel as defined in clauses 8.2 and 11.2.3 of [ITU-T G.993.2].

The main differences between the ITU-T G.997.1 data link layer and the ITU-T G.992.3/ITU-T G.993.2 clear EOC protocol are:

– the address field and control field are specified in clause 7.8.2.4 of [ITU-T G.992.3] or clause 8.2.4.1 of [ITU-T G.993.2];

– the two first bytes of the payload are always 08_{16} and 01_{16} to indicate a clear EOC command;

– each clear EOC command is acknowledged by the far end xTU.

6.3.1 Format convention

The basic format convention used for messages is illustrated in Figure 6-3. Bits are grouped into octets. The bits of each octet are shown horizontally and are numbered from 1 to 8. Octets are displayed vertically and are numbered from 1 to *N*.

The octets are transmitted in ascending numerical order.

The frame check sequence (FCS) field spans two octets: Bit 1 of the first octet is the most significant bit (MSB) and bit 8 of the second octet is the least significant bit (LSB) (see Figure 6-4).

8	7	6	5	4	3	2	1	Octet
								1
								2
								...
								N

Figure 6-3 – Format convention

8	7	6	5	4	3	2	1	Octet
2^8							2^{15}	1
2^0							2^7	2

Figure 6-4 – FCS mapping convention

6.3.2 Operations, administration and maintenance frame structure

The frame structure is as depicted in Figure 6-5.

$7E_{16}$	Opening flag
FF_{16}	Address field
03_{16}	Control field
Information payload	Max 510 bytes
FCS	Frame check sequence (first octet)
FCS	Frame check sequence (second octet)
$7E_{16}$	Closing flag

Figure 6-5 – Operations, administration and maintenance frame structure

The opening and closing flag sequence shall be the octet $7E_{16}$. The address and control field of the frame shall be coded as FF_{16} and 03_{16}, respectively.

Transparency of the information payload to the flag sequence and the frame check sequence are described in clause 6.3.3.

6.3.3 Octet transparency

In this approach, any data that is equal to $7E_{16}$ (01111110_2) (flag sequence) or $7D_{16}$ (control escape) shall be escaped as described in the following.

After frame check sequence (FCS) computation, the transmitter examines the entire frame between the two flag sequences. Any data octets that are equal to the flag sequence ($7E_{16}$) or the control escape ($7D_{16}$) are replaced by a two-octet sequence consisting of the control escape octet followed by the original octet exclusive-ORed with hexadecimal 0x20 (this is bit 5 complemented, where the bit positions are numbered 76543210). In summary, the following substitutions are made:

- a data octet of $7E_{16}$ is encoded as two octets $7D_{16}$, $5E_{16}$;
- a data octet of $7D_{16}$ is encoded as two octets $7D_{16}$, $5D_{16}$.

On reception, prior to FCS computation, each control escape octet ($7D_{16}$) is removed, and the subsequent octet is exclusive-ORed with hexadecimal 20_{16} (unless the following octet is $7E_{16}$, which is the flag, and indicates the end of frame, i.e., an abort has occurred). In summary, the subsequent substitutions are made:

- a sequence of $7D_{16}$, $5E_{16}$ is replaced by the data octet $7E_{16}$;
- a sequence of $7D_{16}$, $5D_{16}$ is replaced by the data octet $7D_{16}$;
- a sequence of $7D_{16}$, $7E_{16}$ aborts the frame.

Note that since octet stuffing is used, the data frame is guaranteed to have an integral number of octets.

6.3.4 Frame check sequence

The FCS field is 16 bits (2 octets) in length. As defined in [b-ISO/IEC 13239], it shall be the one's complement of the sum (modulo 2) of:

a) the remainder of x^k ($x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1$) divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the last bit of the final opening flag and the first bit of the FCS, excluding octets inserted for transparency; and

b) the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the product of x^{16} by the content of the frame existing between, but not including, the last bit of the final opening flag and the first bit of the FCS, excluding octets inserted for transparency.

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all binary 1s and is then modified by division by the generator polynomial (as described in a and b)) on the information field. The one's complement of the resulting remainder is transmitted as the 16-bit FCS.

As a typical implementation at the receiver, the initial content of the register of the device computing the remainder of the division is preset to all binary 1s. The final remainder, after multiplication by 16 and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits after removal of the transparency octets and the FCS, will be 0001110100001111_2 (x^{15} through x^0, respectively) in the absence of transmission errors.

The FCS is calculated over all bits of the address, control, and information payload fields of the frame.

The register used to calculate the cyclic redundancy check (CRC) shall be initialized to the value $FFFF_{16}$, both at the transmitter and the receiver.

The LSB of the FCS is sent first, followed by the MSB.

On the receiver a message received without errors results in a CRC calculation of $F0B8_{16}$.

6.3.5 Invalid frames

The following conditions result in an invalid frame:

- frames that are too short (less than 4 octets in between flags, not including transparency octets);
- frames that contain a control escape octet followed immediately by a flag (i.e., $7D_{16}$, $7E_{16}$).
- frames that contain control escape sequences other than $7D_{16}$, $5E_{16}$ and $7D_{16}$, $5D_{16}$.

Invalid frames shall be discarded. The receiver shall immediately start looking for the beginning flag of a subsequent frame.

6.3.6 Synchronism

The OAM frame structure transport is octet synchronous. Octet transport and synchronism for this transport is defined in accordance with the transmission convergence (TC) layer.

6.3.7 Time fill

Inter-frame time fill shall be accomplished by inserting additional flag octets ($7E_{16}$) between the closing and the subsequent opening flag on the EOC transport channel. Inter-octet time fill is not supported.

6.4 The simple network management protocol protocol

If implemented, SNMP messages shall be used as the message encoding over the HDLC data link channel defined in clause 6.2, for [ITU-T G.992.1] and [ITU-T G.992.2]; or over the clear EOC message embedded in the overhead channel for [ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2].

6.4.1 Simple network management protocol message mapping in HDLC frames

This clause applies only to Recommendations specifying a bit-oriented clear EOC (e.g., [ITU-T G.992.1] and [ITU-T G.992.2]).

The SNMP messages are placed directly in HDLC frames together with the protocol identifier (ID) (see Figure 6-6). The protocol ID is two bytes ahead of the SNMP message. The two bytes contain the ethertype SNMP value $814C_{16}$ as defined in [b-IETF RFC 1700]. A single HDLC frame is used to transport each SNMP message.

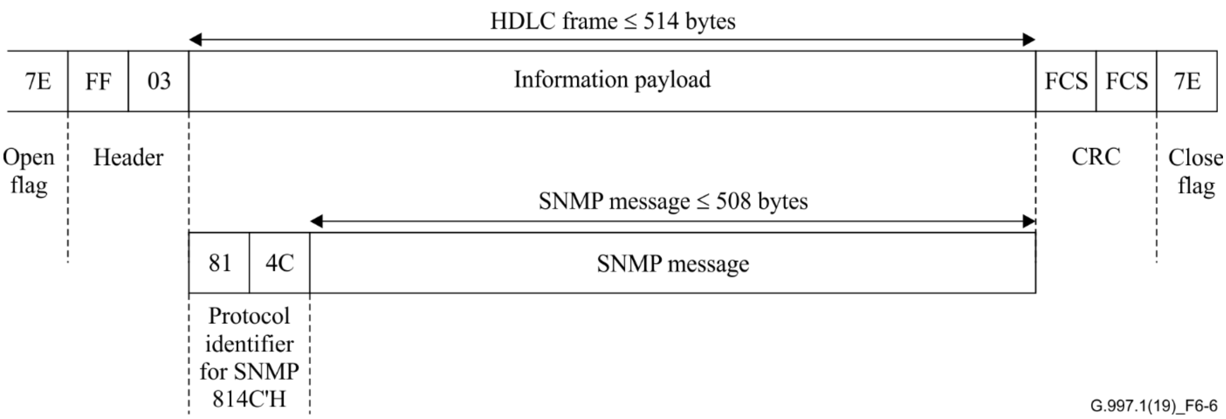


Figure 6-6 – Operations, administration and maintenance communication channel protocol over the U-interface

The length of an SNMP message shall be ≤508 bytes.

Due to the transparency mechanism described in clause 6.3.3, the number of bytes actually transmitted between opening and closing flags may be higher than 514.

6.4.2 Simple network management protocol message mapping in clear embedded operations channel messages

This clause applies only to Recommendations specifying message-oriented clear EOC messages (e.g., [ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2]).

The SNMP messages are placed directly in the clear EOC messages together with the protocol ID(see Figure 6-7). The protocol ID is two bytes prepended to the SNMP message. The two bytes contain the ethertype SNMP value $814C_{16}$ as defined in [b-IETF RFC 1700]. A single HDLC frame is used to transport each SNMP message.

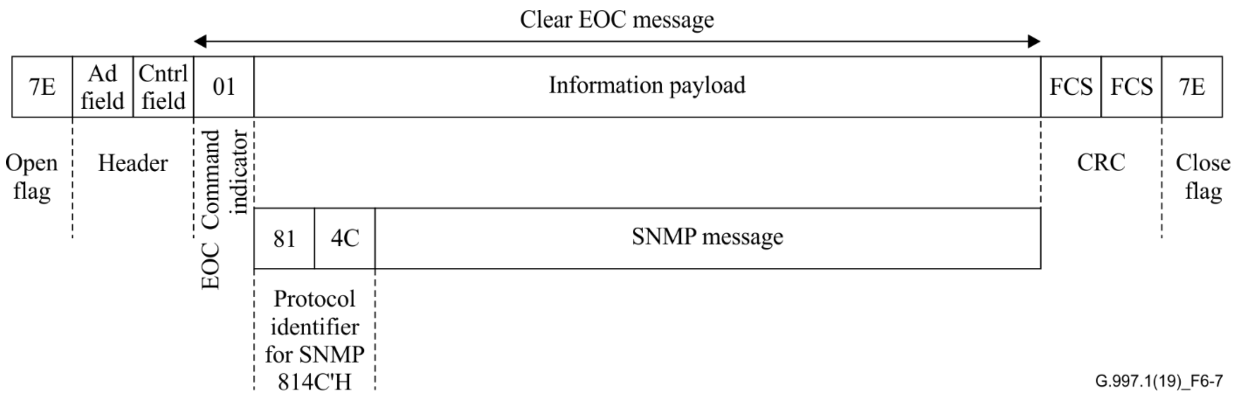


Figure 6-7 – Operations, administration and maintenance communication channel protocol over the U-interface

The length of an SNMP message shall be ≤508 bytes.

Due to the transparency mechanism described in clause 6.3.3, the number of bytes actually transmitted between opening and closing flags may be greater than 516.

6.4.3 Protocol based on simple network management protocol

The SNMP protocol as specified in [IETF RFC 1157] consists of four types of operation, which are used to manipulate management information. These are:

Get	used to retrieve specific management information.
Get-Next	used to retrieve, via traversal of the MIB, management information.
Set	used to alter management information.
Trap	used to report extraordinary events.

The four operations are implemented using five types of protocol data unit (PDU):

GetRequest-PDU	used to request a Get operation.
GetNextRequest-PDU	used to request a Get-Next operation.
GetResponse-PDU	used to respond to a Get, Get-Next, or Set operation.
SetRequest-PDU	used to request a Set operation.
Trap-PDU	used to report a Trap operation.

If implemented, SNMP messages shall be used according to the requirements specified in clauses 6.4.3.1 to 6.4.3.5.

6.4.3.1 Use of embedded operations channel

The ADSL or VDSL2 OAM channel will be used to send HDLC-encapsulated SNMP messages between ADSL management entities (AMEs) or VDSL2 management entities (VMEs) on both sides of the line. An AME or VME residing in the xTU-R and xTU-C will send and interpret these SNMP messages. This ADSL or VDSL2 OAM channel is used for requests, responses and traps, differentiated according to the SNMP PDU type.

6.4.3.2 Message format

The message format specified in [ITU-T G.992.1] shall be used, i.e., SNMP version 1.

All SNMP messages shall use the community name "ADSL", i.e., the OCTET STRING value: "$4144534C_{16}$". This string shall be used for all Recommendations covered by this Recommendation.

In all SNMP traps, the agent-addr field (which has syntax NetworkAddress), shall always have the IpAddress value: 0.0.0.0.

In all SNMP traps, the time-stamp field in the Trap-PDU shall contain the value of an AME or VME MIB object at the time of trap generation.

In any standard SNMP trap, the enterprise field in the Trap-PDU shall contain the value of the agent's sysObjectID MIB object (sysObjectID is defined in the system group of MIB-II).

6.4.3.3 Message sizes

All ADSL and VDSL2 OAM implementations shall be able to support SNMP messages of size up to, and including, 508 octets.

6.4.3.4 Message response time

Response time refers to the time elapsed from the submission of an SNMP message (e.g., GetRequest, GetNextRequest or SetRequest message) by an AME or VME across an ADSL or VDSL2 interface to the receipt of the corresponding SNMP message (e.g., GetResponse message) from the adjacent AME or VME. An SNMP GetRequest, GetNextRequest or SetRequest message is specified in this context as a request concerning a single object.

The AME and VME shall support maximum response times of 1 s for 95% of all SNMP GetRequests, GetNextRequests or SetRequests containing a single object received from an adjacent AME or VME independent of the ADSL or VDSL2 interface's physical line rate.

6.4.3.5 Object value data correctness

Data correctness refers to the maximum time elapsed since an object value in the ADSL or VDSL2 interface MIB was known to be current. The following specifies the requirements on the data correctness of the ADSL or VDSL2 OAM objects and the event notifications.

The ADSL and VDSL2 interface MIB objects shall have a maximum data correctness of 30 s.

The AME and VME shall support event notifications (i.e., SNMP traps) for generic SNMP events within 2 s of the event detection by the AME.

8 Management information base elements

The MIB contains six types of information:

- fault monitoring – failures (alarm indications);
- fault monitoring – threshold crossing (alert messages);
- PM parameters (counters);
- configuration parameters;
- inventory parameters;
- test, diagnostic and status parameters.

Figure 7-1 shows the in-service PM process. The primitives are specified in the physical layer of the ITU-T G.992.x-series of ITU-T Recommendations and [ITU-T G.993.2].

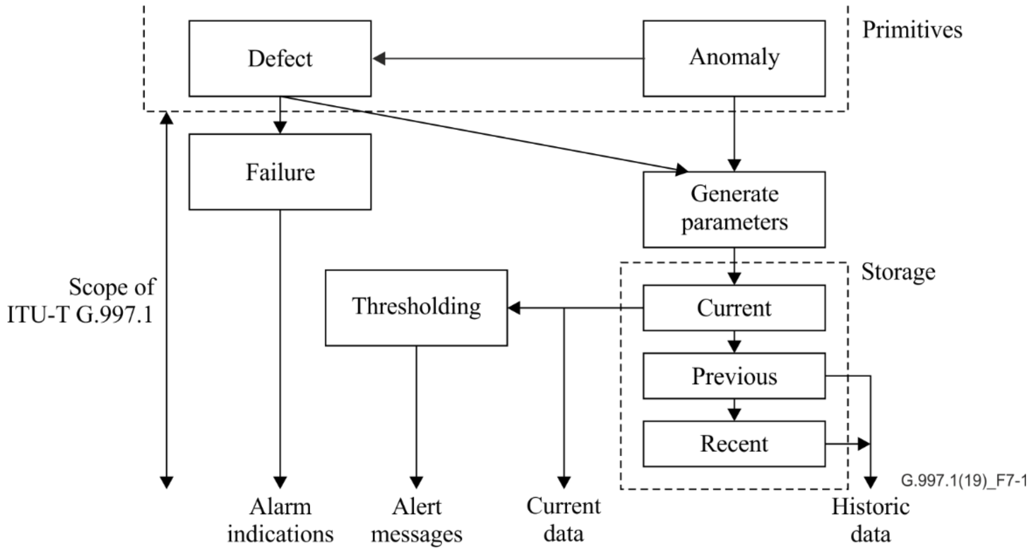


Figure 7-1 – In-service performance monitoring process

As an AN can handle a large number of xTU-Cs (e.g., hundreds or perhaps thousands of ADSL or VDSL2 lines), provisioning every parameter on every xTU-C may become burdensome. In response, two modes have been created to define ADSL and VDSL2 equipment configuration data profiles, as well as a mechanism to associate these profiles to the equipment. Profile tables may be implemented in one of two ways, but not simultaneously.

- MODE-I: Dynamic Profiles – profiles used by one or multiple ADSL/VDSL2 lines.

  Implementations using this mode will enable the operator of the system to dynamically create and delete profiles as needed. One or more ADSL/VDSL2 lines may be configured to share parameters of a single profile (e.g., adslLineConfProfileName = 'silver') by setting its adslLineConfProfile object to the index value of this profile. If a change is made to the profile, all lines that refer to it will be reconfigured to the changed parameters. Before a profile can be deleted or taken out of service, it shall be first unreferenced from all associated lines.

- MODE-II: Static profiles – one profile per ADSL/VDSL2 physical line.

  Implementations with this mode will automatically create a profile one-for-one with each ADSL/VDSL2 line. The name of this profile is a system generated read-only object whose value is equivalent to the index of the line. The management agent in the AN will not allow the operator of the system to create/delete profiles in this mode.

NOTE 1 – For more details on the use of profiles, refer to [b-IETF RFC 2662].

NOTE 2 – The 'data profiles' discussed in this clause are not the 'profiles' discussed in clause 6 of [ITU-T G.993.2]. This clause discusses the use of a 'profile' to simplify the configuration of an xDSL transceiver in the field. Clause 6 of [ITU-T G.993.2] is a discussion of a technique to specify the native capabilities (e.g., the particular subset of [ITU-T G.993.2]) supported by a particular VDSL2 transceiver.

At the Q-interface, a line is configured by linking the following information to the line (see Figure 7-2):

- one line configuration profile (see Table 7-14) for the line;
- one channel configuration profile (see Table 7-16) for each downstream and each upstream bearer channel;
- one data path configuration profile (see Table 7-18) for each downstream and each upstream bearer channel.

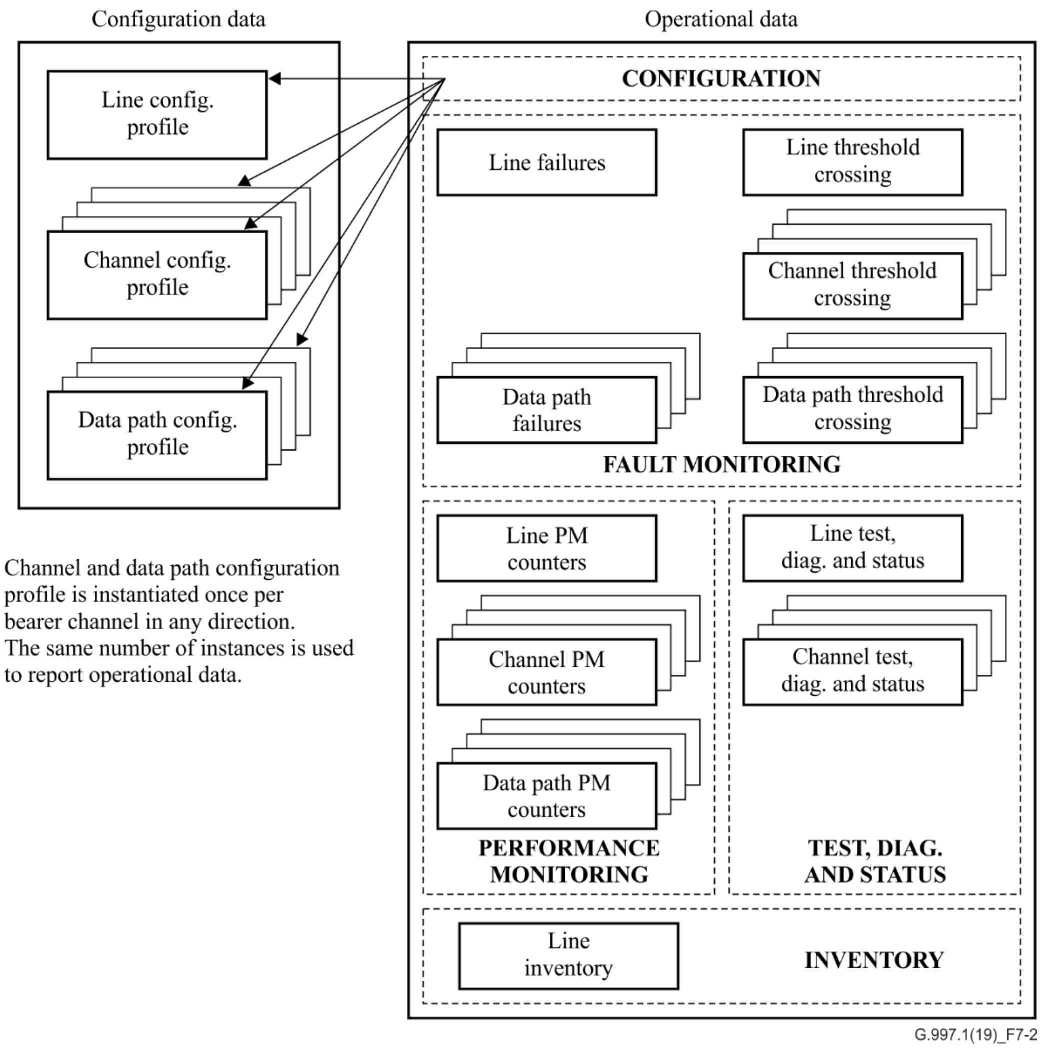


Figure 7-2 – Overview of the MIB elements provided for each line

Some or all of the configuration parameters contained in the line, channel and data path configuration profiles linked to the line may be written or read, depending on the interface under consideration:

Q-interface: management interface towards the xTU-C, from the network side perspective;

U-C-interface: management interface towards the xTU-C, from the xTU-R perspective;

U-R-interface: management interface towards the xTU-R, from the xTU-C perspective;

T/S-interface: management interface towards the xTU-R, from the premises side perspective (interface between ADSL network termination and customer installation or home network).

In clause 7.6, a detailed list is given of the management elements applying to each of these interfaces, with indications whether they are mandatory or optional and whether they can be read, written or both.

As an AN can handle a large number of lines (e.g., hundreds or perhaps thousands of ADSL or VDSL2 lines), maintaining the PM and the test, diagnostic and status information (see Figure 7-2) for every line may become burdensome. Although access to all mandatory management elements shall be supported at all times for all ports on the AN at the Q-interface (see Figure 5-1), the elements may not be maintained within the ME of the AN simultaneously for all lines at all times. Although reasonable performance shall be provided at the Q-interface for access to the management elements of any line, this Recommendation does not specify specific performance requirements at this interface.

7.1 Failures

Any failure specified in this clause shall be conveyed to the NMS by the xTU-C (over the Q-interface) and may be conveyed by the xTU-R over the T/S-interface after it is detected.

The near-end failure detections shall be provided at the xTU-C and shall be provided at the xTU-R.

The far-end failure detections shall be provided at the xTU-C (xTU-R is at the far-end), and may be provided at the xTU-R (xTU-C is at the far-end).

7.1.1 Line failures

7.1.1.1 Line near-end failures

7.1.1.1.1 Loss of signal failure

An LOS failure is declared after 2.5 ± 0.5 s of contiguous LOS defect or if an LOS defect is present when the criteria for loss of frame (LOF) failure declaration have been met (see LOF specification in clause 7.1.1.1.2). An LOS failure is cleared after 10 ± 0.5 s of no LOS defect.

7.1.1.1.2 Loss of frame failure

An LOF failure is declared after 2.5 ± 0.5 s of contiguous severely errored frame (SEF) defect, except when an LOS defect or failure is present (see LOS specifica in clause 7.1.1.1.1). A LOF failure is cleared when an LOS failure is declared or after 10 ± 0.5 s of no SEF defect.

7.1.1.1.3 Loss of power failure

A loss of power (LPR) failure is declared after 2.5 ± 0.5 s of contiguous near-end LPR primitive presence. An LPR failure is cleared after 10 ± 0.5 s of no near-end LPR primitive presence.

7.1.1.1.4 Loss of margin failure

An LOM failure is declared when a re-initialization is triggered by a persistent near-end *lom* defect, except when an LOS or LOF defect or failure is present (see LOS and LOF specifications in clauses 7.1.1.1.1 and 7.1.1.1.2). An LOM failure is cleared when an LOS or LOF failure is declared or after 10 ± 0.5 s of no LOM defect.

7.1.1.2 Line far-end failures

7.1.1.2.1 Far-end loss of signal failure

A far-end loss of signal (LOS-FE) failure is declared after 2.5 ± 0.5 s of contiguous far-end LOS defects or if a far-end LOS defect is present when the criteria for LOF failure declaration have been met (see LOF specification in clause 7.1.1.2.2). A far-end LOS failure is cleared after 10 ± 0.5 s of no far-end LOS defect.

7.1.1.2.2 Far-end loss of frame failure

A far-end loss of frame (LOF-FE) failure is declared after 2.5 ± 0.5 s of contiguous remote defect indication (RDI) defects, except when a far-end LOS defect or failure is present (see LOS specification in clause 7.1.1.2.1). A far-end LOF failure is cleared when a far-end LOS failure is declared or after 10 ± 0.5 s of no RDI defect.

7.1.1.2.3 Far-end loss of power failure

A far-end loss of power (LPR-FE) failure is declared after the occurrence of an LPR-FE primitive followed by 2.5 ± 0.5 s of contiguous near-end LOS defects. An LPR-FE failure is cleared after 10 ± 0.5 s of no near-end LOS defect.

7.1.1.2.4 Loss of margin failure

A far-end loss of margin (LOM-FE) failure is declared when a re-initialization is triggered by a persistent far-end *lom* defect, except when an LOS-FE or LOF-FE defect or failure is present (see LOS and LOF specifications in clauses 7.1.1.2.1 and 7.1.1.2.2). A far-end LOM failure is cleared when a far-end LOS or LOF failure is declared, or after 10 ± 0.5 s of no far-end LOM defect.

7.1.1.3 Line initialization failure

If the line is forced to the L0 state (or into loop diagnostic mode) and an attempt to reach the L0 state (or to successfully complete the loop diagnostic procedures) fails (after a vendor discretionary number of retries or within a vendor discretionary timeout), then an initialization failure occurs. An initialization failure cause and last successful transmitted state are given by the line initialization (LINIT) failure (see clause 7.5.1.6). A LINIT failure shall be conveyed to the NMS by the xTU-C (over the Q-interface) and should be conveyed to the NMS by the xTU-R (over the T/S-interface) after it is detected.

7.1.2 Channel failures

No channel failures are specified.

7.1.3 Synchronous transfer mode data path failures

Synchronous transfer mode (STM) data path failures are for further study.

7.1.4 Asynchronous transfer mode data path failures

7.1.4.1 Asynchronous transfer mode data path near-end failures

7.1.4.1.1 No cell delineation failure

A no cell delineation (NCD) failure is declared when an NCD anomaly persists for more than 2.5 ± 0.5 s after the start of showtime. An NCD failure terminates when no NCD anomaly is present for more than 10 ± 0.5 s.

7.1.4.1.2 Loss of cell delineation failure

A loss of cell delineation (LCD) failure is declared when an LCD defect persists for more than 2.5 ± 0.5 s. An LCD failure terminates when no LCD defect is present for more than 10 ± 0.5 s.

7.1.4.2 Asynchronous transfer mode data path far-end failures

7.1.4.2.1 Far-end no cell delineation failure

A far-end no cell delineation (NCD-FE) failure is declared when an NCD-FE anomaly persists for more than 2.5 ± 0.5 s after the start of showtime. An NCD-FE failure terminates when no NCD-FE anomaly is present for more than 10 ± 0.5 s.

7.1.4.2.2 Far-end loss of cell delineation failure

A far-end loss of cell delineation (LCD-FE) failure is declared when an LCD-FE defect persists for more than 2.5 ± 0.5 s. An LCD-FE failure terminates when no LCD-FE defect is present for more than 10 ± 0.5 s.

7.1.5 Packet transfer mode data path failures

7.1.5.1 Packet transfer mode data path near-end failures

7.1.5.1.1 Out of sync failure

An out of sync (OOS) failure is declared when an oos-*n* anomaly persists for more than 2.5 ± 0.5 s. An OOS failure terminates when no oos-*n* anomaly is present for more than 10 ± 0.5 s.

7.1.5.2 Packet transfer mode data path far-end failures

7.1.5.2.1 Far-end out of sync failure

A far-end out of sync (OOS-FE) failure is declared when an oos-*f* anomaly persists for more than 2.5 ± 0.5 s. An OOS-FE failure terminates when no oos-*f* anomaly is present for more than 10 ± 0.5 s.

7.2 Performance monitoring functions

Near-end PM functions shall be provided at the xTU-C and at the xTU-R. Far-end PM functions shall be provided at the xTU-C (xTU-R is at the far-end) and are optional at the xTU-R (xTU-C is at the far-end).

If the line is forced to the L0 state (see clause 7.3.1.1.3), then PM counters shall be active, irrespective of the actual power management state of the line (see clause 7.5.1.5). If the line is forced to the L3 state, then all PM counters shall be frozen, including the unavailable second (UAS) counter.

7.2.1 Line performance monitoring parameters

This clause defines a set of line PM parameters. Support of the performance parameters in an NE is indicated as mandatory (M) or optional (O) in Table 7-1.

7.2.1.1 Near-end line performance monitoring parameters

7.2.1.1.1 Forward error correction second-line

The forward error correction second-line (FECS-L) parameter is a count of 1 s intervals with one or more forward error correction (FEC) anomalies summed over all received bearer channels.

7.2.1.1.2 Errored second-line

The errored second-line (ES-L) parameter is a count of 1 s intervals with one or more CRC-8 anomalies summed over all received bearer channels, or one or more LOS defects, or one or more SEF defects, or one or more LPR defects.

7.2.1.1.3 Severely errored second-line

The severely errored second-line (SES-L) parameter is a count of severely errored seconds (SESs). An SES is declared if, during a 1 s interval, there are 18 or more CRC-8 anomalies in one or more of the received bearer channels, or one or more LOS defects, or one or more SEF defects, or one or more LPR defects. If [ITU-T G.998.4] is supported and retransmission is enabled in the near-end received direction, a SES is also declared if, during a 1 s interval, there is one or more severe loss of error-free throughput (*seftr*) defect in the near-end received direction.

If the relevant Recommendation (e.g., [ITU-T G.992.3], [ITU-T G.992.5] and [ITU-T G.993.2]) supports 1 s normalized CRC-8 anomaly counter increment, the 1 s counter used to declare SES shall increment with this value instead of incrementing by one for each CRC-8 anomaly.

If a common CRC is applied over multiple bearer channels, then each related CRC-8 anomaly shall be counted only once for the whole set of bearer channels over which the CRC is applied.

7.2.1.1.4 LOS second-line

The LOS second-line (LOSS-L) parameter is a count of 1 s intervals containing one or more LOS defects.

7.2.1.1.5 Unavailable second-line

The unavailable second-line (UAS-L) parameter is a count of 1 s intervals for which the xDSL line is unavailable.

If re-initialization policy (RIPOLICY) is not supported or is not defined for the mode used, or the actual value of RIPOLICY equals 0, the xDSL line becomes unavailable at the onset of 10 contiguous SES-Ls. These 10 SES-Ls shall be included in unavailable time. Once unavailable, the xDSL line becomes available at the onset of 10 contiguous seconds with no SES-Ls. These 10 s with no SES-Ls shall be excluded from unavailable time.

If the actual value of RIPOLICY equals 1, the xDSL line becomes unavailable at the onset of REINIT_TIME_THRESHOLD contiguous SES-Ls. These REINIT_TIME_THRESHOLD SES-Ls shall be included in unavailable time.

Independent of the RIPOLICY, the xDSL line becomes also unavailable when the near-end receiver stops processing showtime symbols, in order to prepare for re-initialization. All contiguous SES-Ls until this moment shall be included in the unavailable time. After initialization or re-initialization, the xDSL line becomes available immediately at the start of showtime.

Some parameter counts are inhibited during unavailability – see clause 7.2.7.13.

7.2.1.1.6 "leftr" defects seconds counter

If retransmission is used in a given transmit direction, this parameter is a count of the seconds with a near-end "leftr" defect present (see clause 11.4.1 of [ITU-T G.998.4] for the specification of this counter).

The near-end counter is only defined in upstream.

The ME shall generate a 15 min and 24 h performance history.

7.2.1.1.7 Error-free bits counter

If retransmission is used in a given transmit direction, this parameter is a count of the number of error-free bits passed over the β_1 reference point, divided by 2^{16}. If retransmission is not used in a given transmit direction and if the "*Extended rate statistics*" option is supported, this counter is the accumulated NDR, divided by 2^{16} (see clause 11.4.2 of [ITU-T G.998.4] for the specification of this counter).

NOTE – An error-free bits counter and UAS can be used to compute the mean EFTR or the mean NDR.

The near-end counter is only defined in upstream.

The ME shall generate a 15 min and 24 h performance history.

NOTE – When retransmission is not used, the bits are not guaranteed error free.

7.2.1.1.8 Minimum error-free throughput

If retransmission is used in a given transmit direction, the minimum error-free throughput (MINEFTR) parameter reports the minimum of the EFTR observed over the 15 min or 24 h accumulation period. If retransmission is not used in a given transmit direction and if the "*Extended rate statistics*" option is supported, this parameter reports the minimum of NDR observed over the 15 min or 24 h accumulation period (see clause 11.4.3 of [ITU-T G.998.4] for the specification of this parameter).

The value is reported in bits per second.

The near-end value is only defined in upstream.

The ME shall generate a 15 min and 24 h performance history.

The ME shall read the ITU-T G.998.4 EFTR_min (at least) every 15 min to determine the minimum EFTR or NDR over the 15 min and 24 h intervals.

NOTE – When retransmission is not used, the throughput is not guaranteed error free.

7.2.1.1.9 Maximum error-free throughput

The maximum error-free throughput (MAXEFTR) parameter shall be reported if "Extended Rate Statistics" option is supported. If retransmission is used in a given transmit direction, this MAXEFTR parameter reports the maximum of the EFTR observed over the 15 min or 24 h accumulation period; otherwise, this parameter reports the maximum of NDR observed over the 15 min or 24 h accumulation period. (See clause 11.4.4 of [ITU-T G.998.4] for the definition of this parameter.)

The value is reported in bits per second.

The near-end value is only defined in upstream.

The ME shall generate a 15 min and 24 h performance history.

The ME shall read the ITU-T G.998.4 EFTR_max (at least) every 15 min to determine the maximum EFTR or NDR over the 15 min and 24 h intervals.

NOTE – When retransmission is not used, the throughput is not guaranteed error free.

7.2.1.2 Far-end line performance monitoring parameters

7.2.1.2.1 Forward error correction second-Line far-end

The forward error correction second-line far-end (FECS-LFE) parameter is a count of 1 s intervals with one or more far-end forward error correction (FFEC) anomalies summed over all transmitted bearer channels.

7.2.1.2.2 Errored second-line far-end

The errored second-line far-end (ES-LFE) parameter is a count of 1 s intervals with one or more far-end block error (FEBE) anomalies summed over all transmitted bearer channels, or one or more LOS-FE defects, or one or more RDI defects, or one or more LPR-FE defects.

7.2.1.2.3 Severely errored second-line far-end

The severely errored second-line far-end (SES-LFE) parameter is a count of SESs. An SES is declared if, during a 1 s interval, there are 18 or more FEBE anomalies in one or more of the transmitted bearer channels, or one or more far-end LOS defects, or one or more RDI defects, or one or more LPR-FE defects. If [ITU-T G.998.4] is supported and retransmission is enabled in the far-end received direction, an SES-LFE is also declared if, during a 1 s interval, there is one or more severe loss of error-free throughput (*seftr*) defect in the far-end received direction.

If the relevant Recommendation (e.g., [ITU-T G.992.3], [ITU-T G.992.5] or [ITU-T G.993.2]) supports 1 s normalized CRC-8 anomaly counter increment, the 1 s counter used to declare SES shall increment with this value instead of incrementing by one for each FEBE anomaly.

If a CRC is applied over multiple bearer channels, then each related FEBE anomaly shall be counted only once for the whole set of related bearer channels.

7.2.1.2.4 LOS second-line far-end

The LOS second-line far-end (LOSS-LFE) parameter is a count of 1 s intervals containing one or more far-end LOS defects.

7.2.1.2.5 Unavailable seconds-line far-end

The unavailable seconds-line far-end (UAS-LFE) parameter is a count of 1 s intervals for which the far-end xDSL line is unavailable.

If the actual value of RIPOLICY equals 0, the far-end xDSL line becomes unavailable at the onset of 10 contiguous SES-LFEs. These 10 SES-LFEs shall be included in unavailable time. Once unavailable, the far-end xDSL line becomes available at the onset of 10 contiguous seconds with no SES-LFEs. These 10 s with no SES-LFEs shall be excluded from unavailable time.

If the actual value of RIPOLICY equals 1, the xDSL line becomes unavailable at the onset of REINIT_TIME_THRESHOLD contiguous SES-LFEs. These REINIT_TIME_THRESHOLD SES-LFEs shall be included in unavailable time.

Independent of the RIPOLICY, the xDSL line becomes also unavailable when the near-end receiver stops processing showtime symbols, in order to prepare for re-initialization. All contiguous SES-LFEs until this moment shall be included in the unavailable time. After initialization or re-initialization, the xDSL line becomes available immediately at the start of showtime.

Some parameter counts are inhibited during unavailability – see clause 7.2.7.13.

7.2.1.2.6 "leftr" defects seconds counter

If retransmission is used in a given transmit direction, this parameter is a count of the seconds with a near-end "leftr" defect present (see clause 11.4.1 of [ITU-T G.998.4] for the specification of this counter).

The far-end counter is only defined in downstream.

The ME shall generate a 15 min and 24 h performance history.

7.2.1.2.7 Error-free bits counter

If retransmission is used in a given transmit direction, this parameter is a count of the number of error-free bits passed over the β_1 reference point, divided by 2^{16}. If retransmission is not used in a given transmit direction and if "*Extended rate statistics*" option is supported, this counter is the accumulated NDR, divided by 2^{16} (see clause 11.4.2 of [ITU-T G.998.4] for the specification of this counter).

NOTE – Error-free bits counter and UAS can be used to compute the mean EFTR or the mean NDR.

The far-end counter is only defined in downstream.

The ME shall generate a 15 min and 24 h performance history.

NOTE – When retransmission is not used the bits are not guaranteed error free.

7.2.1.2.8 Minimum error-free throughput

If retransmission is used in a given transmit direction, the MINEFTR parameter reports the minimum of the EFTR observed over the 15 min or 24 h accumulation period. If retransmission is not used in a given transmit direction and if "Extended Rate Statistics" option is supported, this parameter reports the minimum of NDR observed over the 15 min or 24 h accumulation period (see clause 11.4.3 of [ITU-T G.998.4] for the definition of this parameter).

The value is reported in bits per second.

The far-end value is only defined in downstream.

The ME shall generate a 15 min and 24 h performance history.

The ME shall read the ITU-T G.998.4 EFTR_min (at least) every 15 min to determine the minimum EFTR or NDR over the 15 min and 24 h intervals.

NOTE – When retransmission is not used, the throughput is not guaranteed error free.

7.2.1.1.9 Maximum error-free throughput

The MAXEFTR parameter shall be reported if the extended rate statistics option is supported. If retransmission is used in a given transmit direction, the MAXEFTR parameter reports the maximum of the EFTR observed over the 15 min or 24 h accumulation period; otherwise, this parameter reports the maximum of NDR observed over the 15 min or 24 h accumulation period. (See clause 11.4.4 of [ITU-T G.998.4] for specification of this parameter.)

The value is reported in bits per second.

The far-end value is only defined in downstream.

The ME shall generate a 15 min and 24 h performance history.

The ME shall read the ITU-T G.998.4 EFTR_max (at least) every 15 min to determine the maximum EFTR or NDR over the 15 min and 24 h intervals.

NOTE – When retransmission is not used, the throughput is not guaranteed error free.

7.2.1.3 Line initialization performance monitoring parameters

7.2.1.3.1 Full initialization count

This parameter is a count of the total number of full initializations attempted on the line (successful and failed) during the accumulation period. Parameter procedures shall be as specified in clause 7.2.7.

7.2.1.3.2 Failed full initialization count

This performance parameter is a count of the total number of failed full initializations during the accumulation period. A failed full initialization is when showtime is not reached at the end of the full initialization procedure.

Parameter procedures shall be as specified in clause 7.2.7.

7.2.1.3.3 Short initialization count

This parameter is a count of the total number of fast retrains or short initializations attempted on the line (successful and failed) during the accumulation period. Parameter procedures shall be as specified in clause 7.2.7.

Fast retrain is defined in [ITU-T G.992.2].

Short initialization is defined in [ITU-T G.992.3] and [ITU-T G.992.4].

7.2.1.3.4 Failed short initialization count

This performance parameter is a count of the total number of failed fast retrains or short initializations during the accumulation period. A failed fast retrain or short initialization is when showtime is not reached at the end of the fast retrain or short initialization procedure, e.g., when:

- a CRC error is detected;
- a time-out occurs;
- a fast retrain profile is unknown.

Parameter procedures shall be as specified in clause 7.2.7.

7.2.1.4 Near-end impulse noise performance monitoring parameters

7.2.1.4.1 Impulse noise monitoring INPEQ histogram 1..17

The impulse noise monitoring (INM) INPEQ histogram 1..17 ($INMINPEQ_{1..17}$-L) parameter is a count of the near-end $INMAINPEQ_i$ anomalies occurring on the line during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

7.2.1.4.2 Impulse noise monitoring total measurement

The INM total measurement (INMME-L) parameter is a count of the near-end INMAME anomalies occurring on the line during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

7.2.1.4.3 Impulse noise monitoring IAT histogram 0..7

The INM IAT histogram 0..7 ($INMIAT_{0..7}$-L) parameter is a count of the near-end $INMAIAT_i$ anomalies occurring on the line during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

7.2.1.5 Far-end impulse noise performance monitoring parameters

7.2.1.5.1 Impulse noise monitoring INPEQ histogram 1..17

The INM INPEQ histogram 1..17 ($INMINPEQ_{1..17}$-LFE) parameter is a count of the far-end $INMAINPEQ_i$ anomalies occurring on the line during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

7.2.1.5.2 Impulse noise monitoring total measurement

The INM total measurement (INMME-LFE) parameter is a count of the far-end INMAME anomalies occurring on the line during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

7.2.1.5.3 Impulse noise monitoring IAT histogram 0..7

The INM IAT histogram 0..7 ($INMIAT_{0..7}$-LFE) parameter is a count of the far-end $INMAIAT_i$ anomalies occurring on the line during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

7.2.1.6 Near-end initiated on-line reconfiguration performance monitoring parameters

7.2.1.6.1 Near-end successful save our showtime count

The near-end successful save our showtime (SOS) count (SOS-SUCCESS-NE) parameter is a count of the total number of successful SOS procedures initiated by the near-end xTU on the line during the accumulation period. Parameter procedures shall be as specified in clause 7.2.7.

Successful SOS is defined in clause 11.3.1.5 of [ITU-T G.993.2].

7.2.1.6.2 Near-end successful seamless rate adaptation count

The near-end successful seamless rate adaptation (SRA) count (SRA-SUCCESS-NE) parameter is a count of the total number of successful SRA procedures initiated by the near-end xTU on the line during the accumulation period. Parameter procedures shall be as specified in clause 7.2.7.

Successful SRA is defined in clause 11.3.1.5 of [ITU-T G.993.2].

7.2.1.7 Far-end initiated on-line reconfiguration performance monitoring parameters

7.2.1.7.1 Far-end successful save our showtime count

The far-end successful SOS count (SOS-SUCCESS-FE) parameter is a count of the total number of successful SOS procedures initiated by the far-end xTU on the line during the accumulation period. Parameter procedures shall be as specified in clause 7.2.7.

Successful SOS is defined in clause 11.3.1.6 of [ITU-T G.993.2].

7.2.1.7.2 Far-end successful seamless rate adaptation count

The far-end successful SRA count (SRA-SUCCESS-FE) parameter is a count of the total number of successful SRA procedures initiated by the far-end xTU on the line during the accumulation period. Parameter procedures shall be as specified in clause 7.2.7.

Successful SRA is specified in clause 11.3.1.6 of [ITU-T G.993.2].

7.2.1.8 Short interruption performance monitoring parameters

7.2.1.8.1 Loss of power interruption count

The loss of power interruption count (LPR_INTRPT) parameter is a count of the number of *lpr_intrpt* anomalies occurring during the accumulation period. Those anomalies are specified in clause 11.3.1.1 of [ITU-T G.993.2]. Only the counters on the current and previous 24 h intervals shall be supported. A special value indicates that this counter is not active on the line. Threshold reports (TRs) for this counter are not specified.

7.2.1.8.2 Host-reinit interruption count

The host-reinit interruption count (HRI_INTRPT) parameter is a count of the number of *hri_intrpt* anomalies occurring during the accumulation period. Those anomalies are specified in clause 11.3.1.1 of [ITU-T G.993.2]. Only the counters on the current and previous 24 h intervals shall be supported. A special value indicates that this counter is not active on the line. TRs for this counter are not specified.

7.2.1.8.3 Spontaneous interruption count

The spontaneous interruption count (SPONT_INTRPT) parameter is a count of the number of *spont_intrpt* anomalies occurring during the accumulation period. Those defects are specified in clause 11.3.1.1 of [ITU-T G.993.2]. Only the counters on the current and previous 24 h intervals shall be supported. A special value indicates that this counter is not active on the line. TRs are specified for the 24 h interval counter only.

7.2.2 Channel performance monitoring parameters

This clause specifies a set of channel PM parameters. Support of the performance parameters in an NE is indicated as mandatory (M) or optional (O) in Table 7-2.

7.2.2.1 Channel near-end performance monitoring parameters

7.2.2.1.1 Code violation-channel

The code violation-channel (CV-C) parameter is a count of CRC-8 anomalies (the number of incorrect CRCs) occurring in the bearer channel during the accumulation period. This parameter is subject to inhibiting – see clause 7.2.7.13.

If the CRC is applied over multiple bearer channels, then each related CRC-8 anomaly shall increment each of the counters related to the individual bearer channels.

7.2.2.1.2 Forward error correction-channel

The forward error correction-channel (FEC-C) parameter is a count of FEC anomalies (the number of corrected code words) occurring in the bearer channel during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

If FEC is applied over multiple bearer channels, then each related FEC anomaly shall increment each of the counters related to the individual bearer channels.

7.2.2.1.3 Uncorrected data transfer unit-channel

The uncorrected data transfer unit- (DTU-) channel (RTXUC-C) parameter is a count of rtx-uc anomalies (the number of uncorrected DTUs) occurring in the bearer channel during the accumulation period.

7.2.2.1.4 Retransmitted data transfer unit-channel

The retransmitted DTU-channel (RTXTX-C) parameter is a count of rtx-tx anomalies (the number of retransmitted DTUs, see clause 12 of [ITU-T G.998.4]), occurring in the bearer channel during the accumulation period.

7.2.2.2 Channel far-end performance monitoring parameters

7.2.2.2.1 Code violation-channel far-end

The code violation-channel far-end (CV-CFE) parameter is a count of FEBE anomalies occurring in the bearer channel during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

If the CRC is applied over multiple bearer channels, then each related FEBE anomaly shall increment each of the counters related to the individual bearer channels.

7.2.2.2.2 Forward error correction-Channel far-end

The forward error correction-channel far-end (FEC-CFE) parameter is a count of FFEC anomalies occurring in the bearer channel during the accumulation period. This parameter is subject to inhibition – see clause 7.2.7.13.

If FEC is applied over multiple bearer channels, then each related FFEC anomaly shall increment each of the counters related to the individual bearer channels.

7.2.2.2.3 Uncorrected data transfer unit-channel far-end

The uncorrected DTU-channel far-end (RTXUC-CFE) parameter is a count of far-end rtx-uc anomalies (the number of uncorrected DTUs) occurring in the bearer channel during the accumulation period.

7.2.2.2.4 Retransmitted data transfer unit-channel far-end

The retransmitted DTU-channel far-end (RTXTX-CFE) parameter is a count of far-end rtx-tx anomalies (the number of retransmitted DTUs, see clause 12 of [ITU-T G.998.4]) occurring in the bearer channel during the accumulation period.

7.2.3 Synchronous transfer mode data path performance monitoring parameters

The STM channel PM parameters are for further study.

7.2.4 Asynchronous transfer mode data path performance monitoring parameters

This clause specifies a set of ATM data path PM parameters using cell transfer outcomes. Support of the performance parameters in an NE is indicated as mandatory (M) or optional (O) in Table 7-3.

NOTE – The far-end parameters cannot be supported using only the indicator bits or EOC messages specified in [ITU-T G.992.1] or [ITU-T G.992.2]. They may be provided using the OAM communication channel specified in clause 6.

7.2.4.1 Asynchronous transfer mode data path near-end performance monitoring parameters

7.2.4.1.1 Near-end header error control violation count

The near-end HEC_violation_count (HEC-P) performance parameter is a count of the number of occurrences of a near-end header error control (HEC) anomaly in the ATM data path.

7.2.4.1.2 Near-end delineated total cell count

The near-end delineated_total_cell_count (CD-P) performance parameter is a count of the total number of cells passed through the cell delineation and HEC function process operating on the ATM data path while in the SYNC state.

7.2.4.1.3 Near-end user total cell count

The near-end User_total_cell_count (CU-P) performance parameter is a count of the total number of cells in the ATM data path delivered at the V-C (for the xTU-C) or T-R (for the xTU-R) interface.

7.2.4.1.4 Near-end idle cell bit error count

The near-end idle_bit_error_count (IBE-P) performance parameter is a count of the number of bit errors in the idle cell payload received in the ATM data path at the near-end.

NOTE – The idle cell payload is specified in [b-ITU-T I.361] and the b-ITU-T I.432.x series of Recommendations.

7.2.4.2 Asynchronous transfer mode data path far-end performance monitoring parameters

7.2.4.2.1 Far-end header error control violation count

The far-end HEC_violation_count (HEC-PFE) performance parameter is a count of the number of occurrences of a far-end HEC anomaly in the ATM data path

7.2.4.2.2 Far-end delineated total cell count (CD-PFE)

The far-end delineated_total_cell_count (CD-PFE) performance parameter is a count of the total number of cells passed through the cell delineation process and HEC function operating on the ATM data path while in the SYNC state.

7.2.4.2.3 Far-end user total cell count

The far-end user_total_cell_count (CU-PFE) performance parameter is a count of the total number of cells in the ATM data path delivered at the V-C (for the xTU-C) or T-R (for the xTU-R) interface.

7.2.4.2.4 Far-end idle cell bit error count

The far-end idle_bit_error_count (IBE-PFE) performance parameter is a count of the number of bit errors in the idle cell payload received in the ATM data path at the far-end.

7.2.5 Packet transfer mode data path performance monitoring parameters

This clause defines a set of PTM data path PM parameters. Support of the performance parameters in an NE is indicated as mandatory (M) or optional (O) in Table 7-4.

7.2.5.1 Packet transfer mode data path near-end performance monitoring parameters

7.2.5.1.1 Near-end CRC error count

The near-end CRC error count (CRC-P) performance parameter is a count of the number of occurrences of a CRC-*n* anomaly in the PTM data path at the near-end.

The CRCP-P performance parameter is a count of the number of occurrences of a CRC-*np* anomaly in the PTM data path at the near-end.

7.2.5.1.2 Near-end coding violations count

The near-end coding violations count (CV-P) performance parameter is a count of the number of occurrences of a cv-*n* anomaly in the PTM data path at the near-end.

The CVP-P performance parameter is a count of the number of occurrences of a cv-*np* anomaly in the PTM data path at the near-end.

7.2.5.2 Packet transfer mode data path far-end performance monitoring parameters

NOTE 1 – The far-end counters are not supported by the indicator bits or EOC messages specified in the ITU-T G.992.x-series of Recommendations or in [ITU-T G.993.2]. They may be provided if the higher layer protocol running over this PTM-TC provides means (that lie outside the scope of this Recommendation) to retrieve far-end PTM-TC surveillance primitives from the far-end, or through the OAM communication channel specified in clause 6.

NOTE 2 – In [b-IEEE 802.3], the Ethernet management function (residing above the γ-reference point) maps the near-end surveillance primitives and counters (obtained over the γ-interface through access to clause 45 management data input/output (MDIO) registers) into MIB objects defined in clause 30. MIB objects are exchanged with the far-end using the Ethernet OAM PDU format and protocol defined in clause 57.

7.2.5.2.1 Far-end CRC error count

The far-end CRC error count (CRC-PFE) performance parameter is a count at the far-end of the number of occurrences of a CRC-*n* anomaly (as observed by the far-end) in the PTM data path.

The far-end CRCP-PFE performance parameter is a count at the far-end of the number of occurrences of a CRC-*np* anomaly (as observed by the far-end) in the PTM data path.

7.2.5.2.2 Far-end coding violations count

The far-end coding violations count (CV-PFE) performance parameter is a count at the far-end of the number of occurrences of a cv-*n* anomaly (as observed by the far-end) in the PTM data path.

The far-end CVP-PFE performance parameter is a count of the number of occurrences of a cv-*np* anomaly (as observed by the far-end) in the PTM data path.

7.2.6 Performance monitoring data collection

Parameters, failures, and signals etc. are specified in the foregoing and in Tables 7-1, 7-2, 7-3 and 7-4. Functions are indicated as mandatory (M) or optional (O). Mandatory functions shall be met for PM. Optional functions should be provided according to the user needs.

Table 7-1 – Line performance monitoring parameter definitions

Name	End	Use at xTU-C	Use at xTU-R	Specification
FECS-L	Near	M	M	FEC ≥ 1 for one or more bearer channels.
FECS-LFE	Far	M	O	FFEC ≥ 1 for one or more bearer channels.
ES-L	Near	M	M	CRC-8 ≥ 1 for one or more bearer channels **OR** LOS ≥ 1 **OR** SEF ≥ 1 **OR** LPR ≥ 1
ES-LFE	Far	M	O	FEBE ≥ 1 for one or more bearer channels **OR** LOS-FE ≥ 1 **OR** RDI ≥ 1 **OR** LPR-FE ≥ 1
SES-L	Near	M	M	CRC-8 ≥ 18 for one or more bearer channels **OR** LOS ≥ 1 **OR** SEF ≥ 1 **OR** LPR ≥ 1 Further conditions, see clause 7.2.1.1.3.
SES-LFE	Far	M	O	FEBE ≥ 18 for one or more bearer channels **OR** LOS-FE ≥ 1 **OR** RDI ≥ 1 **OR** LPR-FE ≥ 1 Further condition, see clause 7.2.1.2.3
LOSS-L	Near	O	O	LOS ≥ 1
LOSS-LFE	Far	O	O	LOS-FE ≥ 1
UAS-L	Near	M	M	A second of unavailability
UAS-LFE	Far	M	O	A second of unavailability
INMINPEQ$_i$-L	Near	O		Count of INMAINPEQ$_i$-L anomalies on the line
INMINPEQ$_i$-LFE	Far	O		Count of INMAINPEQ$_i$-LFE anomalies on the line
INMIAT$_i$-L	Near	O		Count of INMAIAT$_i$-L anomalies on the line
INMIAT$_i$-LFE	Far	O		Count of INMAIAT$_i$-LFE anomalies on the line
INMME-L	Near	O		Count of INMAME-L anomalies on the line
INMME-LFE	Far	O		Count of INMAME-LFE anomalies on the line

Table 7-1 – Line performance monitoring parameter definitions

Name	End	Use at xTU-C	Use at xTU-R	Specification

NOTE 1 – Note that **OR** represents a logical OR of two conditions.

NOTE 2 – Unavailability spcifications are presented in clauses 7.2.1.1.5 and 7.2.1.2.5.

NOTE 3 – If a common CRC or FEC is applied over multiple bearer channels, then each related CRC-8 or FEC anomaly shall be counted only once for the whole set of bearer channels over which the CRC or FEC is applied.

NOTE 4 – If the relevant Recommendation supports 1s normalized CRC counter increments, these increments shall be used instead of an increment of one for each CRC-8 and FEBE anomaly to declare SES.

Table 7-2 – Channel performance monitoring parameter definitions

Name	End	Use at xTU-C	Use at xTU-R	Specification
CV-C	Near	M	M	Count of CRC-8 anomalies in the bearer channel
CV-CFE	Far	M	O	Count of FEBE anomalies in the bearer channel
EC-C	Near	M	M	Count of FEC anomalies in the bearer channel
EC-CFE	Far	M	O	Count of FFEC anomalies in the bearer channel

Table 7-3 – Asynchronous transfer mode data path performance monitoring parameter definitions

Name	End	Use at xTU-C	Use at xTU-R	Specification
HEC-P	Near	M	M	Count of HEC anomalies in the bearer channel
HEC-PFE	Far	M	O	Count of FHEC anomalies in the bearer channel
CD-P	Near	M	M	Count of delineated cells in the bearer channel
CD-PFE	Far	M	O	Count of delineated cells in the bearer channel
CU-P	Near	M	M	Count of cells to user in the bearer channel
CU-PFE	Far	M	O	Count of cells to user in the bearer channel
IBE-P	Near	M	M	Count of idle cell payload bit errors in the bearer channel
IBE-PFE	Far	M	O	Count of idle cell payload bit errors in the bearer channel

Table 7-4 – Packet transfer mode data path performance monitoring parameter definitions

Name	End	Use at xTU-C	Use at xTU-R	Specification
CRC-P	Near	M	M	Count of non-pre-emptive packets with CRC error in the bearer channel
CRC-PFE	Far	M	O	Count of non-pre-emptive packets with CRC error in the bearer channel
CRCP-P	Near	M	M	Count of pre-emptive packets with CRC error in the bearer channel
CRCP-PFE	Far	M	O	Count of pre-emptive packets with CRC error in the bearer channel
CV-P	Near	M	M	Count of non-pre-emptive packets with coding violation in the bearer channel

Table 7-4 – Packet transfer mode data path performance monitoring parameter definitions

Name	End	Use at xTU-C	Use at xTU-R	Specification
CV-PFE	Far	M	O	Count of non-pre-emptive packets with coding violation in the bearer channel
CVP-P	Near	M	M	Count of pre-emptive packets with coding violation in the bearer channel
CVP-PFE	Far	M	O	Count of pre-emptive packets with coding violation in the bearer channel

The line PM parameters (Table 7-1) are observed for the downstream and upstream directions. In the downstream direction, the near-end line PM parameters are observed by the xTU-R and far-end line PM parameters are observed by the xTU-C. In the upstream direction, near-end line PM parameters are observed by the xTU-C and far-end line PM parameters are observed by the xTU-R.

For a downstream bearer channel, near-end channel (Table 7-2), ATM data path (Table 7-3, if applicable), and PTM data path (Table 7-4, if applicable) PM parameters are observed by the xTU-R and far-end PM parameters are observed by the xTU-C. For an upstream bearer channel, near-end channel and ATM data path PM parameters are observed by the xTU-C and far-end PM parameters are observed by the xTU-R.

7.2.7 Procedures for performance monitoring functions

The functions specified in this clause can be performed inside or outside the NE.

7.2.7.1 Line transmission states

A line can be in one of two transmission states:

- unavailable state;
- available state.

The transmission state is determined from filtered SES/non-SES data. Unavailable state is specified in clause 7.2.1.1.5. An xDSL line is in the available state when it is not in the unavailable state.

7.2.7.2 Threshold reports

A TR is an unsolicited error performance report from an ME over the Q-interface and from the xTU-R over the U-interface with respect to either a 15 min or 24 h evaluation period. TRs can only occur when the concerned direction is in the available state. At the Q-interface, TRs for near-end and far-end errored second (ES), SES and UAS parameters are mandatory, and TRs for the other defined parameters are optional except for INM parameters, LPR_INTRPT, HRI_INTRPT, for which TRs are not defined. TRs are not provided at the T/S-interface.

TR1s shall occur within 10 s after the 15 min threshold is reached or exceeded.

TR2s shall occur within 10 s after the 24 h threshold is reached or exceeded.

7.2.7.3 Unavailable and available state filters

The unavailable state filter is a 10 s rectangular sliding window with a 1 s granularity of the slide.

The available state filter is also a 10 s rectangular sliding window with a 1 s granularity of the slide.

7.2.7.4 TR1 filter

The TR1 filter is a 15 min rectangular fixed window. The start and end times for the 15 min rectangular fixed windows shall fall on the hour and at 15, 30 and 45 min after the hour.

7.2.7.5 TR2 filter

The TR2 filter is a 24 h rectangular fixed window. The start and end times for the 24 h rectangular fixed windows shall fall on a 15 min window boundary.

7.2.7.6 Evaluation of TR1

The parameters are counted separately, second by second, over each 15 min rectangular fixed window period. The threshold values should be programmable over the range 0 to 900 with default values. The default values are given in [b-ITU-T M.2100] and [b-ITU-T M.2101].

A threshold can be crossed at any second within the 15 min rectangular fixed window. As soon as a threshold is crossed, a TR1 as appropriate should be sent to the NMS together with a date/time-stamp. Moreover, performance events should continue to be counted to the end of the current 15 min period, at which time the current parameter counts are stored in the history registers and the current parameter registers are reset to zero.

7.2.7.7 Evaluation of TR2

The parameters are counted separately over each 24 h period. The threshold values should be programmable over the range 0 to 86 400 with default values.

The NE shall recognize a 24 h threshold crossing within 15 min of its occurrence. The threshold crossing shall be given the date/time-stamp of the moment of recognition. A TR2 as appropriate should be sent to the NMS with the date/time-stamp. Moreover, performance events should continue to be counted to the end of the current 24 h period, at which time the parameter counts are stored in the history registers and the current parameter registers are reset to zero.

7.2.7.8 Threshold report evaluation during transmission state changes

Care should be taken to ensure that TRs are correctly generated and parameter counters are correctly processed during changes in the transmission state. This implies that all TRs should be delayed by 10 s (see [b-ITU-T M.2120]).

7.2.7.9 Performance history storage in network elements

The parameters for ME performance history storage at the Q-interface that shall be supported are ES, SES and UAS. Performance history storage for the other defined parameters is optional.

There shall be a current 15 min register (which can also facilitate the TR1 filter) plus a further *N* 15 min history registers for each parameter in each ME. The *N* 15 min history registers are used as a stack, i.e., the value held in each register is pushed down the stack one place at the end of each 15 min period, and the oldest register value at the bottom of the stack is discarded.

The value of *N* for the parameters ES, SES and UAS shall be at least 16. For the other parameters, the value of *N* shall be at least 1 (i.e., only current and previous values are required). If INM parameters are supported, the value of *N* for those parameters shall be 1.

There shall be a current 24 h register (which can also facilitate the TR2 filter) plus one previous 24 h register for each parameter.

As a minimum, an invalid data flag shall be provided for each stored interval for each direction for each monitored transmission entity. An example follows.

An invalid data flag is set to indicate that the data stored is incomplete or otherwise invalid when the data:

- in the previous and recent intervals has been accumulated over a period of time that is greater or less than the nominal accumulation period duration;
- in the current interval is suspect because a terminal is restarted or a register is reset in the middle of an accumulation period;

- is incomplete in an accumulation period. e.g., an incoming transmission failure or defect may prevent complete collection of far-end performance reports.

The invalid data flag is not set as a result of register saturation.

7.2.7.10 Register size

The minimum register size is 16 bits. The maximum register sizes are vendor discretionary. When the maximum value of a register is reached, the register shall remain at that maximum value until it is reset or the value is transferred or discarded, as described in this clause.

7.2.7.11 Parameter counts

All parameter counts shall be actual counts for the 15 min filtering period.

Although all parameter counts should (ideally) also be actual for the 24 h filtering periods, it is recognized that it might be desirable to limit register sizes. In such cases, register overflow may occur, in which case, the registers shall hold their maximum value for the parameter considered until the registers are read and reset at the end of the 24 h period. An implementation involving setting and resetting an overflow bit may be used.

If the AN-ME does not force the line into the L3 state, then PM counters shall be active, irrespective of the actual link state of the line.

If the AN-ME forces the line into the L3 state, then all PM counters shall be frozen, including the UAS counter.

The time when the PM counters are frozen shall be excluded from the accumulation period (see clause 7.2.7.9).

NOTE – The AN-ME may force the line into the L3 state, e.g., when the line is configured with AdminStatus="down", during loop diagnostics mode (see clause 7.3.1.1.8), or during a single-ended line test (SELT) measurement (see ITU-T G.996.2).

7.2.7.12 Date/time stamping of reports

The date/time-stamping accuracy of reports, together with the method of maintaining the accuracy, is under study.

The format for date/time stamps is as follows:

- 15 min window will be stamped year, month, day, hour, minute;
- 24 h window will be stamped year, month, day, hour;
- unavailable time events will be stamped year, month, day, hour, minute, second;
- alarms will be stamped either at the declaration of the alarm by the equipment or at the exact time of the event (to be decided) with year, month, day, hour, minute, second.

Equipment clock accuracy requirements are for further study.

7.2.7.13 Inhibiting performance monitoring parameters

For a given monitored entity, the accumulation of certain performance parameters is inhibited during periods of unavailability, during SESs or during seconds containing defects on that monitored entity. Inhibiting a given monitored entity (e.g., ADSL ATM data path) is not explicitly affected by conditions on any other monitored entity (xDSL line). The inhibiting rules are as follows.

- UAS and failure count parameters shall not be inhibited.
- *leftr* defect seconds counter and MINEFTR shall not be inhibited.
- INM parameters shall be inhibited during a 1 s interval, if they contain one or more LOS defects, or one or more SEF defects, or one or more LPR defects.

SES-L, SES-LFE, ES-L, ES-LFE, LOSS-L and LOSS-LFE counters shall be inhibited only during unavailable time, even if the unavailable time is declared retroactively.

NOTE – An implementation may count the SES-L, ES-L and LOSS-L during the contiguous SES-L leading to the declaration of UAS-L and subtract them at the onset of the declaration of UAS-L. The same may apply for the LOSS-LFE. See Figure 4 of [b-ITU-T M.2100].

• All other performance parameter counts shall be inhibited during UAS and SES. Inhibition shall be retroactive to the onset of unavailable time and shall end retroactively to the end of unavailable time.

7.3 Configuration functions

7.3.1 Line configuration parameters

7.3.1.1 State configuration parameters

7.3.1.1.1 xTU transmission system enabling

The xTU transmission system enabling (XTSE) configuration parameter defines the transmission system types to be allowed by the near-end xTU on this line. This parameter only applies to the Q-interface. It is coded in a bit-map representation (0 if not allowed, 1 if allowed), with the following specification.

Bit Representation

Octet 1

1 Regional standards (see Note)

2 Regional standards (see Note)

3 ITU-T G.992.1 operation over plain old telephone service (POTS; one of the services using the voiceband; sometimes used as a descriptor for all voiceband services) non-overlapped spectrum (see Annex A of [ITU-T G.992.1])

4 ITU-T G.992.1 operation over POTS overlapped spectrum (see Annex A of [ITU-T G.992.1])

5 ITU-T G.992.1 operation over the integrated services digital network (ISDN) non-overlapped spectrum (see Annex B of [ITU-T G.992.1])

6 ITU-T G.992.1 operation over ISDN overlapped spectrum (see Annex B of [ITU-T G.992.1])

7 ITU-T G.992.1 operation in conjunction with TCM-ISDN non-overlapped spectrum (see Annex C of [ITU-T G.992.1])

8 ITU-T G.992.1 operation in conjunction with TCM-ISDN overlapped spectrum (see Annex C of [ITU-T G.992.1])

Octet 2

9 ITU-T G.992.2 operation over POTS non-overlapped spectrum (see Annex A of [ITU-T G.992.2])

10 ITU-T G.992.2 operation over POTS overlapped spectrum (see Annex B of [ITU-T G.992.2])

11 ITU-T G.992.2 operation in conjunction with TCM-ISDN non-overlapped spectrum (see Annex C of [ITU-T G.992.2])

12 ITU-T G.992.2 operation in conjunction with TCM-ISDN overlapped spectrum (see Annex C of [ITU-T G.992.2])

13 Reserved

14 Reserved

15 Reserved

16 Reserved

Octet 3

17 Reserved

18 Reserved

19 ITU-T G.992.3 operation over POTS non-overlapped spectrum (see Annex A of [ITU-T G.992.3])

20 ITU-T G.992.3 operation over POTS overlapped spectrum (see Annex A of [ITU-T G.992.3])

21 ITU-T G.992.3 operation over ISDN non-overlapped spectrum (see Annex B of [ITU-T G.992.3])

22 ITU-T G.992.3 operation over ISDN overlapped spectrum (see Annex B of [ITU-T G.992.3])

23 ITU-T G.992.3 operation in conjunction with TCM-ISDN non-overlapped spectrum (see Annex C of [ITU-T G.992.3])

24 ITU-T G.992.3 operation in conjunction with TCM-ISDN overlapped spectrum (see Annex C of [ITU-T G.992.3])

Octet 4

25 ITU-T G.992.4 operation over POTS non-overlapped spectrum (see Annex A of [ITU-T G.992.4])

26 ITU-T G.992.4 operation over POTS overlapped spectrum (see Annex A of [ITU-T G.992.4])

27 Reserved

28 Reserved

29 ITU-T G.992.3 all digital mode operation with non-overlapped spectrum (see Annex I of [ITU-T G.992.3])

30 ITU-T G.992.3 all digital mode operation with overlapped spectrum (see Annex I of [ITU-T G.992.3])

31 ITU-T G.992.3 all digital mode operation with non-overlapped spectrum (see Annex J of [ITU-T G.992.3])

32 ITU-T G.992.3 all digital mode operation with overlapped spectrum (see Annex J of [ITU-T G.992.3])

Octet 5

33 ITU-T G.992.4 all digital mode operation with non-overlapped spectrum (see Annex I of [ITU-T G.992.4])

34 ITU-T G.992.4 all digital mode operation with overlapped spectrum (see Annex I of [ITU-T G.992.4])

35 ITU-T G.992.3 reach extended operation over POTS, mode 1 (non-overlapped, wide upstream) (see Annex L of [ITU-T G.992.3])

36 ITU-T G.992.3 reach extended operation over POTS, mode 2 (non-overlapped, narrow upstream) (see Annex L of [ITU-T G.992.3])

37 ITU-T G.992.3 reach extended operation over POTS, mode 3 (overlapped, wide upstream) (see Annex L of [ITU-T G.992.3])

38 ITU-T G.992.3 reach extended operation over POTS, mode 4 (overlapped, narrow upstream) (see Annex L of [ITU-T G.992.3])

39 ITU-T G.992.3 extended upstream operation over POTS non-overlapped spectrum (see Annex M of [ITU-T G.992.3])

40 ITU-T G.992.3 extended upstream operation over POTS overlapped spectrum (see Annex M of [ITU-T G.992.3])

Octet 6

41 ITU-T G.992.5 operation over POTS non-overlapped spectrum (see Annex A of [ITU-T G.992.5])

42 ITU-T G.992.5 operation over POTS overlapped spectrum (see Annex A of [ITU-T G.992.5])

43 ITU-T G.992.5 operation over ISDN non-overlapped spectrum (see Annex B of [ITU-T G.992.5])

44 ITU-T G.992.5 operation over ISDN overlapped spectrum (see Annex B of [ITU-T G.992.5])

45 ITU-T G.992.5 operation in conjunction with TCM-ISDN non-overlapped spectrum (see Annex C of [ITU-T G.992.5])

46 ITU-T G.992.5 operation in conjunction with TCM-ISDN overlapped spectrum (see Annex C of [ITU-T G.992.5])

47 ITU-T G.992.5 all digital mode operation with non-overlapped spectrum (see Annex I of [ITU-T G.992.5])

48 ITU-T G.992.5 all digital mode operation with overlapped spectrum (see Annex I of [ITU-T G.992.5])

Octet 7

49 ITU-T G.992.5 all digital mode operation with non-overlapped spectrum (see Annex J of [ITU-T G.992.5])

50 ITU-T G.992.5 all digital mode operation with overlapped spectrum (see Annex J of [ITU-T G.992.5])

51 ITU-T G.992.5 extended upstream operation over POTS non-overlapped spectrum (see Annex M of [ITU-T G.992.5])

52 ITU-T G.992.5 extended upstream operation over POTS overlapped spectrum (see Annex M of [ITU-T G.992.5])

53 Reserved

54 Reserved

55 Reserved

56 Reserved

Octet 8

57 ITU-T G.993.2 Region A (North America) (see Annex A of [ITU-T G.993.2])

58 ITU-T G.993.2 Region B (Europe) (see Annex B of [ITU-T G.993.2])

59 ITU-T G.993.2 Region C (Japan) (see Annex C of [ITU-T G.993.2])

60 ITU-T G.993.2 Region D (China) (see Annex N of [ITU-T G.993.2]).

61 Reserved

62 Reserved

63 Reserved

64 Reserved

NOTE – It is recommended that bit 1 be used for [b-ATIS 0600413]. It is recommended that bit 2 be used for Annex C of [b-ETSI TS 101 388].

7.3.1.1.2 Asymmetric digital subscriber line transceiver unit impedance state forced

The ADSL transceiver unit impedance state forced (AISF) configuration parameter defines the impedance state to be forced on the near-end ADSL transceiver unit (ATU). It applies only to the T/S-interface. It is coded as an integer value with the following assignments.

1 Force the near-end ATU to the disabled state

2 Force the near-end ATU to the inactive state

3 Force the near-end ATU to the active state

Impedance states apply only to Annex A of [ITU-T G.992.3] operation mode and are specified in clause A.4.1 of [ITU-T G.992.3].

7.3.1.1.3 Power management state forced

The power management state forced (PMSF) configuration parameter defines the line states to be forced by the near-end xTU on this line. It is coded as an integer value with the following specification.

0 Force the line to transition from the L3 idle state to the L0 full-on state (i.e., both xTUs are in showtime). This transition requires the (short or full) initialization procedures. After reaching the L0 state, the line may transition into or exit from the L2 low power state (if L2 state is defined and enabled). If the L0 state is not reached (after a vendor discretionary number of retries or within a vendor discretionary timeout), then an initialization failure occurs. Whenever the line is in the L3 state, attempts shall be made to transition to the L0 state until it is forced into another state through this configuration parameter.

2 Force the line to transition from L0 full on to L2 low power state. This transition requires the entry into L2 mode. This is an out-of-service test value for triggering the L2 mode and is valid only for Recommendations supporting L2 mode.

3 Force the line to transition from the L0 full-on or L2 low power state to the L3 idle state. This transition requires the (orderly) shutdown procedure. After reaching the L3 state, the line shall remain in the L3 idle state until it is forced into another state through this configuration parameter.

Forced line state transitions require the line to enter or exit the L3 idle state. These transitions are not restricted by the power management state enabling parameter value.

NOTE – This configuration parameter maps to the AdminStatus of the line, which is part of the GeneralInformationGroup object group specified in [b-IETF RFC 2233], and may not need to be duplicated in the ADSL MIB. See also [b-IETF RFC 2662]. The administrative status of the line is up when the line is forced to the L0 state and is down when the line is forced to the L3 state.

7.3.1.1.4 Power management state enabling

The power management state enabling (PMMode) configuration parameter specifies the line states the xTU-C or xTU-R may autonomously transition to on this line. It is coded in a bit-map representation (0 if not allowed, 1 if allowed) with following assignments.

bit 0 L3 state (idle state)

bit 1 L1/L2 state (low power state)

NOTE – L1/L2 state may not be defined in some ITU-T Recommendations.

7.3.1.1.5 Minimum L0 time interval between L2 exit and next L2 entry

The minimum L0 time interval between L2 exit and next L2 entry (L0-TIME) parameter represents the minimum time (in seconds) between an exit from the L2 state and the next entry into the L2 state. It ranges from 0 s to 255 s.

7.3.1.1.6 Minimum L2 time interval between L2 entry and first L2 trim

The minimum L2 time interval between L2 entry and first L2 trim (L2-TIME) parameter represents the minimum time (in seconds) between an entry into the L2 state and the first power trim in the L2 state and between two consecutive power trims in the L2 state. It ranges from 0 s to 255 s.

7.3.1.1.7 Maximum aggregate transmit power reduction per L2 request or L2 power trim

The maximum aggregate transmit power reduction per L2 request or L2 power trim (L2-ATPR) parameter represents the maximum aggregate transmit power reduction, in decibels, that can be performed in the L2 request (i.e., at the transition of the L0 to L2 state) or through a single power trim in the L2 state. It ranges from 0 dB to 31 dB in steps of 1 dB.

7.3.1.1.8 Loop diagnostic mode status forced

The loop diagnostic mode status forced (LDSF) configuration parameter determines whether the line should be forced into the loop diagnostic mode by the near-end xTU on this line. It is coded as an integer value with the following assignments.

0 Inhibits the near-end xTU from performing loop diagnostic mode procedures on the line. Loop diagnostic mode procedures may still be initiated by the far-end xTU

1 Forces the near-end xTU to perform the loop diagnostic procedures

Upon the NMS forcing the loop diagnostics mode on the line, the AN shall force the line to the L3 state before it forces the near-end xTU to perform the loop diagnostic mode procedures. Only while the line power management state is the L3 state (see clause 7.5.1.5), can the near-end xTU be forced to perform the loop diagnostic mode procedures.

If the loop diagnostics mode status and results status (LDS and LDR, see clauses 7.5.1.46 and 7.5.1.47) MIB elements are not supported, then upon successful completion of the loop diagnostic mode procedures, the AN shall set the LDSF MIB element to 0, and the xTUs shall return to the idle state. The loop diagnostic data shall be available at least until the NMS no longer forces the loop diagnostic mode. If the loop diagnostic mode procedures cannot be completed successfully (after a vendor discretionary number of retries or within a vendor discretionary timeout), then an initialization failure shall occur.

If the LDS and LDR (see clauses 7.5.1.46 and 7.5.1.47) MIB elements are supported, then upon successful completion of the loop diagnostic mode procedures, the AN shall set the LDS to "inactive" and the LDR to "loop-diagnostics-succeeded-results-valid", and the xTUs shall return to the idle state. The loop diagnostic mode data shall be available at least until the NMS no longer forces the loop diagnostic mode. If the loop diagnostic mode procedures cannot be completed successfully (after a vendor discretionary number of retries or within a vendor discretionary timeout), then the AN shall set the LDS to "inactive" and the LDR to "loop diagnostics failed results invalid", and the xTUs shall return to the idle state.

7.3.1.1.9 Total maximum aggregate transmit power reduction in L2

The total maximum aggregate transmit power reduction in L2 (L2-ATPRT) parameter represents the total maximum aggregate transmit power reduction, in decibels, that can be performed in an L2 state. This is the sum of all reductions of L2 request (i.e., at transition of L0 to L2 state) and power trims. It ranges from 0 dB to 31 dB in steps of 1 dB.

7.3.1.1.10 Automode cold start forced

This parameter is specified in order to improve testing of the performance of xTUs supporting automode when it is enabled in the MIB. The valid values are 0 and 1. A change in value of this parameter indicates a change in loop conditions applied to the devices under test. The xTUs shall reset any historical information used for automode, for shortening ITU-T G.994.1 handshake or for shortening the initialization procedure.

Automode is defined as the case where multiple operation-modes are enabled in the MIB in the XTSE line configuration parameter (see 8.3.1.1.1) and where the selection of the operation-mode to be used for transmission does not only depend on the common capabilities of both xTUs (as exchanged in [ITU-T G.994.1]), but depends also on achievable data rates under given loop conditions.

This parameter is mandatory at the Q-interface for modems supporting automode.

7.3.1.1.11 VDSL2 profiles enabling

The VDSL2 profiles enabling (PROFILES) configuration parameter contains the ITU-T G.993.2 profiles to be allowed by the near-end xTU on this line. It is coded in a bit-map representation (0 if not allowed, 1 if allowed) with the following specification.

Bit	**Representation**
Octet 1	
1	ITU-T G.993.2 profile 8a
2	ITU-T G.993.2 profile 8b
3	ITU-T G.993.2 profile 8c
4	ITU-T G.993.2 profile 8d
5	ITU-T G.993.2 profile 12a
6	ITU-T G.993.2 profile 12b
7	ITU-T G.993.2 profile 17a
8	ITU-T G.993.2 profile 30a
Octet 2	
1	ITU-T G.993.2 profile 35b
2	reserved by ITU-T
3	reserved by ITU-T
4	reserved by ITU-T
5	reserved by ITU-T
6	reserved by ITU-T
7	reserved by ITU-T
8	reserved by ITU-T

7.3.1.1.12 Re-Initialization policy selection

7.3.1.1.12.1 Downstream re-initialization policy selection

The downstream RIPOLICY selection (RIPOLICYds) parameter indicates which policy shall be applied to determine the triggers for re-initialization in the downstream direction (see clause 12.1.4 of [ITU-T G.993.2] and clauses 7.3.1.1.13 and 7.2.1.1.5).

If RIPOLICYds=1 is configured and it is detected during ITU-T G.993.2 initialization that RIPOLICYds=1 is not supported in the downstream direction by either XTU, they shall fallback to RIPOLICYds=0.

The valid values for RIPOLICYds are 0 and 1.

7.3.1.1.12.2 Upstream re-initialization policy selection

The upstream RIPOLICY selection (RIPOLICYus) parameter indicates which policy shall be applied to determine the triggers for re-initialization in the upstream direction (see clause 12.1.4 of [ITU-T G.993.2] and clauses 7.3.1.1.13 and 7.2.1.1.5).

If RIPOLICYus=1 is configured and it is detected during ITU-T G.993.2 initialization that RIPOLICYus=1 is not supported in the upstream direction by either XTU, they shall fallback to RIPOLICYus=0.

The valid values for RIPOLICYus are 0 and 1.

7.3.1.1.13 SES- based re-initialization threshold

7.3.1.1.13.1 Downstream SES- based re-initialization threshold

The REINIT_TIME_THRESHOLDds parameter determines the downstream threshold for re-initialization based on SES to be used by the VDSL2 transceiver unit (VTU) receiver when RIPOLICY 1 is used in downstream (see clause 12.1.4 of [ITU-T G.993.2]).

The valid range is from 5 to 31.

7.3.1.1.13.2 Upstream SES- based re-initialization threshold

The REINIT_TIME_THRESHOLDus parameter determines the upstream threshold for re-initialization based on SES, to be used by the VTU receiver when RIPOLICY 1 is used in upstream (see clause 12.1.4 of [ITU-T G.993.2]).

The valid range is from 5 to 31.

7.3.1.2 Power/power spectral density configuration parameters

7.3.1.2.1 Downstream maximum nominal power spectral density

The downstream maximum nominal power spectral density (MAXNOMPSDds) parameter represents the maximum nominal transmit power spectral density (PSD) in the downstream direction during initialization and showtime, in decibels with reference to 1 mW per hertz. A single MAXNOMPSDds parameter is defined per mode enabled in the XTSE line configuration parameter. It ranges from –60 dBm/Hz to –30 dBm/Hz, with 0.1 dBm/Hz steps.

7.3.1.2.2 Upstream maximum nominal power spectral density

The upstream maximum nominal power spectral density (MAXNOMPSDus) parameter represents the maximum nominal transmit PSD in the upstream direction during initialization and showtime, in decibels with reference to 1 mW per hertz. A single MAXNOMPSDus parameter is defined per mode enabled in the XTSE line configuration parameter. It ranges from –60 dBm/Hz to –30 dBm/Hz, with 0.1 dBm/Hz steps.

7.3.1.2.3 Downstream maximum nominal aggregate transmit power

The downstream maximum nominal aggregate transmit power (MAXNOMATPds) parameter represents the maximum nominal aggregate transmit power in the downstream direction during initialization and showtime, in decibels with reference to 1 mW. It ranges from 0 dBm to 25.5 dBm, with 0.1 dBm steps.

7.3.1.2.4 Upstream maximum nominal aggregate transmit power

The upstream maximum nominal aggregate transmit power (MAXNOMATPus) parameter represents the maximum nominal aggregate transmit power in the upstream direction during initialization and showtime, in decibels with reference to 1 mW. It ranges from 0 dBm to 25.5 dBm, with 0.1 dB steps.

7.3.1.2.5 Upstream maximum aggregate receive power

The upstream maximum aggregate receive power (MAXRXPWRus) parameter represents the maximum upstream aggregate receive power over a set of subcarriers, in decibels with reference to 1 mW, as specified in the relevant Recommendation. The xTU-C shall request an upstream power cutback such that the upstream aggregate received power over that set of subcarriers is at or below the configured maximum value. It ranges from –25.5 dBm to 25.5 dBm, with 0.1 dB steps. A special value is used to indicate that no upstream maximum aggregate receive power limit is to be applied (i.e., the maximum value is infinite).

7.3.1.2.6 Downstream subcarrier masking

The downstream subcarrier masking (CARMASKds) configuration parameter is an array of boolean values, sc(i). Each entry sc(i) determines whether a subcarrier with index i is masked on this line in the downstream direction, for i ranging from 0 to NSCds−1. It is coded as 1 if the subcarrier is masked and 0 if the subcarrier is not masked.

NSCds is the highest subcarrier index that can be transmitted in the downstream direction. For [ITU-T G.992.3], [ITU-T G.992.4], and [ITU-T G.992.5], it is specified in the corresponding Recommendations. For [ITU-T G.992.1], NSCds = 256 and for [ITU-T G.992.2], NSCds = 128.

7.3.1.2.7 Upstream subcarrier masking

The upstream subcarrier masking (CARMASKus) configuration parameter is an array of Boolean values sc(i). Each entry sc(i) defines whether transmission of subcarrier with index i is masked on this line in the upstream direction, for i ranging from 0 to NSCus−1. It is coded as 1 if the subcarrier is masked and 0 if the subcarrier is not masked.

NSCus is the highest subcarrier index that can be transmitted in the upstream direction. For [ITU-T G.992.3], [ITU-T G.992.4] and [ITU-T G.992.5], it is specified in the corresponding Recommendation. For Annex A of [ITU-T G.992.1] and [ITU-T G.992.2], NSCus = 32 and for Annex B of [ITU-T G.992.1], NSCus = 64.

7.3.1.2.8 VDSL2 subcarrier masking

The VDSL2 subcarrier masking (VDSL2-CARMASK) configuration parameter specifies the restrictions, additional to the band plan, to determine the set of subcarriers allowed for transmission in both upstream and downstream directions.

The VDSL2-CARMASK shall describe the unmasked subcarriers as one or more frequency bands. Each band is represented by start and stop subcarrier indices with a subcarrier spacing of 4.312 5 kHz. The valid range of subcarrier indices specifying the VDSL2-CARMASK is from 0 to at least the index of the highest allowed subcarrier in both transmission directions among all profiles enabled by the parameter PROFILES (see clause 7.3.1.1.11). Up to 32 bands may be specified. Other subcarriers shall be masked.

For profiles using 8.625 kHz tone spacing, the odd subcarrier indices $i_{4.312\,5}$ in VDSL2-CARMASK shall be transformed into actual subcarrier indices $i_{8.625}$ using the following rule:

– for the start frequency of each band: $i_{8.625} = (i_{4.312\,5} + 1)/2$

– for the stop frequency of each band: $i_{8.625} = (i_{4.312\,5} - 1)/2$.

7.3.1.2.9 Downstream power spectral density mask

The downstream PSD mask (PSDMASKds) configuration parameter defines the downstream PSD mask applicable at the U-C2 reference point as defined in the respective Recommendation. A modified PSD mask, as defined in clause 7.3.1.2.13, may apply at the U-C2 reference point. This MIB PSD mask may impose PSD restrictions in addition to the limit PSD mask specified in the relevant Recommendation (e.g., [ITU-T G.992.5] and [ITU-T G.993.2]).

NOTE – In [ITU-T G.993.2], the PSDMASKds parameter is referred to as MIBMASKds.

The downstream PSD mask in the central office-management information base (CO-MIB) shall be specified through a set of breakpoints. Each breakpoint shall consist of a subcarrier index t, with a subcarrier spacing of 4.312 5 kHz, and a MIB PSD mask level (expressed in decibels with reference to 1 mW per hertz) at that subcarrier. The set of breakpoints can then be represented as [(t_1, PSD_1), (t_2, PSD_2), …, (t_N, PSD_N)]. The subcarrier index shall be coded as an unsigned integer. The MIB PSD mask level shall be coded as an unsigned integer representing the MIB PSD mask levels 0 dBm/Hz to –127.5 dBm/Hz, in steps of 0.5 dBm/Hz, with a valid range from 0 to –95 dBm/Hz. The maximum number of breakpoints is 32.

The requirements for a valid set of breakpoints are specified in he relevant Recommendations (e.g., [ITU-T G.992.5] and [ITU-T G.993.2]).

7.3.1.2.10 Remote failure indication bands

For [ITU-T G.992.5], the remote failure indication bands (RFIBANDS) configuration parameter determines the subset of downstream PSD mask breakpoints, as specified in PSDMASKds, that shall be used to notch a remote failure indication (RFI) band. This subset consists of couples of consecutive subcarrier indices belonging to breakpoints: [t_i; t_i + 1], corresponding to the low level of the notch. The specific interpolation around these points is specified in the relevant Recommendations (e.g., [ITU-T G.992.5]). The CO-MIB shall define the RFI notches using breakpoints in PSDMASKds as specified in the relevant Recommendations (e.g., [ITU-T G.992.5]).

For [ITU-T G.993.2], this configuration parameter determines the bands where the PSD shall be reduced as specified in clause 7.2.1.2 of [ITU-T G.993.2]. Each band shall be represented by a start and stop subcarrier index with a subcarrier spacing of 4.312 5 kHz. Up to 16 bands may be specified. This parameter defines the RFI bands for both upstream and downstream directions.

7.3.1.2.11 Upstream power spectral density mask selection

This configuration parameter determines which upstream PSD mask is enabled. This parameter is used only for Annexes J and M of [ITU-T G.992.3] and [ITU-T G.992.5]. As only one selection parameter is defined in the MIB, the same selection value applies to all relevant modes enabled in the XTSE line configuration parameter. Its value ranges from 1 to 9 and selects the mask with the assignments in Table 7-5.

Table 7-5 – Asignments of values of upstream power spectral density mask selection parameter for Annex J of [ITU-T G.992.3] and Annex M of [ITU-T G.992.5]

Upstream PSD mask selection value	Selected mask	
	Annex J of [ITU-T G.992.3]	Annex M of [ITU-T G.992.5]
1	ADLU-32	EU-32
2	ADLU-36	EU-36
3	ADLU-40	EU-40
4	ADLU-44	EU-44
5	ADLU-48	EU-48
6	ADLU-52	EU-52
7	ADLU-56	EU-56
8	ADLU-60	EU-60
9	ADLU-64	EU-64

7.3.1.2.12 Upstream power spectral density mask

The upstream PSD mask (PSDMASKus) configuration parameter determines the upstream PSD mask applicable at the U-R2 reference point as specified in the respective Recommendation. This MIB PSD mask may impose PSD restrictions in addition to the limit PSD mask specified in the relevant Recommendations (e.g., [ITU-T G.992.3], [ITU-T G.993.2]).

NOTE – In [ITU-T G.993.2], the PSDMASKus parameter is referred to as MIBMASKus and does not include breakpoints to shape US0.

The upstream PSD mask in the CO-MIB shall be specified through a set of breakpoints. Each breakpoint shall consist of a subcarrier index t, with a subcarrier spacing of 4.312 5 kHz, and a MIB PSD mask level (expressed in decibels with reference to 1 mW per hertz) at that subcarrier.

The set of breakpoints can then be represented as [(t_1, PSD_1), (t_2, PSD_2), … , (t_N, PSD_N)]. The subcarrier index shall be coded as an unsigned integer. The MIB PSD mask level shall be coded as an unsigned integer representing the MIB PSD mask levels 0 dBm/Hz to –127.5 dBm/Hz, in steps of 0.5 dBm/Hz, with a valid range from 0 to –95 dBm/Hz. The maximum number of breakpoints is four for [ITU-T G.992.3] and 16 for [ITU-T G.993.2].

The requirements for a valid set of breakpoints are specified in the relevant Recommendations (e.g., [ITU-T G.992.3] or [ITU-T G.993.2]).

7.3.1.2.13 Downstream power back-off-Shaped (DPBOSHAPED)

This clause provides a set of line configuration parameters and a procedure to generate a modified downstream MIB PSD mask. The modified PSD mask shall be used instead of PSDMASKds to configure the downstream PSD mask applicable at the U-C2 reference point. An example of application of this method is described in Appendix II.

a) Downstream power back-off configuration parameters

a.1) Assumed exchange PSD mask

The assumed exchange PSD mask (DPBOEPSD) parameter determines the PSD mask that is assumed to be permitted at the exchange. This parameter shall use the same format as PSDMASKds.

The maximum number of breakpoints for DPBOEPSD is 16.

a.2) E-side electrical length

The E-side electrical length (DPBOESEL) configuration parameter determines the assumed electrical length of cables (E-side cables) connecting exchange-based DSL services to a remote flexibility point (cabinet), which hosts the xTU-C that is subject to spectrally shaped downstream power back-off (DPBO) depending on this length. For this parameter, the electrical length is defined as the loss, in decibels, of an equivalent length of hypothetical cable at a reference frequency determined by the network operator or in spectrum management regulations. DPBOESEL shall be coded as an unsigned integer representing an electrical length from 0 dB to 255.5 dB in steps of 0.5 dB. All values in the range are valid.

If DPBOESEL is set to zero, the DPBO in this clause shall be disabled.

a.3) E-side cable model

The E-side cable model (DPBOESCM) configuration parameter specifies a cable model in terms of three scalars DPBOESCMA, DPBOESCMB and DPBOESCMC that shall be used to describe the frequency dependent loss of E-side cables using the formula:

$$\mathrm{ESCM}(f) = \left(\mathrm{DPBOESCMA} + \mathrm{DPBOESCMB} \cdot \sqrt{f} + \mathrm{DPBOESCMC} \cdot f\right) \cdot \mathrm{DPBOESEL}$$

where ESCM is expressed in decibels and f is expressed in megahertz. Parameters DPBOESCMA, DPBOESCMB, DPBOESCMC shall be coded as unsigned integers representing a scalar value from –1 to 1.5 in steps of 2^{-8}. All values in the range are valid.

a.4) Minimum usable signal

The minimum usable signal (DPBOMUS) determines the assumed minimum usable receive PSD mask, in decibels with reference to 1 mW per hertz, for exchange based services, used to modify parameter DPBOFMAX specified in a.6). It shall be coded as an unsigned integer representing a PSD mask level from 0 dBm/Hz to –127.5 dBm/Hz in steps of 0.5 dB. All values in the range are valid.

NOTE – The PSD mask level is 3.5 dB above the signal PSD level.

a.5) DPBO span minimum frequency

The DPBO span minimum frequency (DPBOFMIN) determines the minimum frequency from which the DPBO shall be applied. It ranges from 0 kHz to 883 2 kHz in steps of 4.312 5 kHz.

a.6) DPBO span maximum frequency

The DPBO span maximum frequency (DPBOFMAX) determines the maximum frequency at which DPBO may be applied. It ranges from 138 kHz to 35 323.687 5 kHz in steps of 4.312 5 kHz.

b) Downstream power back-off variables derived from PDMASKds

These variables are not directly accessible through the Q-interface and shall be derived in the AN from the PSDMASKds parameter.

b.1) DPBO maximum PSD mask

If the set of breakpoints determining PSDMASKds (t_i, PSD_i) are monotonic in frequency, i.e., $t_i \leq t_{i+1}$ for $0 < i \leq 32$, then DPBOPSDMASKds = PSDMASKds.

If there exists in the set of breakpoints PSDMASKds (t_i, PSD_i) a single violation of monotonic frequency sequence, i.e., $t_d > t_{d+1}$, then the DPBO maximum PSD mask, DPBOPSDMASKds = PSDMASKds (t_i, PSD_i), $0 < i \leq d$.

b.2) DPBO low frequency override

The DPBO low frequency override (DPBOLFO*)* parameter determines the PSD mask that overrides DPBO at low frequencies. If there exists in the set of breakpoints PSDMASKds (t_i, PSD_i) a single violation of monotonic frequency sequence, i.e., $t_d > t_{d+1}$, then DPBOLFO = PSDMASKds (t_i, PSD_i), $d < i \leq 32$. Otherwise, DPBOLFO shall be assumed to be –91.5 dBm/Hz or less everywhere.

c) Procedure to derive the modified downstream power spectral density mask

From the parameters defined in section b) and the PSDMASKds, a modified PSD mask after DPBO shall be derived using the following method:

- The predicted attenuated exchange PSD mask (PEPSD(*f*)) is determined by:

$$\text{PEPSD}(f) = \text{DPBOEPSD}(f) - \left(\text{DPBOESCMA} + \text{DPBOESCMB} \cdot \sqrt{f} + \text{DPBOESCMC} \cdot f\right) \cdot \text{DPBOESEL}$$

- The maximum usable frequency (MUF) is defined as the highest frequency for which the PEPSD(*f*) is greater than DPBOMUS.
- The minimum PSD mask, DPBOMPSD(*f*), is defined between frequencies DPBOFMIN and F_1 = min(DPBOFMAX,MUF) as:

$$\text{DPBOMPSD}(f) = \begin{cases} \max\left[\text{DPBOLFO}(f), -91.5\right] \text{ dBm/Hz} & \text{for } f \leq F_1 - 175 \text{ kHz} \\ \max\left[\text{DPBOLFO}(f), \frac{11.5}{175}\left(f - F_1\right) - 80\right] \text{ dBm/Hz} & \text{for } F_1 - 175 \text{ kHz} < f < F_1 \end{cases}$$

where *f* is expressed in kilohertz.

- The DPBO is applied so that at each frequency the resultant PSD mask is equal to:

$$\text{RESULTMASKds}(f) = \begin{cases} \max\left[\min\left(\text{DPBOPSDMASKds}(f), \text{PEPSD}(f)\right), \text{DPBOMPSD}(f)\right] & \text{DPBOFMIN} \leq f \leq F_1 \\ \text{DPBOPSDMASKds}(f) & \text{Otherwise} \end{cases}$$

- Finally, a modified PSD mask shall be set as close as possible to, but everywhere less than, the RESULTMASKds. This mask shall comply with the constraints of the relevant Recommendations. Its computation is vendor discretionary. This modified mask is applied to the xTU-C.

7.3.1.2.14 Upstream power back-off shaped (UPBOSHAPED)

Upstream power back-off (UPBO) is specified in [ITU-T G.993.2] to provide spectral compatibility between loops of different lengths deployed in the same binder. The upstream transmit PSD mask, UPBOMASKus, is specified in clause 7.2.1.3.2 of [ITU-T G.993.2].

The ITU-T G.993.2 UPBO configuration parameters *a*, *b*, and the reference electrical lengths kl_{0_REF} shall be set by the NMS in the CO-MIB. The parameter kl_0 may be determined during initialization by the VTUs or forced by the CO-MIB.

a) Upstream power back-off configuration parameters

a.1) Upstream power back-off reference PSD per band

The upstream power back-off reference PSD per band (UPBOPSD-pb) parameter defines the UPBO reference PSD used to compute the upstream power back-off for each upstream band except US0. A UPBOPSD defined for each band shall consist of two parameters [*a*, *b*]. Parameter *a* ranges from 40 dBm/Hz to 80.95 dBm/Hz in steps of 0.01 dBm/Hz; and parameter *b* ranges from 0 dB/Hz to 40.95 dBm/Hz in steps of 0.01 dBm/Hz. The UPBO reference PSD at the frequency *f* expressed in megahertz shall be equal to $-a - b\sqrt{f}$. The set of parameter values a = 40 dBm/Hz, b = 0 dBm/Hz is a special configuration to disable UPBO in the respective upstream band.

a.2) Upstream electrical length

The upstream electrical length (UPBOKL) parameter defines the electrical length expressed in decibels at 1 MHz, kl_0, configured by the CO-MIB. The value ranges from 0 dB to 128 dB in steps of 0.1 dB.

a.3) Force CO-MIB electrical length

The force CO-MIB electrical length (UPBOKLF) parameter is a flag that forces the VTU-R to use the electrical length of the CO-MIB (UPBOKL) to compute the UPBO. The value shall be forced if the flag is set to 1. Otherwise, the VTUs shall determine the electrical length.

a.4) UPBO reference electrical length per band

The UPBO reference electrical length per band (UPBOKLREF-pb) parameter determines the UPBO reference electrical length used to compute the upstream power back-off for each upstream band except US0, for the optional equalized far-end crosstalk (FEXT) UPBO method. The value ranges from 1.8 dB to 63.5 dB in steps of 0.1 dB with special value 0. The use of the special value 0 is described in clause 7.2.1.3.2 of [ITU-T G.993.2].

a.5) Alternative electrical length estimation mode

The alternative electrical length estimation mode (AELE-MODE) parameter determines the UPBO electrical length estimation mode to be used in the alternative electrical length estimation method (ELE-M1) in clause 7.2.1.3.2.2 of [ITU-T G.993.2]. The value of this parameter is 0, 1, 2 or 3.

a.6) UPBO electrical length threshold percentile

The UPBO electrical length threshold percentile (UPBOELMT) parameter determines the UPBO electrical length minimum threshold percentile, in per cent, used in the alternative electrical length estimation method (ELE-M1) in clause 7.2.1.3.2.2 of [ITU-T G.993.2]. It is set by network management via the CO-MIB. The parameter ranges from 0% to 15% in steps of 1%. This value is communicated to the VTU-R in accordance with [ITU-T G.994.1] at start-up.

7.3.1.2.15 VDSL2 power spectral density mask class selection (CLASSMASK)

In order to reduce the number of configuration possibilities, the limit PSD masks are grouped into the following PSD mask classes:

– class 998-30 Annex A of [ITU-T G.993.2]: D-32, D-48, D-64, D-128

– class 998-35b Annex A of [ITU-T G.993.2]: D-32, D-48, D-64, D-128
– class 997-M1c Annex B of [ITU-T G.993.2]: 997-M1c-A-7
– class 997-M1x Annex B of [ITU-T G.993.2]: 997-M1x-M
– class 997-M2x Annex B of [ITU-T G.993.2]: 997E17-M2x-A, 997E30-M2x-NUS0
– class 998-M2x Annex B of [ITU-T G.993.2]: 998-M2x-A, 998-M2x-M, 998-M2x-B, 998-M2x-NUS0, 998E17-M2x-NUS0, 998E17-M2x-NUS0-M, 998E30-M2x-NUS0, 998E30-M2x-NUS0-M, 998E17-M2x-A
– class 998ADE-M2x Annex B of [ITU-T G.993.2]: 998-M2x-A, 998-M2x-M, 998-M2x-B, 998-M2x-NUS0, 998ADE17-M2x-A, 998ADE17-M2x-B, 998ADE17-M2x-M, 998ADE17-M2x-NUS0-M, 998ADE30-M2x-NUS0-A, 998ADE30-M2x-NUS0-M
– class 998-B Annex C of [ITU-T G.993.2]: POTS-138b, POTS-276b (clause C.2.1.1 of [ITU-T G.993.2]), TCM-ISDN (clause C.2.1.2 of [ITU-T G.993.2])
– class 998-CO Annex C of [ITU-T G.993.2]: POTS-138co, POTS-276co (clause C.2.1.1 of [ITU-T G.993.2])
– class 998E35-M2x Annex B of [ITU-T G.993.2]: 998-M2x-A, 998-M2x-M, 998-M2x-B, 998-M2x-NUS0, 998E17-M2x-NUS0, 998E17-M2x-NUS0-M, 998E17-M2x-A, 998E35-M2x-A
– class 998ADE35-M2x Annex B of [ITU-T G.993.2]: 998-M2x-A, 998-M2x-M, 998-M2x-B, 998-M2x-NUS0, 998ADE17-M2x-A, 998ADE17-M2x-B, 998ADE17-M2x-M, 998ADE17-M2x-NUS0-M, 998ADE35-M2x-A, 998ADE35-M2x-B, 998ADE35-M2x-M
– class CN-M2x Annex N of [ITU-T G.993.2]: CN17-M2x-A, CN17-M2x-B, CN17-M2x-M, CN17-M2x-NUS0-M, CN35-M2x-A, CN35-M2x-B, CN35-M2x-M, CN35-M2x-NUS0-M

Each class is designed such that the PSD levels of each limit PSD mask of a specific class are equal in their respective passband above 552 kHz.

One CLASSMASK parameter is determined from the relevant annex of [ITU-T G.993.2] enabled in the XTSE. It selects a single PSD mask class per the relevant annex of [ITU-T G.993.2] that is activated at the VTU-O. The coding is as indicated in Table 7-6.

Table 7-6 – Determination of values of CLASSMASK from the relevant annex of [ITU-T G.993.2]

Parameter value	Annex A of [ITU-T G.993.2]	Annex B of [ITU-T G.993.2]	Annex C of [ITU-T G.993.2]	Annex N of [ITU-T G.993.2]
1	998-30	997-M1c	998-B	CN-M2x
2	998-35b	997-M1x	998-CO	
3		997-M2x		
4				
5		998-M2x		
6		998ADE-M2x		
7				
8		998E35-M2x		
9		998ADE35-M2x		
NOTE – A single PSD mask class shall be selected from the relevant annex of [ITU-T G.993.2].				

7.3.1.2.16 VDSL2 limit power spectral density masks and band plans enabling

The VDSL2 limit PSD masks and band plans enabling (LIMITMASK) configuration parameter contains the ITU-T G.993.2 limit PSD masks of the selected PSD mask class, enabled by the near-end xTU on this line for each class of profiles. One LIMITMASK parameter is determined from the relevant annex of [ITU-T G.993.2] enabled in the XTSE.

The profiles are grouped in the following profile classes:

– class 8: profiles 8a, 8b, 8c, 8d

– class 12: profiles 12a, 12b

– class 17: profile 17a

– class 30: profile 30a

– class 35: profile 35b

For each profile class, several limit PSD masks of the selected PSD mask class (CLASSMASK) may be enabled. The enabling parameter is coded in a bit-map representation (0 if the associated mask is not allowed, 1 if it is allowed).

The parameter has the bit definitions for each PSD mask class as indicated in Table 7-7.

Table 7-7 – Determination of bits of LIMITMASK for each CLASSMASK from the relevant annex of [ITU-T G.993.2]

Bit number	Profile class	PSD mask classes											
		Annex A		Annex B							Annex C		Annex N
		998-30	998-35b	998-M2x	998ADE-M2x	997-M1x	997-M1c	997-M2x	998E35-M2x	998ADE35-M2x	998-B	998-CO	CN-M2x
Octet 1													
1	8	D-32	D-32	M2x-A	M2x-A		M1c-A-7		M2x-A	M2x-A	POTS-138b	POTS_ 138co	CN17-M2x-A
2	8	D-48	D-48	M2x-B	M2x-B				M2x-B	M2x-B	TCM-ISDN	POTS_ 276co	CN17-M2x-B
3	8			M2x-M	M2x-M	M1x-M			M2x-M	M2x-M	POTS_276b		CN17-M2x-M
4	8			M2x-NUS0	M2x-NUS0				M2x-NUS0	M2x-NUS0			CN17-M2x-NUS0
5	8												
6	8												
7	8												
8	8												
Octet 2													
1	8	D-64	D-64										
2	8	D-128	D-128										
3	8												
4	8												
5	8												
6	8												
7	8												
8	8												

Table 7-7 – Determination of bits of LIMITMASK for each CLASSMASK from the relevant annex of [ITU-T G.993.2]

Bit number	Profile class	PSD mask classes											
		Annex A		Annex B							Annex C		Annex N
		998-30	998-35b	998-M2x	998ADE-M2x	997-M1x	997-M1c	997-M2x	998E35-M2x	998ADE35-M2x	998-B	998-CO	CN-M2x
Octet 3													
1	12	D-32	D-32	M2x-A	M2x-A				M2x-A	M2x-A	POTS-138b	POTS_ 138co	CN17-M2x-A
2	12	D-48	D-48	M2x-B	M2x-B				M2x-B	M2x-B	TCM-ISDN	POTS_ 276co	CN17-M2x-B
3	12			M2x-M	M2x-M	M1x-M			M2x-M	M2x-M	POTS_276b		CN17-M2x-M
4	12			M2x-NUS0	M2x-NUS0				M2x-NUS0	M2x-NUS0			CN17-M2x-NUS0
5	12												
6	12												
7	12												
8	12												
Octet 4													
1	12	D-64	D-64										
2	12	D-128	D-128										
3	12												
4	12												
5	12												
6	12												
7	12												
8	12												

Table 7-7 – Determination of bits of LIMITMASK for each CLASSMASK from the relevant annex of [ITU-T G.993.2]

Bit number	Profile class	PSD mask classes											
		Annex A		Annex B							Annex C		Annex N
		998-30	998-35b	998-M2x	998ADE-M2x	997-M1x	997-M1c	997-M2x	998E35-M2x	998ADE35-M2x	998-B	998-CO	CN-M2x
Octet 5													
1	17	D-32	D-32	E17-M2x-NUS0	ADE17-M2x-A			E17-M2x-A	E17-M2x-NUS0	ADE17-M2x-A	POTS-138b		CN17-M2x-A
2	17	D-48	D-48	E17-M2x-NUS0-M	ADE17-M2x-B				E17-M2x-NUS0-M	ADE17-M2x-B	TCM-ISDN		CN17-M2x-B
3	17			E17-M2x-A	ADE17-M2x-NUS0-M				E17-M2x-A	ADE17-M2x-NUS0-M	POTS_276b		CN17-M2x-M
4	17				ADE17-M2x-M					ADE17-M2x-M			CN17-M2x-NUS0
5	17												
6	17												
7	17												
8	17												
Octet 6													
1	17	D-64	D-64										
2	17	D-128	D-128										
3	17												
4	17												
5	17												
6	17												
7	17												
8	17												

Table 7-7 – Determination of bits of LIMITMASK for each CLASSMASK from the relevant annex of [ITU-T G.993.2]

Bit number	Profile class	PSD mask classes											
		Annex A		Annex B							Annex C		Annex N
		998-30	998-35b	998-M2x	998ADE-M2x	997-M1x	997-M1c	997-M2x	998E35-M2x	998ADE35-M2x	998-B	998-CO	CN-M2x
Octet 7													
1	30	D-32		E30-M2x-NUS0	ADE30-M2x-NUS0-A			E30-M2x-NUS0			POTS-138b		
2	30	D-48		E30-M2x-NUS0-M	ADE30-M2x-NUS0-M						TCM-ISDN		
3	30										POTS_276b		
4	30												
5	30												
6	30												
7	30												
8	30												
Octet 8													
1	30	D-64											
2	30	D-128											
3	30												
4	30												
5	30												
6	30												
7	30												
8	30												

Table 7-7 – Determination of bits of LIMITMASK for each CLASSMASK from the relevant annex of [ITU-T G.993.2]

Bit number	Profile class	PSD mask classes											
		Annex A		Annex B							Annex C		Annex N
		998-30	998-35b	998-M2x	998ADE-M2x	997-M1x	997-M1c	997-M2x	998E35-M2x	998ADE35-M2x	998-B	998-CO	CN-M2x
Octet 9													
1	35		D-32						E35-M2x-A	ADE35-M2x-A			CN35-M2x-A
2	35		D-48							ADE35-M2x-B			CN35-M2x-B
3	35		D-64							ADE35-M2x-M			CN35-M2x-M
4	35		D-128										CN35-M2x-NUS0
5	35												
6	35												
7	35												
8	35												
NOTE – All unassigned bits are reserved by ITU.													

7.3.1.2.17 VDSL2 US0 disabling

The VDSL2 US0 disabling (US0DISABLE) configuration parameter indicates whether the use of US0 is disabled for each limit PSD mask enabled in the LIMITMASK parameter. One US0DISABLE parameter is specified per the relevant Annex of [ITU-T G.993.2] enabled in the XTSE.

For each limit PSD mask enabled in the LIMITMASK parameter, a bit shall indicate whether US0 is disabled. The disabling parameter is coded as a bit-map. The bit is set to 1 if US0 is disabled for the associated limit mask. The bit-map has the same structure as the LIMITMASK parameter.

7.3.1.2.18 VDSL2 US0 PSD mask

The VDSL2 US0 PSD mask (US0MASK) parameter contains the US0 PSD masks to be allowed by the near-end xTU on the line. This parameter is only specified for Annex A of [ITU-T G.993.2]. It is represented as a bitmap (0 if not allowed and 1 if allowed) with the definitions of Table 7-8.

Table 7-8 – Specification of bits of US0MASK for Annex A of [ITU-T G.993.2]

Bit	Annex A of [ITU-T G.993.2] US0MASK
Octet 1	
1	EU-32
2	EU-36
3	EU-40
4	EU-44
5	EU-48
6	EU-52
7	EU-56
8	EU-60
Octet 2	
1	EU-64
2	EU-128
3	reserved by ITU
4	reserved by ITU
5	reserved by ITU
6	reserved by ITU
7	reserved by ITU
8	reserved by ITU
Octet 3	
1	ADLU-32
2	ADLU-36
3	ADLU-40
4	ADLU-44
5	ADLU-48
6	ADLU-52
7	ADLU-56
8	ADLU-60

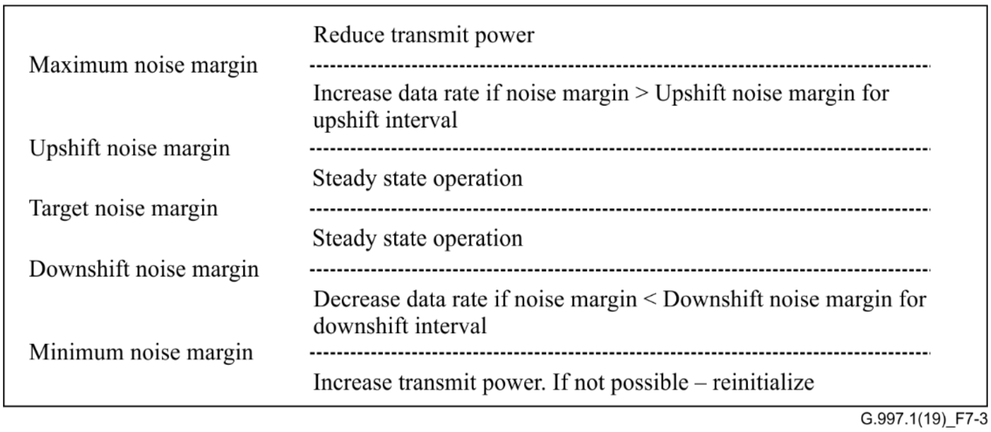
Table 7-8 – Specification of bits of US0MASK for Annex A of [ITU-T G.993.2]

Bit	Annex A of [ITU-T G.993.2] US0MASK
Octet 4	
9	ADLU-64
10	ADLU-128
11	reserved by ITU
12	reserved by ITU
13	reserved by ITU
14	reserved by ITU
15	reserved by ITU
16	reserved by ITU
NOTE 1 – Valid combinations of US0MASK and LIMITMASK are described in [ITU-T G.993.2]. NOTE 2 – More than one mask may be enabled simultaneously. If no US0 PSD masks are enabled, the line is configured without US0 support.	

7.3.1.3 Noise margin configuration parameters

The configuration parameters in clauses 7.3.1.3.1 to 7.3.1.3.6 are specified to control the noise margin in the receive direction in the xTU. A downstream noise margin applies to the xTU-R, an upstream noise margin applies to the xTU-C.

NOTE – The noise margin should be controlled to ensure operation at the target bit error ratio (BER) for each of the received bearer channels, or better. Figure 7-3 shows the relationship between these parameters.



NOTE 1 – Upshift noise margin, and downshift noise margin are only supported for rate adaptive mode.

NOTE 2 – Minimum noise margin ≤ Downshift noise margin ≤ Target noise margin ≤ Upshift noise margin ≤ Maximum noise margin.

Figure 7-3 – Noise margins

7.3.1.3.1 Downstream target noise margin

The downstream target noise margin (TARSNRMds) is the noise margin that the xTU-R receiver shall achieve, relative to the BER requirement for each of the downstream bearer channels, or better, to successfully complete initialization. The target noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps.

7.3.1.3.2 Upstream target noise margin

The upstream target noise margin (TARSNRMus) is the noise margin that the xTU-C receiver shall achieve, relative to the BER requirement for each of the upstream bearer channels, or better, to successfully complete initialization. The target noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps.

7.3.1.3.3 Downstream maximum noise margin

The downstream maximum noise margin (MAXSNRMds) is the maximum noise margin the xTU-R receiver shall try to sustain. If the noise margin is above this level, the xTU-R shall request the xTU-C to reduce the xTU-C transmit power to get a noise margin below this limit (if this functionality is supported by the relevant DSL Recommendation – see Note 1). The maximum noise margin ranges from 0 dB to 31 dB with 0.1 dB steps. A special value is used to indicate that reduction in transmit power is not required for the purpose of reducing the noise margin below the maximum noise margin limit (i.e., the maximum noise margin value is infinite).

NOTE 1 – This functionality should be supported by ADSL transmission systems. This functionality is supported by ADSL2 transmission systems.

NOTE 2 – The transmit power may be reduced for other reasons.

7.3.1.3.4 Upstream maximum noise margin

The upstream maximum noise margin (MAXSNRMus) is the maximum noise margin the xTU-C receiver shall try to sustain. If the noise margin is above this level, the xTU-C shall request the xTU-R to reduce the xTU-R transmit power to get a noise margin that is below this limit (if this functionality is supported by the relevant DSL Recommendation – see Note 1). The maximum noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps. A special value is used to indicate that reduction in transmit power is not required for the purpose of reducing the noise margin below the maximum noise margin limit (i.e., the maximum noise margin value is infinite).

NOTE 1 – This functionality should be supported by ADSL transmission systems. This functionality is supported by ADSL2 transmission systems.

NOTE 2 – The transmit power may be reduced for other reasons.

7.3.1.3.5 Downstream minimum noise margin

The downstream minimum noise margin (MINSNRMds) is the minimum noise margin the xTU-R receiver shall tolerate. If the noise margin falls below this level, the xTU-R shall request the xTU-C to increase the xTU-C transmit power. If an increase to xTU-C transmit power is not possible, a loss of margin (LOM) defect occurs, the xTU-R shall fail and attempt to re-initialize and the NMS shall be notified. The minimum noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps.

7.3.1.3.6 Upstream minimum noise margin

The upstream minimum noise margin (MINSNRMus) is the minimum noise margin the xTU-C receiver shall tolerate. If the noise margin falls below this level, the xTU-C shall request the xTU-R to increase the xTU-R transmit power. If an increase of xTU-R transmit power is not possible, a loss of margin (LOM) defect occurs, the xTU-C shall fail and attempt to re-initialize and the NMS shall be notified. The minimum noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps.

7.3.1.4 Rate adaptation configuration parameters

The configuration parameters in clauses 7.3.1.4.1 to 7.3.1.4.10 are specified to manage the rate-adaptive behaviour in the transmit direction for both the xTU-C and the xTU-R. An xTU-C rate adaptation mode applies to the upstream direction. An xTU-R rate adaptation mode applies to the downstream direction.

7.3.1.4.1 Downstream rate adaptation mode

The downstream rate adaptation mode (RA-MODEds) parameter specifies the mode of operation of a rate-adaptive xTU-C in the transmit direction. The parameter can take four values: mode 1, 2, 3 or 4.

NOTE 1 – Modes 1 and 2 both are mandatory modes. The commonality between modes 1 and 2 is that both are characterized by a constant data rate in showtime. The difference between modes 1 and 2 is that mode 1 fixes this data rate at the configured minimum data rate, whereas with mode 2 forces the modem subsystem to fix the data rate within the range determined by the configured minimum and maximum data rates. In the case of ITU-T G.998.4 operation, the "data rate" is replaced in this Note by "expected throughput (ETR)".

Mode 1: MANUAL – Data rate/ETR changed manually.

Support of this mode is mandatory.

7.3.1.4.1.1 If ITU-T G.998.4 retransmission is not used in the downstream direction

The downstream minimum data rate parameter (see clause 7.3.2.1.1) specifies the exact data rate the xTU-C transmitter shall operate at for each of the bearer channels.

NOTE 2 – The downstream minimum data rate parameter value shall override the configured maximum data rate parameter value (see clause 7.3.2.1.3).

Although the xTU-C and the line might be able to support a higher data rate, the xTU-C shall not transmit a higher data rate than that requested for each of the bearer channels.

At startup

a) For [ITU-T G.992.1] and [ITU-T G.992.2], the channel initialization policy is defined in this paragraph. The ATUs shall initialize with a downstream noise margin that is at least as large as the specified downstream target noise margin, TARSNRMds (see clause 7.3.1.3.1), relative to the required BER for each of the downstream bearer channels, or better.

   If the xTU-C fails to achieve the downstream minimum data rate for one of the bearer channels, the xTU-C will fail to initialize, and the NMS is notified.

b) For operational modes other than [ITU-T G.992.1] or [ITU-T G.992.2], the channel initialization policy is defined in the relevant Recommendation and controlled by the CIPOLICY parameter (see clause 7.3.2.10).

At showtime

The xTU-C transmitter shall maintain the specified downstream minimum data rate for each bearer channel.

7.3.1.4.1.2 If ITU-T G.998.4 retransmission is used in the downstream direction

The downstream MINETR_RTX parameter (see clause 7.3.2.1.8) specifies the exact ETR the xTU-C transmitter shall operate at.

NOTE 3 – The downstream MINETR_RTX parameter value shall override the configured downstream MAXETR_RTX parameter value (see clause 7.3.2.1.9).

At startup

The channel initialization policy is specified in clause 11.5 of [ITU-T G.998.4].

At showtime

The xTU-C transmitter shall maintain the specified downstream minimum ETR.

Mode 2: AT_INIT – Data rate/ETR automatically selected at startup only and does not change after that.

Support of this mode is mandatory.

7.3.1.4.1.3 If ITU-T G.998.4 retransmission is not used in the downstream direction

The downstream minimum data rate parameter (see clause 7.3.2.1.1) and downstream maximum data rate parameter (see clause 7.3.2.1.3) specify the data rate range within which the xTU-C transmitter shall operate at for each of the bearer channels. The data rate is determined during initialization and remains constant during the subsequent showtime phase.

At startup

a) For [ITU-T G.992.1] and [ITU-T G.992.2], the channel initialization policy is defined in this paragraph. The ATUs shall initialize at a downstream data rate in the range between minimum data rate and maximum data rate and with a downstream noise margin that is at least as large as the specified downstream target noise margin, TARSNRMds (see clause 7.3.1.3.1), relative to the required BER for each of the bearer channels, or better.

   If the xTU-C fails to achieve the downstream minimum data rate for one of the bearer channels, the xTU-C will fail to initialize, and the NMS is notified.

   If the xTU-C transmitter is able to support a higher downstream data rate at initialization, the excess data rate will be distributed amongst the downstream bearer channels according to the ratio (0% to 100%) specified by the rate adaptation ratio parameter for each bearer channel (adding up to 100% over all bearer channels). When the downstream maximum data rate is achieved in one of the bearer channels, then the remaining excess bit rate is assigned to the other bearer channels, still according to their relative rate adaptation ratio parameters.

   As long as the downstream data rate is below the downstream maximum data rate for one of the bearer channels, data rate increase shall take priority over transmit power reduction.

b) For operational modes other than [ITU-T G.992.1] or [ITU-T G.992.2], the channel initialization policy is defined in the relevant Recommendation and controlled by the CIPOLICY parameter (see clause 7.3.2.10).

At showtime

During showtime, no downstream data rate adaptation is allowed. The downstream data rate selected during initialization for each of the bearer channels shall be maintained.

7.3.1.4.1.4 If ITU-T G.998.4 retransmission is used in the downstream direction

The downstream MINETR_RTX parameter (see clause 7.3.2.1.8) and downstream MAXETR_RTX parameter (see clause 7.3.2.1.9) specify the range of the ETR within which the xTU-C transmitter shall operate.

The ETR is determined during initialization and remains constant during the subsequent showtime phase.

At startup

The channel initialization policy is defined in [ITU-T G.998.4] (see clause 11.5 of [ITU-T G.998.4]).

At showtime

During showtime, no downstream data rate adaptation is allowed. The downstream ETR, which has been selected during initialization, shall be maintained.

Mode 3: DYNAMIC – Data rate/ETR is automatically selected at initialization and is continuously adapted during operation (showtime). The DYNAMIC rate adaptation mode is optional. All related configuration parameters are also optional.

7.3.1.4.1.5 If ITU-T G.998.4 retransmission is not used in the downstream direction

At startup

In mode 3, the xTU-C shall start up as in mode 2.

At showtime

• *Rate range*

During showtime, rate adaptation is allowed with respect to the rate adaptation ratio for distributing the excess data rate amongst the bearer channels (see mode 2), and assuring that the downstream minimum data rate remains available at the required BER for each of the bearer channels or better. The downstream data rate can vary between the downstream minimum data rate, and the downstream maximum data rate.

• *Procedure*

SRA may be performed, when the conditions specified by the SRA trigger parameters are satisfied.

If operating in ITU-T G.992.3 or ITU-T G.992.5, the detailed SRA on-line reconfiguration (OLR) procedure is specified [ITU-T G.992.3] with trigger conditions specified as follows.

Downstream rate adaptation is performed when the conditions specified for downstream upshift noise margin and downstream upshift interval – or for downstream downshift noise margin and downstream downshift interval – are satisfied. This means:

– For an upshift action: Allowed when the downstream noise margin is above the downstream upshift noise margin during downstream minimum time interval for upshift rate adaptation (i.e., upon RAU anomaly – see [ITU-T G.992.3]).

– For a downshift action: Allowed when the downstream noise margin is below the downstream downshift noise margin during downstream minimum time interval for downshift rate adaptation (i.e., upon RAD anomaly – see [ITU-T G.992.3]).

As long as the downstream data rate is below the downstream maximum data rate for one of the bearer channels, data rate increase shall take priority over transmit power reduction.

If operating in accordance with [ITU-T G.993.2], the detailed SRA OLR procedure and the trigger conditions are specified in [ITU-T G.993.2]. As long as the downstream data rate is below the downstream maximum data rate for one of the bearer channels, data rate increase shall take priority over transmit power reduction.

• *Fallback*

If in [ITU-T G.993.2], it is detected at startup that SRA is not supported in the downstream direction by either XTU, the XTUs shall fallback to mode 2. This shall be reported by the downstream actual rate adaptation mode parameter, ACT-RA-MODEds (see clause 7.5.1.33.1).

7.3.1.4.1.6 In case ITU-T G.998.4 retransmission is used in the downstream direction

• *At startup*

In mode 3, the xTU-C shall start up as in mode 2.

• *At showtime*

SRA OLR procedures are defined in [ITU-T G.998.4].

• *Rate range*

The downstream MINETR_RTX parameter (see clause 7.3.2.1.8) and downstream MAXETR_RTX parameter (see clause 7.3.2.1.9) specify the range of the ETR within which the xTU-C transmitter shall operate. The ETR is determined during initialization and updated in showtime upon OLR.

If ETR reaches its maximum value MAXETR_RTX, the NDR may be further increased without increasing the ETR. The downstream MAXNDR_RTX parameter (see clause 7.3.2.1.10) specifies maximum allowed value for the net data rate (NDR), within which the xTU-C transmitter shall operate. The NDR is determined during initialization and updated in showtime upon OLR.

- *Procedure*

SRA may be performed, when the conditions specified by the SRA trigger parameters are satisfied.

If operating in accordance with [ITU-T G.992.3] or [ITU-T G.992.5], the detailed SRA OLR procedure is specified in [ITU-T G.998.4] with the same trigger conditions as those specified if ITU T G.998.4 retransmission is not used (see clause 7.3.1.4.1.5).

If operating in accordance with [ITU-T G.993.2], the detailed SRA OLR procedure is specified in [ITU-T G.998.4] with trigger conditions specified in clause C.3.3 of [ITU-T G.998.4]. As long as the downstream NDR is below the downstream MAXNDR_RTX, data rate increase shall take priority over transmit power reduction.

- *Fallback*

If operating in accordance with [ITU-T G.993.2] and it is detected at startup that SRA is not supported in the downstream direction by either XTU, they shall fallback to RA-Mode = 2. This shall be reported by the downstream actual rate adaptation mode parameter, ACT-RA-MODEds (see clause 7.5.1.33.1).

NOTE – If operating in accordance with [ITU-T G.992.3], SRA support is not exchanged at startup. Therefore, it is not possible to determine the actual RA-MODE at the start of showtime. Therefore, the parameter ACT-RA-MODE is not specified in [ITU-T G.992.3].

Mode 4: DYNAMIC with SOS – Data rate/ETR is automatically selected at initialization and may be continuously adapted during operation (showtime) by SOS and SRA. The rate adaptation mode 4 is optional. In this mode, enabling of SOS and SRA is mandatory.

7.3.1.4.1.7 If ITU-T G.998.4 retransmission is not used in the downstream direction

At startup

In mode 4, the xTU-C shall start up as in mode 2.

At showtime

- *Procedure*

SRA behaviour shall be identical to that described for mode 3, unless the actual data rate is below the minimum data rate as a result of an SOS procedure.

Additionally, SOS may be performed, when the conditions specified by the SOS trigger parameters are satisfied. The detailed SOS OLR procedure is specified in [ITU-T G.993.2].

- *Fallback*

If at startup it is detected that SOS is not supported in the downstream direction by either XTU, but SRA is supported by both XTUs, the XTUs shall fallback to mode 3. This shall be reported by the downstream actual rate adaptation mode parameter, ACT-RA-MODEds (see clause 7.5.1.33.1).

If at startup it is detected that SOS is not supported in the downstream direction by either XTU, and SRA is not supported by either XTU, the XTUs shall fallback to mode 2. This shall be reported by the downstream actual rate adaptation mode parameter, ACT-RA-MODEds (see clause 7.5.1.33.1).

7.3.1.4.1.8 If ITU-T G.998.4 retransmission is used in the downstream direction

At startup

In mode 4, the xTU-C shall start up as in mode 2.

At showtime

SRA and SOS OLR procedures are defined in [ITU-T G.998.4].

• *Procedure*

If it is detected at startup that SOS and SRA is supported in the downstream direction by both XTUs then the following procedure applies.

– SRA may be performed as described for mode 3.

– Additionally, SOS may be performed. The detailed SOS OLR procedure is specified in [ITU-T G.998.4] with trigger conditions and rate constraints specified in clause C.3.3 of [ITU-T G.998.4].

– Additionally, SRA may be performed as a result of an SOS procedure. The detailed SRA OLR procedure is specified in [ITU-T G.998.4] with trigger conditions and rate constraints specified in clause C.3.3 of [ITU-T G.998.4].

• *Fallback*

If it is detected at startup that SOS is not supported in the downstream direction by either XTUs, but SRA is supported by both XTUs, the XTUs shall fallback to mode 3. This shall be reported by the downstream actual rate adaptation mode parameter, ACT-RA-MODEds (see clause 7.5.1.33.1).

If it is detected at startup that SOS is not supported in the downstream direction by either XTUs, and that SRA is not supported in the downstream direction by either XTUs, the XTUs shall fallback to mode 2. This shall be reported by the downstream actual rate adaptation mode parameter, ACT-RA-MODEds (see clause 7.5.1.33.1).

7.3.1.4.2 Upstream rate adaptation mode

The upstream rate adaptation mode (RA-MODEus) parameter specifies the mode of operation of a rate-adaptive xTU-R in the transmit direction. The parameter is used only if the rate-adaptive functionality is supported, and can take four values (mode 1 = MANUAL, mode 2 = AT_INIT, mode 3 = DYNAMIC, mode 4 = DYNAMIC with SOS). The definition of each of the values is identical to its definition in the downstream rate adaptation mode (with xTU-C replaced by xTU-R and downstream replaced by upstream).

7.3.1.4.3 Downstream upshift noise margin

If the downstream noise margin is above the downstream upshift noise margin (RA-USNRMds) and stays above that for more than the time specified by the downstream minimum upshift rate adaptation interval, the xTU-R shall attempt to increase the downstream net data rate. The downstream upshift noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps.

7.3.1.4.4 Upstream upshift noise margin

If the upstream noise margin is above the upstream upshift noise margin (RA-USNRMus) and stays above that for more than the time specified by the upstream minimum upshift rate adaptation interval, the xTU-C shall attempt to increase the upstream net data rate. The upstream upshift noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps.

7.3.1.4.5 Downstream minimum time interval for upshift rate adaptation

The downstream minimum time interval for upshift rate adaptation (RA-UTIMEds) parameter determines the interval of time the downstream noise margin should stay above the downstream upshift noise margin before the xTU-R shall attempt to increase the downstream net data rate. The time interval ranges from 0 s to 16 383 s with steps of 1 s.

7.3.1.4.6 Upstream minimum time interval for upshift rate adaptation

The upstream minimum time interval for upshift rate adaptation (RA-UTIMEus) parameter determines the interval of time the upstream noise margin should stay above the upstream upshift noise margin before the xTU-C shall attempt to increase the upstream net data rate. The time interval ranges from 0 s to 16 383 s with steps of 1 s.

7.3.1.4.7 Downstream downshift noise margin

If the downstream noise margin is below the downstream downshift noise margin (RA-DSNRMds) and stays below that for more than the time specified by the downstream minimum downshift rate adaptation interval, the xTU-R shall attempt to decrease the downstream net data rate. The downstream downshift noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps.

7.3.1.4.8 Upstream downshift noise margin

If the upstream noise margin is below the upstream downshift noise margin (RA-DSNRMus) and stays below that for more than the time specified by the upstream minimum downshift rate adaptation interval, the xTU-C shall attempt to decrease the upstream net data rate. The upstream downshift noise margin ranges from 0 dB to 31 dB, with 0.1 dB steps.

7.3.1.4.9 Downstream minimum time interval for downshift rate adaptation

The downstream minimum time interval for downshift rate adaptation (RA-DTIMEds) parameter determines the interval of time the downstream noise margin should stay below the downstream downshift noise margin before the xTU-R shall attempt to decrease the downstream net data rate. The time interval ranges from 0 s to 16 383 s with steps of 1 s.

7.3.1.4.10 Upstream minimum time interval for downshift rate adaptation

The upstream minimum time interval for downshift rate adaptation (RA-DTIMEus) parameter determines the interval of time the upstream noise margin should stay below the upstream downshift noise margin before the xTU-C shall attempt to decrease the upstream net data rate. The time interval ranges from 0 s to 16 383 s with steps of 1 s.

7.3.1.5 Line overhead configuration parameters

These parameters are used for testing purposes.

7.3.1.5.1 Minimum overhead rate upstream

The minimum overhead rate upstream (MSGMINus) parameter determines the minimum rate of the message based overhead that shall be maintained by the xTU in the upstream direction. MSGMINus is expressed in bits per second and ranges from 4 000 to 248 000 bit/s with 1 000 bit/s steps. Valid values are specified in the relevant ITU-T Recommendation, e.g., [ITU-T G.992.3] and [ITU-T G.993.2].

7.3.1.5.2 Minimum overhead rate downstream

The minimum overhead rate downstream (MSGMINds) parameter determines the minimum rate of the message based overhead that shall be maintained by the xTU in the downstream direction. MSGMINds is expressed in bits per second and ranges from 4 000 bit/s to 248 000 bit/s with 1 000 bit/s steps. Valid values are specified in the relevant ITU-T Recommendation, e.g., [ITU-T G.992.3] and [ITU-T G.993.2].

7.3.1.6 Cyclic extension configuration parameter

7.3.1.6.1 Optional cyclic extension flag

The optional cyclic extension flag (CEFLAG) parameter is a bit that enables the use of the optional cyclic extension values. If the bit is set to 1, the optional cyclic extension values may be used. Otherwise, the cyclic extension shall be forced to the mandatory length (5N/32).

7.3.1.7 Virtual noise configuration parameters

7.3.1.7.1 Downstream signal-to-noise ratio mode

The downstream signal-to-noise ratio mode (SNRMODEds) parameter enables the transmitter referred virtual noise in the downstream direction. If set to 1, the virtual noise is disabled. If set to 2, the virtual noise is enabled. For [ITU-T G.993.2], if set to 4, the virtual noise together with the virtual noise scaling factor is enabled. The value of 3 is reserved by ITU-T.

7.3.1.7.2 Upstream signal-to-noise ratio mode

The upstream signal-to-noise ratio mode (SNRMODEus) parameter enables the transmitter referred virtual noise in the upstream direction. If set to 1, the virtual noise is disabled. If set to 2, the transmitter referred virtual noise is enabled. For [ITU-T G.993.2], if set to 3, the receiver referred virtual noise is enabled. For [ITU-T G.993.2], if set to 4, the receiver referred virtual noise together with the virtual noise scaling factor is enabled.

7.3.1.7.3 Downstream virtual noise

The downstream virtual noise (VNds) configuration parameter defines the downstream transmitter referred virtual noise (TXREFVNds). The TXREFVNds shall be specified through a set of breakpoints. Each breakpoint shall consist of a subcarrier index t, with a subcarrier spacing of 4.312 5 kHz, and a noise PSD level (expressed in decibels with reference to 1 mW per hertz) at that subcarrier. The set of breakpoints can then be represented as [(t_1, PSD_1), (t_2, PSD_2), …, (t_N, PSD_N)]. The subcarrier index shall be coded as an unsigned integer. The noise level ranges from –40 dBm/Hz to –140 dBm/Hz in steps of 0.5 dBm/Hz. A special value indicates a noise level of 0 W/Hz. The maximum number of breakpoints is 32. The same TXREFVNds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT TXREFVNds and near-end crosstalk (NEXT) TXREFVNds.

To comply with [ITU-T G.992.3] or [ITU-T G.992.5], no more than 15 breakpoints shall be configured below the upper edge of the passband of every mode enabled for [ITU-T G.992.3] and [ITU-T G.992.5].

7.3.1.7.3.1 Far-end crosstalk downstream transmitter referred virtual noise

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the downstream transmitter referred virtual noise (see clause 7.3.1.7.3) specified for $FEXT_R$ duration is defined as FEXT downstream transmitter referred virtual noise (FEXT TXREFVNds).

7.3.1.7.3.2 Near- end crosstalk downstream transmitter referred virtual noise

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the downstream transmitter referred virtual noise (see clause 7.3.1.7.3) specified for $NEXT_R$ duration is defined as NEXT downstream transmitter referred virtual noise (NEXT TXREFVNds).

7.3.1.7.4 Upstream virtual noise

If SNRM_MODE = 2, the upstream virtual noise (VNus) configuration parameter determines the upstream transmitter referred virtual noise (TXREFVNus). For [ITU-T G.993.2], if SNRM_MODE is equal to 3 or 4, this configuration parameter determines the upstream receiver referred virtual noise (RXREFVNus). The VNus shall be specified through a set of breakpoints. Each breakpoint shall consist of a subcarrier index *t*, with a subcarrier spacing of 4.312 5 kHz, and a noise PSD level (expressed in decibels with reference to 1 mW per hertz) at that subcarrier. The set of breakpoints can then be represented as [(t_1, PSD$_1$), (t_2, PSD$_2$), …, (t_N, PSD$_N$)]. The subcarrier index shall be coded as an unsigned integer. The noise level ranges from –40 dBm/Hz to –140 dBm/Hz in steps of 0.5 dBm/Hz. A special value indicates a noise level of 0 W/Hz. The maximum number of breakpoints is 16.

For [ITU-T G.992.3] or [ITU-T G.992.5], no more than three breakpoints shall be configured below the upper edge of the passband of every mode enabled for [ITU-T G.992.3] and [ITU-T G.992.5].

7.3.1.7.5 Upstream virtual noise scaling factor

If SNRM_MODE = 4, the upstream virtual noise scaling factor (RXREFVNSFus) configuration parameter determines the upstream receiver-referred virtual noise scaling factor. The valid values for the receiver-referred virtual noise scaling factor range from –64.0 dB to 63.5 dB, in steps of 0.5 dB.

7.3.1.7.6 Downstream virtual noise scaling factor

If SNRM_MODE = 4, the downstream virtual noise scaling factor (TXREFVNSFds) configuration parameter determines the downstream transmitter referred virtual noise scaling factor. The valid values for the transmitter referred virtual noise scaling factor range from –64.0 dB to 63.5 dB, in steps of 0.5 dB.

7.3.1.8 Line performance monitoring parameter thresholds

All supported line PM parameters (counters, see Table 7-1) shall have an individual 15 min and 24 h threshold parameter except for the error-free bits counter and MINEFTR for which threshold parameters are not specified.

7.3.1.9 Impulse noise monitoring configuration parameters

The following configuration parameters are specified to control the impulse noise monitor in the receive direction in the xTU. A downstream impulse noise monitor applies to the xTU-R, an upstream impulse noise monitor applies to the xTU-C.

7.3.1.9.1 Impulse noise monitoring interarrival time offsetImpulse noise monitoring

The INM interarrival time offset (INMIATO) is the interarrival time offset that the xTU receiver shall use to determine in which bin of the interarrival time histogram the IAT is reported. The valid values for INMIATO ranges from 3 to 511 discrete multitone (DMT) symbols in steps of 1 DMT symbol.

7.3.1.9.2 Impulse noise monitoring interarrival time step

The INM interarrival time step (INMIATS) is the interarrival time step that the xTU receiver shall use to determine in which bin of the interarrival time histogram the IAT is reported. The valid values for INMIATS ranges from 0 to 7 in steps of 1.

7.3.1.9.3 Impulse noise monitoring cluster continuation value

The INM cluster continuation value (INMCC) is the cluster continuation value that the xTU receiver shall use in the cluster indication process specified in the relevant ITU-T Recommendation. The valid values for INMCC range from 0 to 64 DMT symbols in steps of one DMT symbol.

7.3.1.9.4 Impulse noise monitoring equivalent impulse noise protection mode

The INM equivalent impulse noise protection (INP) mode (INM_INPEQ_MODE) is the INM equivalent INP mode that the xTU receiver shall use in the computation of the Equivalent INP, as specified in the relevant ITU-T Recommendation. The valid values for INM_INPEQ_MODE are 0, 1, 2, 3, and 4.

7.3.1.9.5 Impulse noise monitoring equivalent impulse noise protection format

The INM equivalent INP format (INM_INPEQ_FORMAT) is the INM equivalent INP format that the xTU receiver shall use in to scale the INPEQ histogram, as specified in the relevant ITU-T Recommendation. The valid values for INM_INPEQ_FORMAT are 0 (linear), 1 (logarithmic).

7.3.1.9.6 Impulse noise monitoring enable

The INM enable (INM_ENABLE) is the enable/disable of the INM facility in both directions, as specified in the relevant ITU-T Recommendation. The valid values for INM_ENABLE are 0 (disabled), 1 (enabled). If INM is disabled, all other configuration parameters for INM are not applicable.

NOTE – If INM is disabled in the MIB, the transceiver may use vendor-discretionary values taken from the range of valid values for the control parameters of INM.

7.3.1.10 save our showtime line related configuration parameters

7.3.1.10.1 Downstream save our showtime time window

The downstream SOS time window (SOS-TIME-ds) parameter is used in the specification of the receiver initiated SOS (see clause 13.4.3 of [ITU-T G.993.2]). If the value of this parameter is not zero, the standard SOS triggering criteria are enabled, and the value corresponds to the duration of the time window used in the standard SOS triggering criteria in the downstream direction. See [ITU-T G.993.2] for detailed usage rules.

The special value zero indicates that the standard SOS triggering criteria are disabled, i.e., vendor discretionary values may be used instead of the values configured in the MIB for the following parameters: SOS-NTONES-ds, SOS-CRC-ds, SOS-TIME-ds.

This parameter applies in the downstream direction. The valid range of non-zero values is from 64 ms to 16 320 ms in steps of 64 ms.

7.3.1.10.2 Upstream save our showtime time window

The upstream SOS time window (SOS-TIME-us) parameter is used in the specification of the receiver-initiated SOS (see clause 13.4.3 of [ITU-T G.993.2]). If the value of this parameter is not zero, the standard SOS triggering criteria are enabled, and the value corresponds to the duration of the time window used in the standard SOS triggering criteria in the upstream direction. See [ITU-T G.993.2] for detailed usage rules.

The special value zero indicates that the standard SOS triggering criteria are disabled, i.e., vendor discretionary values may be used instead of the values configured in the MIB for the following parameters: SOS-NTONES-us, SOS-CRC-us, SOS-TIME-us.

This parameter applies in the upstream direction. The valid range of non-zero values is from 64 ms to 16 320 ms in steps of 64 ms.

7.3.1.10.3 Downstream minimum percentage of degraded tones

The downstream minimum percentage of degraded tones (SOS-NTONES-ds) parameter is the minimum percentage of tones in the downstream MEDLEY SET that must be degraded in order to arm the first sub-condition of the standard SOS triggering criteria (see clause 13.4.3.2 of [ITU-T G.993.2]) in the downstream direction. The parameter SOS-NTONES-ds is a percentage of tones. See [ITU-T G.993.2] for detailed usage rules. The valid range of values is from 1 to 100 in steps of 1. Use of the special value 0 is described in clause 13.4.3.2 of [ITU-T G.993.2].

7.3.1.10.4 Upstream minimum percentage of degraded tones

The upstream minimum percentage of degraded tones (SOS-NTONES-us) parameter is the minimum percentage of tones in the upstream MEDLEY SET that must be degraded in order to arm the first sub-condition of the standard SOS triggering criteria (see clause 13.4.3.2 of [ITU-T G.993.2]) in the upstream direction. The parameter SOS-NTONES-us is a percentage of tones. See [ITU-T G.993.2] for detailed usage rules. The valid range of values is from 1 to 100 in steps of 1. Use of the special value 0 is described in clause 13.4.3.2 of [ITU-T G.993.2].

7.3.1.10.5 Downstream minimum number of normalized CRC anomalies

The downstream minimum number of normalized CRC anomalies (SOS-CRC-ds) parameter is the minimum number of normalized CRC anomalies received in SOS-TIME-ds seconds in order to arm the second sub-condition of the standard SOS triggering criteria (see clause 13.4.3.2 of [ITU-T G.993.2]) in the downstream direction. See [ITU-T G.993.2] for detailed usage rules. The valid range of SOS-CRC values is 0.02 to ((2^16)–1) × 0.02, in steps of 0.02.

7.3.1.10.6 Upstream minimum number of normalized CRC anomalies

The upstream minimum number of normalized CRC anomalies (SOS-CRC-us) parameter is the minimum number of normalized CRC anomalies received in SOS-TIME-us seconds in order to arm the second sub-condition of the standard SOS triggering criteria (see clause 13.4.3.2 of [ITU-T G.993.2]) in the upstream direction. See [ITU-T G.993.2] for detailed usage rules. The valid range of SOS-CRC values is 0.02 to ((2^16)–1) × 0.02, in steps of 0.02.

7.3.1.10.7 Downstream maximum number of save our showtime

The downstream maximum number of SOS (MAX-SOS-ds) parameter is used in ITU-T G.993.2 de-activation (see clause 12.1.4 of [ITU-T G.993.2]). If the number of successful SOS procedures in the downstream direction performed within a 120 s interval exceeds MAX-SOS-ds, the modem shall transition to the L3 state. See [ITU-T G.993.2] for detailed usage rules (see clause 12.1.4 of [ITU-T G.993.2]). The valid range of values is 1 to 15. Use of the special value 0 is described in clause 12.1 of [ITU-T G.993.2].

7.3.1.10.8 Upstream maximum number of save our showtime (MAX-SOS-us)

The upstream maximum number of SOS (MAX-SOS-us) parameter is used in ITU-T G.993.2 de-activation (see clause 12.1.4 of [ITU-T G.993.2]). If the number of successful SOS procedures in the upstream direction performed within a 120 s interval exceeds MAX-SOS-us, the modem shall transition to the L3 state. See [ITU-T G.993.2] for detailed usage rules (see clause 12.1.4 of [ITU-T G.993.2]). The valid range of values is 1 to 15. Use of the special value 0 is described in clause 12.1 of [ITU-T G.993.2].

7.3.1.10.9 Downstream signal-to-noise ratio margin offset of robust overhead channel

The downstream SNR margin offset of the robust overhead channel (ROC) (SNRMOFFSET-ROC-ds) parameter is the signal-to-noise ratio (SNR) margin offset for the ROC channel in the downstream direction. The parameter is used in the specification of the channel initialization policy (see clause 12.3.7.1 of [ITU-T G.993.2]).

The valid range of SNR margin offset values is from 0 to 31 dB, with 0.1 dB steps.

7.3.1.10.10 Upstream signal-to-noise ratio margin offset of robust overhead channel

The upstream SNR margin offset of ROC (SNRMOFFSET-ROC-us) parameter is the SNR margin offset for the ROC channel in the upstream direction. The parameter is used in the specification of the channel initialization policy (see clause 12.3.7.1 of [ITU-T G.993.2]).

The valid range of SNR margin offset values is from 0 to 31 dB, with 0.1 dB steps.

7.3.1.10.11 Downstream minimum impulse noise protection of robust overhead channel

The downstream minimum INP of ROC (INPMIN-ROC-ds) parameter contains the minimum INP to apply on the ROC in the downstream direction expressed in multiples of equivalent 4*k* DMT symbol length (denoted T_{4k}, see clause 10.4.4 of [ITU-T G.993.2]). The minimum INP is an integer ranging from 0 to 8.

7.3.1.10.12 Upstream minimum impulse noise protection of robust overhead channel

The upstream minimum INP of ROC (INPMIN-ROC-us) parameter contains the minimum INP to apply on the robust ROC in the upstream direction expressed in multiples of T_{4k}. The minimum INP is an integer ranging from 0 to 8.

7.3.1.11 Retransmission mode

The retransmission mode (RTX_MODE) parameter controls the mode of operation of ITU-T G.998.4 retransmission in a given transmit direction. The parameter in downstream is RTX_MODE_ds, and the parameter in upstream is RTX_MODE_us. In [ITU-T G.992.3] and [ITU-T G.992.5], only the downstream parameter RTX_MODE_ds is relevant, the value in the upstream direction shall be ignored. In [ITU-T G.993.2], both parameters are relevant.

This parameter has four valid values as follows.

0: RTX_FORBIDDEN: ITU-T G.998.4 retransmission not allowed

1: RTX_PREFERRED: ITU-T G.998.4 retransmission is preferred by the operator (i.e., if ITU-T G.998.4 RTX capability is supported by both XTUs, the XTUs shall select ITU-T G.998.4 operation for this direction)

2: RTX_FORCED: Force the use of the ITU-T G.998.4 retransmission (i.e., if ITU-T G.998.4 RTX capability in this direction is not supported by both XTUs or not selected by the XTUs, an initialization failure shall result)

NOTE – Due to the optionality of ITU-T G.998.4 retransmission in the upstream direction, the use of RTX_FORCED in upstream may lead to initialization failure, even if the XTU supports ITU-T G.998.4 (in downstream).

3: RTX_TESTMODE: Force the use of the ITU-T G.998.4 retransmission in test mode (i.e., if ITU-T G.998.4 RTX capability is not supported by both XTUs or not selected by the XTUs, an initialization failure shall result).

7.3.1.12 "leftr'' defect threshold

If retransmission is used in a given transmit direction, "leftr" defect threshold (LEFTR_THRESH) specifies the threshold for declaring a near-end "leftr" defect (see clause 11.1.12 of [ITU-T G.998.4] for the definition of this threshold).

The value is coded as a fraction of the NDR with a valid range from 0.01 to 0.99 with increments of 0.01. A special value means the ETR shall be used as the default threshold for declaring a "leftr" defect.

7.3.1.13 Line configuration parameters for [ITU-T G.993.5]

7.3.1.13.1 Vectoring frequency-band control

The vectoring frequency-band control upstream (VECTOR_BAND_CONTROLus) configuration parameter is an array of pairs of sub-carrier indices ($a(i)$, $b(i)$). Each pair specifies a frequency band starting from sub-carrier index $a(i)$ and ending at sub-carrier index $b(i)$ (including both start and end points) in which upstream FEXT cancellation for the line is not required. Up to eight frequency bands may be configured. The same value of this parameter shall be set for all lines of the same vector group.

7.3.1.13.2 Vectoring frequency-band control downstream

The vectoring frequency-band control downstream (VECTOR_BAND_CONTROLds) configuration parameter is an array of pairs of sub-carrier indices ($a(i)$, $b(i)$). Each pair specifies a frequency band starting from sub-carrier index $a(i)$ and ending at sub-carrier index $b(i)$ (including both start and end points) in which downstream FEXT cancellation for the line is not required. Up to eight frequency bands may be configured. The same value of this parameter shall be set for all lines of the same vector group.

7.3.1.13.3 Far-end crosstalk cancellation line priorities upstream

The FEXT cancellation line priorities upstream (FEXT_CANCEL_PRIORITYus) parameter specifies line priority for the line in the vectored group in the upstream direction, as defined in [ITU-T G.993.5]. Two line priorities are specified as low and high.

7.3.1.13.4 Far-end crosstalk cancellation line priorities downstream

The FEXT cancellation line priorities downstream (FEXT_CANCEL_PRIORITYds) parameter specifies line priority for the line in the vectored group in the downstream direction, as defined in [ITU-T G.993.5]. Two line priorities are specified as low and high.

7.3.1.13.5 Far-end crosstalk cancellation enabling/disabling upstream

FEXT cancellation enabling/disabling upstream (FEXT_CANCEL_ENABLEus) has a value of 1 to enable and a value of 0 to disable FEXT cancellation in the upstream direction from all the other vectored lines into the line in the vectored group.

7.3.1.13.6 Far-end crosstalk cancellation enabling/disabling downstream

FEXT cancellation enabling/disabling downstream (FEXT_CANCEL_ENABLEds) has a value of 1 to enable and a value of 0 to disable FEXT cancellation in the downstream direction from all the other vectored lines into the line in the vectored group.

7.3.1.13.7 Downstream requested XLIN subcarrier group size

The downstream requested XLIN subcarrier group size (XLINGREQds) parameter is the requested value of XLINGds. The valid values are 1, 2, 4, 8, 16, 32, and 64.

7.3.1.13.8 Upstream requested XLIN subcarrier group size

The upstream requested XLIN subcarrier group size (XLINGREQus) parameter is the requested value of XLINGus.

7.3.1.13.9 Vectoring mode enable

The vectoring mode enable (VECTORMODE_ENABLE) configuration parameter determines the vectoring initialization type to be allowed by the VTU-O on the line.

It is coded in a bit-map representation (0 if not allowed, 1 if allowed), with the following definition.

bit 0: initialization in ITU-T G.993.2 mode with neither Annex X nor Annex Y enabled

bit 1: initialization in Annex X of ITU-T G.993.2

bit 2: initialization in Annex Y of ITU-T G.993.2

bit 3: initialization in ITU-T G.993.5

bit 4 to 7: reserved by ITU-T

If ITU-T G.993.2 is enabled in the XTSE (octet 8), then at least one of the bits 0-3 shall be set to 1.

NOTE – If bit 0 is set to 0, the system is not allowed to operate in any ITU-T G.993.2 modes except those where Annex X, Annex Y or [ITU-T G.993.5] are enabled.

7.3.1.14 MAXDELAYOCTET-split parameter

The line configuration parameter MAXDELAYOCTET-split (MDOSPLIT) determines the percentage of the MAXDELAYOCTET_ext if operating in ITU-T G.998.4 or MAXDELAYOCTET in other cases allocated to the downstream direction. All of the remaining MAXDELAYOCTET or MAXDELAYOCTET_ext shall be allocated for use in the upstream direction.

The detailed specification is in [ITU-T G.993.2] and [ITU-T G.998.4].

MDOSPLIT shall be expressed as a percentage, with a valid range from 5% to 95% inclusive, in steps of 1%. The value 0% is valid only if the maximum downstream interleaving delay is configured with the special value S1 (see clause 7.3.2.2) and retransmission is disabled in the downstream direction. The value 100% is valid only if the maximum upstream interleaving delay is configured with the special value S1 (see clause 7.3.2.2) and retransmission is disabled in the upstream direction. A special value shall indicate that the VTU-O is allowed to use a vendor discretionary algorithm.

NOTE – The special value is introduced to ensure backwards compatibility.

7.3.1.15 Attainable net data rate configuration parameters

7.3.1.15.1 Attainable net data rate method

The attainable net data rate (ATTNDR) method (ATTNDR_METHOD) parameter specifies the method to be used for the calculation of the ATTNDR in the downstream and upstream direction.

The parameter can take three values: 0, 1 and 2.

For detailed definition see clause 11.4.1.1.7 of [ITU-T G.993.2].

7.3.1.15.2 Attainable net data rate MAXDELAYOCTET-split

The ATTNDR MAXDELAYOCTET-split (ATTNDR_MDOSPLIT) line configuration parameter determines the percentage of the MAXDELAYOCTET_ext if operating in ITU-T G.998.4 or MAXDELAYOCTET in other cases allocated to the downstream direction to be used in the improved method for calculation of the ATTNDR. All of the remaining MAXDELAYOCTET_ext or MAXDELAYOCTET shall be allocated for use in the upstream direction.

The detailed specification is in [ITU-T G.993.2] and [ITU-T G.998.4].

The valid values are identical to the values of the line configuration parameter MDOSPLIT (see clause 7.3.1.14).

7.3.1.16 VDSL2-LR configuration parameter

7.3.1.16.1 VDSL2-LR enable

The VDSL2-LR enable (VDSL2-LR_ENABLE) parameter specifies which VDSL2-LR operation types are allowed. The parameter is encoded as a bitmap representation (0 is not allowed, 1 is allowed):

– bit 0: short loop operation type
– bit 1: medium loop operation type.
– bit 2: long loop operation type

If no operation type is allowed, the VDSL2-LR mode, i.e., operation according to Annex D of [ITU-T G.993.2] or Annex B of [ITU-T G.993.5], is disabled. If at least one operation type is allowed, the VDSL2-LR mode is enabled.

For detailed specification of this parameter, see clause B.10.1.1 of [ITU-T G.993.5].

7.3.1.17 STRONGFEXT MODE configuration parameter

7.3.1.17.1 STRONGFEXT mode (STRONGFEXT_MODE)

The STRONGFEXT mode (STRONGFEXT_MODE) parameter specifies whether operation according to G.993.5 Annex A is disabled, preferred, forced, or forced above 17 MHz. The parameter can take four values: 0 (disabled), 1 (preferred), 2 (forced) and 3 (forced above 17 MHz).

For detailed specification of this parameter, see clause A.8.1.1 of [ITU-T G.993.5].

7.3.2 Channel configuration parameters

7.3.2.1 Data rate configuration parameters

These data rate parameters refer to the transmit direction for both the xTU-C and the xTU-R and apply to the configuration of an individual upstream or downstream bearer channel. The two data rate parameters define the data rate minimum and maximum bounds as specified by the operator of the system (the operator of the xTU-C). It is assumed that the xTU-C and the xTU-R will interpret the value set by the operator as appropriate for the specific implementation of xDSL between the xTU-C and the xTU-R in setting the line rates. The ranges of the data rate configuration parameters are not specified. The NMS used by the operator to manage the xTU-R and the xTU-C may implement its own limits on the allowed values for the desired bit rate parameters based on the particulars of the system managed. The definition of such a system lies outside the scope of this Recommendation.

7.3.2.1.1 Minimum data rate

If retransmission is not used in a given transmit direction, this parameter specifies the minimum net data rate for the bearer channel as desired by the operator of the system. The rate is coded in steps of 1 000 bit/s.

7.3.2.1.2 Minimum reserved data rate

This parameter specifies the minimum reserved net data rate for the bearer channel as desired by the operator of the system. The rate is coded in steps of 1 000 bit/s.

This parameter is optional. It is used only if the rate adaptation mode is set to DYNAMIC.

7.3.2.1.3 Maximum data rate

If retransmission is not used in a given transmit direction, this parameter specifies the maximum net data rate for the bearer channel as desired by the operator of the system. The data rate is coded in steps of 1 000 bit/s.

7.3.2.1.4 Rate adaptation ratio

This parameter, expressed as a percentage, specifies the ratio that shall be taken into account for the bearer channel when performing rate adaptation in the transmission direction of the bearer channel. The ratio is defined as a percentage in the 0 to 100 range. A ratio of 20% means that 20% of the available data rate (in excess of the minimum data rate summed over all bearer channels) will be assigned to this bearer channel and 80% to the other bearer channels.

The sum of rate adaptation ratios over all bearers in one direction shall be equal to 100%.

7.3.2.1.5 Minimum data rate in low power state

This parameter specifies the minimum net data rate for the bearer channel as desired by the operator of the system during the low power state (L1/L2). The power management low power states L1 and L2 are defined in [ITU-T G.992.2] and [ITU-T G.992.3], respectively. The data rate is coded in steps of 1 000 bit/s.

7.3.2.1.6 Minimum save our showtime data rate

The minimum SOS data rate (MIN-SOS-DR) parameter specifies the minimum net data rate for the bearer channel required for a valid SOS request in the direction of the bearer channel. The value shall be coded as an unsigned integer representing the data rate as a multiple of 8 kbit/s.

7.3.2.1.7 *Clause intentionally left blank*

7.3.2.1.8 Minimum expected throughput for retransmission

If retransmission is used in a given transmit direction, the minimum ETR for retransmission (MINETR_RTX) parameter specifies the minimum ETR for the bearer channel (as specified in clause 11.1.1 of [ITU-T G.998.4]).

The rate is coded in steps of 1 000 bit/s.

7.3.2.1.9 Maximum expected throughput for retransmission

If retransmission is used in a given transmit direction, the maximum ETR for retransmission (MAXETR_RTX) parameter specifies the maximum ETR for the bearer channel (as specified in clause 11.1.2 of [ITU-T G.998.4]).

The rate is coded in steps of 1 000 bit/s.

7.3.2.1.10 Maximum net data rate for retransmission

If retransmission is used in a given transmit direction, the maximum net data rate for retransmission (MAXNDR_RTX) parameter specifies the maximum net data rate for the bearer channel (as specified in clause 11.1.3 of [ITU-T G.998.4]).

The data rate is coded in steps of 1 000 bit/s.

7.3.2.2 Maximum interleaving delay

If retransmission is not used in a given transmit direction, this parameter is the maximum one-way interleaving delay introduced by the physical media specific-transmission convergence (PMS-TC) between the α and the β reference points, in the direction of the bearer channel. The one-way interleaving delay is defined in individual ADSL Recommendations as $\lceil S \times D \rceil / 4$ ms, where S is the S-factor and D is the interleaving depth and the ceiling brackets $\lceil \dots \rceil$ denote rounding to the higher integer.

The xTUs shall choose the S and D values such that the actual one-way interleaving delay (see actual interleaving delay status parameter in clause 7.5.2.3) is less than or equal to the configured maximum interleaving delay. The delay ranges from 2 ms to 63 ms by steps of 1 ms. Three special values, $S0$, $S1$ and $S2$, are specified. The value $S0$ indicates no delay bound is being imposed. The value $S1$ indicates the fast latency path shall be used in the ITU-T G.992.1 operating mode and S and D shall be selected such that $S \leq 1$ and $D = 1$ in [ITU-T G.992.2], [ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2] operating modes. The value $S2$ indicates a delay bound of 1 ms in [ITU-T G.993.2].

NOTE – A single maximum delay value is configured for operation without ITU-T G.998.4 retransmission mode. As a consequence, xTUs supporting multiple xDSL Recommendations will use the configured value regardless of the xDSL operating mode actually being selected at LINIT.

7.3.2.3 Minimum impulse noise protection

If retransmission is not used in a given transmit direction, the minimum INP (INPMIN) parameter specifies the minimum INP for the bearer channel if it is transported over DMT symbols with a subcarrier spacing of 4.312 5 kHz. The impulse noise protection is expressed in DMT symbols with a subcarrier spacing of 4.312 5 kHz and can take the values ½ and any integer from 0 to 16, inclusive.

If the xTU does not support the configured INPMIN value, it shall use the nearest supported INP greater than INPMIN.

7.3.2.3.1 Special requirements for [ITU-T G.992.1]

It is optional to apply the INPMIN parameter in the case of [ITU-T G.992.1]. If INPMIN is supported, the ATU-C shall offer to the ATU-R a range of combinations of framing parameters (C-RATES-1 and C-RATES-RA options) during initialization, which provide an ACTINP value equal to or greater than the INPMIN value specified over the Q-interface. The ACTINP value for [ITU-T G.992.1] is defined in clause 7.5.2.4.

7.3.2.4 Minimum impulse noise protection for system using 8.625 kHz subcarrier spacing

If retransmission is not used in a given transmit direction, the minimum INP for system using 8.625 kHz subcarrier spacing (INPMIN8) parameter specifies the minimum INP for the bearer channel if it is transported over DMT symbols with a subcarrier spacing of 8.625 kHz. The INP is expressed in DMT symbols with a subcarrier spacing of 8.625 kHz and can take any integer value from 0 to 16, inclusive.

7.3.2.5 Force framer setting for impulse noise protection

If retransmission is not used in a given transmit direction, the force framer setting for INP (FORCEINP) parameter indicates that the framer settings of the bearer shall be selected such that the INP computed according to the formula specified in the relevant Recommendation is greater than or equal to the minimal INP requirement.

This flag shall have the same value for all the bearers of one line in the same direction.

7.3.2.6 Maximum bit error ratio

If retransmission is not used in a given transmit direction, this parameter specifies the maximum bit error ratio for the bearer channel as desired by the operator of the system. The bit error ratio can take the values 10^{-3}, 10^{-5} or 10^{-7}.

NOTE – ATUs supporting multiple ADSL Recommendations may use or ignore the configured value depending on the operating mode actually being selected at LINIT. In [ITU-T G.992.3], [ITU-T G.992.4] and [ITU-T G.992.5], the ATUs will use the configured value. In [ITU-T G.992.1] and [ITU-T G.992.2], ATUs operate with the maximum bit error ratio fixed to 10^{-7}, regardless of the configured value.

7.3.2.7 Channel performance monitoring parameter thresholds

All supported channel PM parameters (counters, see Table 7-2) shall have an individual 15 min and 24 h threshold parameter.

7.3.2.8 Channel data rate thresholds

The data rate threshold parameter procedures shall be as specified in clause 7.2.7.

7.3.2.8.1 Data rate threshold upshift

If retransmission is not used in a given transmit direction, this parameter is a threshold on the net data rate upshift achieved over one or more bearer channel data rate adaptations. An upshift rate change alarm (event) is triggered when the actual data rate exceeds the data rate at the last entry into showtime by more than the threshold. The data rate threshold is coded in bits per second.

7.3.2.8.2 Data rate threshold downshift

If retransmission is not used in a given transmit direction, this parameter is a threshold on the net data rate downshift achieved over one or more bearer channel data rate adaptations. A downshift rate change alarm (event) is triggered when the actual data rate is below the data rate at the last entry into showtime by more than the threshold. The data rate threshold is coded in bits per second.

7.3.2.9 Maximum delay variation

The maximum delay variation (DVMAX) parameter specifies the maximum value for the delay variation allowed in an OLR procedure.

It ranges from 0.1 ms to 25.4 ms in steps of 0.1 ms.

A special value indicates that no delay variation bound is imposed.

7.3.2.10 Channel initialization policy selection

If retransmission is not used in a given transmit direction, the channel initialization policy selection (CIPOLICY) parameter indicates which policy shall be applied to determine the transceiver configuration parameters at initialization. The valid values for CIPOLICY are 0, 1 and 2. They are specified in the respective Recommendations.

7.3.2.11 Maximum delay for retransmission

If retransmission is used in a given transmit direction, the maximum delay for retransmission (DELAYMAX_RTX) parameter specifies the maximum for the instantaneous delay due to the effect of retransmission only (see [ITU-T G.998.4] for detailed specification). The delay ranges from 1 ms to 63 ms by steps of 1 ms.

NOTE – A single maximum delay value is configured for operation in ITU-T G.998.4 retransmission mode. As a consequence, xTUs supporting multiple xDSL Recommendations in conjunction with [ITU-T G.998.4] will use the configured value regardless of the xDSL operating mode actually being selected at LINIT.

7.3.2.12 Minimum delay for retransmission

If retransmission is used in a given transmit direction, the minimum delay for retransmission (DELAYMIN_RTX) parameter specifies the minimum for the instantaneous delay due to the effect of retransmission only (see [ITU-T G.998.4] for detailed specification). The delay ranges from 0 ms to 63 ms by steps of 1 ms.

NOTE – A single minimum delay value is configured for operation in ITU-T G.998.4 retransmission mode. As a consequence, xTUs supporting multiple xDSL Recommendations in conjunction with [ITU-T G.998.4] will use the configured value regardless of the xDSL operating mode actually being selected at LINIT.

7.3.2.13 Minimum impulse noise protection against SHINE for retransmission

If retransmission is used in a given transmit direction, the minimum INP against SHINE for retransmission (INPMIN_SHINE_RTX) parameter specifies the minimum INP against SHINE for the bearer channel if it is transported over DMT symbols with a subcarrier spacing of 4.312 5 kHz. The INP is expressed in DMT symbols with a subcarrier spacing of 4.312 5 kHz and can take any integer value from 0 to 63, inclusive.

7.3.2.14 Minimum impulse noise protection against SHINE for retransmission for systems using 8.625 kHz subcarrier spacing

If retransmission is used in a given transmit direction, the minimum INP against SHINE for retransmission for systems using 8.625 kHz subcarrier spacing (INPMIN8_SHINE_RTX) parameter specifies the minimum INP against SHINE for the bearer channel if it is transported over DMT symbols with a subcarrier spacing of 8.625 kHz. The INP is expressed in DMT symbols with a subcarrier spacing of 8.625 kHz and can take any integer value from 0 to 127, inclusive.

7.3.2.15 SHINE ratio for retransmission (SHINERATIO_RTX)

If retransmission is used in a given transmit direction, the SHINE ratio for retransmission (SHINERATIO_RTX) parameter specifies the SHINE ratio (see [ITU-T G.998.4] for details).

The values range from 0 to 0.100 in increments of 0.001.

7.3.2.16 Minimum impulse noise protection against repetitive electrical impulse noise for retransmission

If retransmission is used in a given transmit direction, the minimum INP against repetitive electrical impulse noise (REIN) for retransmission (INPMIN_REIN_RTX) parameter specifies the minimum INP against REIN for the bearer channel if it is transported over DMT symbols with a subcarrier spacing of 4.312 5 kHz. The INP is expressed in DMT symbols with a subcarrier spacing of 4.312 5 kHz and can take any integer value from 0 to 7, inclusive.

7.3.2.17 Minimum impulse noise protection against repetitive electrical impulse noise for retransmission for systems using 8.625 kHz subcarrier spacing

If retransmission is used in a given transmit direction, the minimum INP against REIN for retransmission for systems using 8.625 kHz subcarrier spacing (INPMIN8_REIN_RTX) parameter specifies the minimum INP against REIN for the bearer channel if it is transported over DMT symbols with a subcarrier spacing of 8.625 kHz. The INP is expressed in DMT symbols with a subcarrier spacing of 8.625 kHz and can take any integer value from 0 to 13, inclusive.

7.3.2.18 Repetitive electrical impulse noise interarrival time for retransmission

If retransmission is used in a given transmit direction, the REIN interarrival time for retransmission (IAT_REIN_RTX) parameter specifies the interarrival time that shall be assumed for REIN protection.

- The value 0 indicates an interarrival time derived from a REIN at 100 Hz
- The value 1 indicates an interarrival time derived from a REIN at 120 Hz

7.3.2.19 Channel configuration parameters for [ITU-T G.993.5]

7.3.2.19.1 Target net data rate

If retransmission is not used in a given transmit direction, the target net data rate (TARGET_NDR) parameter specifies the target net data rate as defined in [ITU-T G.993.5] of the bearer channel.

The target net data rate is coded in steps of 1 000 bit/s.

7.3.2.19.2 Target expected throughput for retransmission

If retransmission is used in a given transmit direction, the target ETR for retransmission (TARGET_ETR) parameter specifies the target ETR as defined in [ITU-T G.993.5] for the bearer channel.

The target ETR is coded in steps of 1 000 bit/s.

7.3.3 Synchronous transfer mode data path configuration parameters

No STM data path configuration parameters are defined.

7.3.4 Asynchronous transfer mode data path configuration parameters

7.3.4.1 IMA operation mode enable parameter

This parameter enables the inverse multiplexing over ATM (IMA) operation mode in the ATM data path. It indicates that the ATM data path shall comply with the requirements for IMA transmission, i.e., minimum amount of idle cells shall be inserted and no cell discard shall be enabled at the receiver.

7.3.4.2 Asynchronous transfer mode data path performance monitoring parameter thresholds

All supported ATM data path PM parameters (counters, see Table 7-3) shall have an individual 15 min and 24 h threshold parameter.

7.3.5 Packet transfer mode data path configuration parameters

7.3.5.1 Packet transfer mode data path performance monitoring parameter thresholds

All supported PTM data path PM parameters (counters, see Table 7-4) shall have an individual 15 min and 24 h threshold parameter.

7.3.6 Data gathering configuration parameters

7.3.6.1 Logging depth event percentage per event – VTU-O

The logging depth event percentage per event – VTU-O (LOGGING_DEPTH_EVENT_PERCENTAGE_Oi) parameter is the percentage of the data gathering event buffer assigned to event type *i* at the VTU-O. The ID, *i*, of the event type is defined in Table 11-43 of [ITU-T G.993.2].

7.3.6.2 Logging depth event percentage per event – VTU-R

The logging depth event percentage per event – VTU-R (LOGGING_DEPTH_EVENT_PERCENTAGE_Ri) parameter is the percentage of the data gathering event buffer assigned to event type *i* at the VTU-R. The ID, *i*, of the event type is defined in Table 11-43 of [ITU-T G.993.2].

7.3.6.3 Logging depth for VTU-O reporting – VTU-R

The logging depth for VTU-O reporting – VTU-R (LOGGING_DEPTH_REPORTING_O) parameter is the logging depth that is requested for reporting the VTU-O event trace buffer in the CO-MIB, in number of 6-byte data gathering records.

7.3.6.4 Logging depth for VTU-R reporting – VTU-R

The logging depth for VTU-R reporting – VTU-R (LOGGING_DEPTH_REPORTING_R) parameter is the logging depth that is requested for reporting the VTU-R event trace buffer over the eoc channel, in number of 6-byte data gathering records.

7.3.6.5 Logging data report newer events first – VTU-R

If true, the logging data report newer events first – VTU-R (LOGGING_REPORT_NEWER_FIRST) parameter instructs the VTU-R to report newer events first, from the beginning of the event trace buffer. If false, this parameter instructs the VTU-R to report older events first, from the end of the event trace buffer.

7.4 Inventory information

7.4.1 xTU-C ITU-T G.994.1 vendor identifier

The xTU-C ITU-T G.994.1 vendor ID is the vendor ID as inserted by the xTU-C in the ITU-T G.994.1 capabilities list (CL) message. It consists of 8 binary octets, including a country code followed by a (regionally allocated) provider code, as specified in [ITU-T T.35].

Table 7-9 – Vendor identifier information block (8 octets)

T.35 country code (2 octets)
T.35 provider code (vendor identification) (4 octets)
T.35 provider oriented code (vendor revision number) (2 octets)

The ITU-T G.994.1 vendor ID should typically identify the vendor of the xTU-C ITU-T G.994.1 functionality, whether implemented in hardware or software. It is not intended to indicate the system integrator. Further details are given in [ITU-T G.994.1].

7.4.2 xTU-R ITU-T G.994.1 vendor identifier

The xTU-R ITU-T G.994.1 vendor ID is the vendor ID as inserted by the xTU-R in the ITU-T G.994.1 capabilities list request (CLR) message. It consists of 8 binary octets, with the same format as the xTU-C ITU-T G.994.1 vendor ID.

The ITU-T G.994.1 vendor ID should typically identify the vendor of the xTU-R ITU-T G.994.1 functionality, whether implemented in hardware or software. It is not intended to indicate the system integrator. Further details are given in [ITU-T G.994.1].

7.4.3 xTU-C system vendor identifier

The xTU-C system vendor ID is the vendor ID as inserted by the xTU-C in the overhead messages ([ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2]). It consists of 8 binary octets, with same format as the xTU-C ITU-T G.994.1 vendor ID.

The xTU-C system vendor ID should typically identify the xTU-C system integrator. In this context, the system integrator usually refers to the vendor of the smallest field-replaceable unit. As such, the xTU-C system vendor ID may not be the same as the xTU-C ITU-T G.994.1 vendor ID.

7.4.4 xTU-R system vendor identifier

The xTU-R system vendor ID is the vendor ID as inserted by the xTU-R in the EOC ([ITU-T G.992.1] and [ITU-T G.992.2]) and the overhead messages ([ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2]). It consists of 8 binary octets, with same format as the xTU-C ITU-T G.994.1 vendor ID.

The xTU-R system vendor ID should typically identify the xTU-R system integrator. In this context, the system integrator usually refers to the vendor of the smallest field-replaceable unit. As such, the xTU-R system vendor ID may not be the same as the xTU-R ITU-T G.994.1 vendor ID.

7.4.5 xTU-C version number

The xTU-C version number is the version number as inserted by the xTU-C in the overhead messages ([ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2]). It is for version control and is vendor specific information. It consists of up to 16 binary octets.

7.4.6 xTU-R version number

The xTU-R version number is the version number as inserted by the xTU-R in the embedded operations channelEOC ([ITU-T G.992.1] and [ITU-T G.992.2]) or overhead messages ([ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2]). It is for version control. It consists of up to 16 American standard code for information interchange (ASCII) characters. The characters should be in the range of printable ASCII characters, i.e., the decimal code 32 to 126. It shall contain the xTU-R firmware version and the xTU-R model. Both shall be encoded in this order and separated by a space character, i.e., "<xTU-R firmware version> <xTU-R model>".

The xTU-R version number of equipment prior to this Recommendation may contain up to 16 vendor specific binary octets. These should be replaced by the information specified above at the time of the next firmware or hardware update.

NOTE – This field is intended to contain information about the firmware and model of the xTU-R physical layer interface (chipset).

NOTE – The ASCII characters should be printable as the version number is intended to be displayed.

7.4.7 xTU-C serial number

The xTU-C serial number is the serial number as inserted by the xTU-C in the overhead messages ([ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2]). It is vendor specific information. It consists of up to 32 ASCII characters.

Note that the combination of system vendor ID and serial number creates a unique number for each xTU-C.

7.4.8 xTU-R serial number

The xTU-R serial number is the serial number as inserted by the xTU-R in the EOC ([ITU-T G.992.1] and [ITU-T G.992.2]) or overhead messages ([ITU-T G.992.3], [ITU-T G.992.4], [ITU-T G.992.5] and [ITU-T G.993.2]). It consists of up to 32 ASCII characters. The characters should be in the range of printable ASCII characters, i.e., the decimal code 32 to 126. It shall contain the equipment serial number, the equipment model and the equipment firmware version. All shall be encoded in this order and separated by space characters, i.e., "<equipment serial number> <equipment model> <equipment firmware version>".

The xTU-R serial number of equipment prior to this Recommendation may contain up to 32 vendor specific ASCII characters. These should be replaced by the information specified above at the time of the next firmware or hardware update.

Note that the combination of system vendor ID and serial number creates a unique number for each xTU-R.

NOTE – The ASCII characters should be printable as the serial number is intended to be displayed.

7.4.9 xTU-C self-test result

This parameter specifies the xTU-C self-test result. It is coded as a 32-bit integer. The most significant octet of the self-test result is 00_{hex} if the self-test is passed and 01_{hex} if the self-test is failed. The interpretation of the other octets is vendor discretionary and can be interpreted in combination with ITU-T G.994.1 and system vendor IDs.

7.4.10 xTU-R self-test result

This parameter specifies the xTU-R self-test result. It is coded as a 32-bit integer. The most significant octet of the self-test result is 00_{hex} if the self-test is passed and 01_{hex} if the self-test is failed. The interpretation of the other octets is vendor discretionary and can be interpreted in combination with ITU-T G.994.1 and system vendor IDs.

7.4.11 xTU-C transmission system capabilities

This parameter specifies the xTU-C capability list of the different transmission system types. It is coded in a bit-map representation with the bits specified in clause 7.3.1.1.1. This parameter may be derived from the handshaking procedures specified in [ITU-T G.994.1].

7.4.12 xTU-R transmission system capabilities

This parameter specifies the xTU-R capability list of the different transmission system types. It is coded in a bit-map representation with the bits specified in clause 7.3.1.1.1. This parameter may be derived from the handshaking procedures specified in [ITU-T G.994.1].

7.4.13 Inventory information for [ITU-T G.993.5]

7.4.13.1 Vectoring control entity identifier

For the line in a vectored group, the vectoring control entity (VCE) ID (VCE_ID) uniquely identifies the VCE that manages and controls the vectored group to which the line belongs. It consists of one octet and valid ranges are from 1 to 255. A special value means the line is not in a vectored group.

7.4.13.2 Vectoring control entity port index

For the line in a vectored group, the VCE port index (VCE_port_index) is the physical index that uniquely identifies the VCE port to which the line is connected. It is an integer from 1 to the maximum number of lines supported by the VCE.

NOTE – The combination of VCE ID and VCE port index creates a unique ID for each vectored VTU-O/-R.

7.4.14 Inventory information for VDSL2-LR

7.4.14.1 VTU-O VDSL2-LR support

The VTU-O VDSL2-LR support (VDSL2-LR_SUPPORT_O) parameter indicates the support of VDSL2-LR mode by the VTU-O. The parameter is set to 0 if VDSL2-LR mode is not supported and set to 1 if VDSL2-LR mode is supported.

7.4.14.2 VTU-R VDSL2-LR support

The VTU-R VDSL2-LR support (VDSL2-LR_SUPPORT_R) parameter indicates the support of VDSL2-LR mode by the VTU-R. The parameter is set to 0 if VDSL2-LR mode is not supported and set to 1 if VDSL2-LR mode is supported.

7.4.15 Inventory information for STRONGFEXT MODE

7.4.15.1 VTU-O STRONGFEXT mode support

The VTU-O STRONGFEXT mode support (STRONGFEXT_MODE_SUPPORT_O) parameter indicates the support of operation according to [ITU-T G.993.5] Annex A by the VTU-O. The parameter is set to 0 if STRONGFEXT mode is not supported and set to 1 if STRONGFEXT mode is supported.

7.4.15.2 VTU-R STRONGFEXT mode support

The VTU-R STRONGFEXT mode support (STRONGFEXT_MODE_SUPPORT_R) parameter indicates the support of operation according to [ITU-T G.993.5] Annex A by the VTU-R. The parameter is set to 0 if STRONGFEXT mode is not supported and set to 1 if STRONGFEXT mode is supported.

7.5 Test, diagnostic and status parameters

NOTE – The requirement on how recent the AN MIB data are and on the update time for test parameters does not include the transfer time between the transceiver and the AN MIB. The transfer time is implementation specific.

7.5.1 Line test, diagnostic and status parameters

7.5.1.1 xDSL transmission system

This parameter specifies the transmission system in use. It is coded in a bit-map representation with the bits specified in clause 7.3.1.1.1. This parameter may be derived from the handshaking procedures defined in [ITU-T G.994.1].

7.5.1.2 VDSL2 profile

This parameter specifies the profile in use. It is coded in a bit-map representation with the bits specified in clause 7.3.1.1.11. This parameter may be derived from the handshaking procedures specified in [ITU-T G.994.1].

7.5.1.3 VDSL2 limit power spectral density mask and band plan

This parameter specifies the limit PSD mask and band plan in use. It is coded in a bit-map representation with the bits specified in clause 7.3.1.2.16.

7.5.1.4 VDSL2 US0 PSD mask

This parameter specifies the US0 PSD mask in use. It is coded in a bit-map representation with the bits specified in clause 7.3.1.2.18. This parameter may be derived from the handshaking procedures specified in [ITU-T G.994.1].

7.5.1.5 Line power management state

The line has four possible power management states, numbered 0 to 3 and corresponding to the following.

L0 – Synchronized – This line state (L0) is when the line has full transmission (i.e., showtime)

L1 – Power down data transmission – This line state (L1) is when there is transmission on the line but the net data rate is reduced (e.g., only for OAM and higher layer connection and session control). This state applies to [ITU-T G.992.2] only

L2 – Power down data transmission – This line state (L2) is when there is transmission on the line, but the net data rate is reduced (e.g., only for OAM and higher layer connection and session control). This state applies to [ITU-T G.992.3] and [ITU-T G.992.4] only

L3 – No-power – This line state (L3) is when there is no power transmitted on the line at all.

NOTE – This configuration parameter maps to the OperStatus of the line, which is part of the GeneralInformationGroup object group specified in [b-IETF RFC 2233], and may not need to be duplicated in the ADSL MIB. See also [b-IETF RFC 2662] and [b-IETF RFC 3440]. The operational status of the line is up in the L0, L1 or L2 state (i.e., during showtime) and is down in the L3 state (e.g., during (short) initialization and loop diagnostic mode).

7.5.1.6 Initialization success/failure cause

This parameter indicates whether the last full initialization procedure was successful. If the last initialization procedure was not successful, this parameter provides the reason. It is coded as an integer in the 0 to 6 range, as follows.

0 Successful

1 Configuration error

This error occurs with inconsistencies in configuration parameters. For example, when the line is initialized in an xDSL transmission system where an xTU does not support the configured maximum delay or the configured minimum or maximum data rate for one or more bearer channels

2 Configuration not feasible on the line

This error occurs if the minimum data rate cannot be reached on the line with the minimum noise margin, maximum PSD level, maximum delay and maximum bit error ratio for one or more bearer channels

3 Communication problem

This error occurs, for example, due to corrupted messages or bad syntax messages or if no common mode can be selected in the ITU-T G.994.1 handshaking procedure or due to a timeout

4 No peer xTU detected

This error occurs if the peer xTU is not powered or not connected or if the line is too long to allow detection of a peer xTU

5 Any other or unknown initialization failure cause

6 ITU-T G.998.4 retransmission mode was not selected while RTX_MODE = FORCED or with RTX_MODE = RTX_TESTMODE

7.5.1.7 Downstream last transmitted state

This parameter represents the last successful transmitted initialization state in the downstream direction in the last full initialization performed on the line. Initialization states are specified in the individual xDSL Recommendations and are counted from 0 (if [ITU-T G.994.1] is used) or 1 (if [ITU-T G.994.1] is not used) up to showtime. This parameter must be interpreted along with the xDSL transmission system.

This parameter is available only when, after a failed full initialization, the loop diagnostic procedures are activated on the line. Loop diagnostic procedures can be activated by the operator of the system (through the line state forced line configuration parameter) or autonomously by the xTU-C or xTU-R.

7.5.1.8 Upstream last transmitted state

This parameter represents the last successful transmitted initialization state in the upstream direction in the last full initialization performed on the line. Initialization states are specified in the individual xDSL Recommendations and are counted from 0 ([if ITU-T G.994.1] is used) or 1 (if [ITU-T G.994.1] is not used) up to showtime. This parameter must be interpreted along with the xDSL Transmission System.

This parameter is available only when, after a failed full initialization, the loop diagnostic procedures are activated on the line. Loop diagnostic procedures can be activated by the operator of the system (through the line state forced line configuration parameter) or autonomously by the xTU-C or xTU-R.

7.5.1.9 Downstream line attenuation per band

The downstream line attenuation per band (LATNds) parameter is specified per usable band. It is squared magnitude of the channel characteristics function H(*f*) averaged over this band, and measured during loop diagnostic mode and initialization. The exact specification is included in the relevant xDSL ITU-T Recommendation. The downstream line attenuation ranges per band from 0 dB to +127 dB, with 0.1 dB steps. A special value indicates the line attenuation per band is out of range to be represented.

For ADSL systems, a single parameter is specified as a single downstream band is usable.

7.5.1.10 Upstream line attenuation per band

The upstream line attenuation per band (LATNus) parameter is specified per usable band. It is the squared magnitude of the channel characteristics function H(*f*) averaged over this band and measured during loop diagnostic mode and initialization. The exact specification is included in the relevant xDSL ITU-T Recommendation. The upstream line attenuation ranges per band from 0 dB to +127 dB, with 0.1 dB steps. A special value indicates the line attenuation per band is out of range to be represented.

For ADSL systems, a single parameter is defined as a single upstream band is usable.

7.5.1.11 Downstream signal attenuation per band

The downstream signal attenuation per band (SATNds) parameter is specified per usable band. It is the measured difference between the total power transmitted in this band by the xTU-C and the total power received in this band by the xTU-R in this band during loop diagnostic mode, initialization and showtime. The exact specificaition is included in the relevant DSL ITU-T Recommendation. The downstream signal attenuation per band ranges from 0 dB to +127 dB, with 0.1 dB steps. A special value indicates the signal attenuation per band is out of the range to be represented.

For ADSL systems, a single parameter is specified as a single downstream band is usable.

NOTE – During showtime, only a subset of the subcarriers may be transmitted by the xTU-C, as compared to loop diagnostic mode and initialization. Therefore, the downstream signal attenuation value during showtime may be significantly lower than the downstream signal attenuation value during loop diagnostic mode and initialization.

7.5.1.12 Upstream signal attenuation per band

The upstream signal attenuation per band (SATNus) parameter is specified per usable band. It is the measured difference, in decibels, between the total power transmitted in this band by the xTU-R and the total power received in this band by the xTU-C in this band during loop diagnostic mode, initialization and showtime. The exact specification is included in the relevant DSL ITU-T Recommendation. The upstream signal attenuation per band ranges from 0 dB to +127 dB, with 0.1 dB steps. A special value indicates the signal attenuation per band is out of the range to be represented.

For ADSL systems, a single parameter is defined as a single upstream band is usable.

NOTE – During showtime, only a subset of the subcarriers may be transmitted by the xTU-R, as compared to loop diagnostic mode and initialization. Therefore, the upstream signal attenuation value during showtime may be significantly lower than the upstream signal attenuation value during loop diagnostic mode and initialization.

7.5.1.13 Downstream signal-to-noise ratio margin

The downstream signal-to-noise ratio margin (SNRMds)is the maximum increase, in decibels, of the noise power received at the xTU-R, such that the BER requirements are met for all downstream bearer channels. The downstream SNR margin ranges from –64 dB to +63 dB, with 0.1 dB steps. A special value indicates the parameter is out of range to be represented. The same SNRMds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT SNRMds and NEXT SNRMds.

NOTE – The downstream SNR margin measurement at the xTU-R may take up to 10 s.

7.5.1.13.1 Far-end crosstalk downstream signal-to-noise ratio margin

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, downstream SNR margin (see clause 7.5.1.13) measured during $FEXT_R$ duration at ATU-R is specified as the FEXT downstream signal-to-noise ratio margin (FEXT SNRMds).

7.5.1.13.2 Near- end crosstalk downstream signal-to-noise ratio margin

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, downstream SNR margin (see clause 7.5.1.13) measured during $NEXT_R$ duration at ATU-R is specified as the NEXT downstream signal-to-noise ratio margin (NEXT SNRMds).

7.5.1.14 Downstream signal-to-noise ratio margin per band

This parameter is specified per usable band. The downstream signal-to-noise ratio margin per band (SNRMpbds) is the maximum increase, in decibels, of the noise power received at the xTU-R, such that the BER requirements are met for all downstream bearer channels. The SNRMpbds ranges from –64 dB to +63 dB, with 0.1 dB steps. A special value indicates the parameter is out of the range to be represented.

NOTE – The SNRMpbds measurement at the xTU-R may take up to 10 s.

7.5.1.15 Actual downstream signal-to-noise ratio mode (ACTSNRMODEds)

The actual downstream signal-to-noise ratio mode (ACTSNRMODEds) parameter indicates whether the transmitter referred virtual noise is active on the line in the downstream direction. If ACTSNRMODEds equals 1, the virtual noise is inactive. If ACTSNRMODEds equals 2, the virtual noise is active. If ACTSNRMODEds equals 4, the virtual noise together with the virtual noise scaling factor is active.

7.5.1.16 Upstream signal-to-noise ratio margin

The upstream signal-to-noise ratio margin (SNRMus) is the maximum increase, in decibels, of the noise power received at the xTU-C, such that the BER requirements are met for all upstream bearer channels. The SNRMus ranges from –64 dB to +63 dB, with 0.1 dB steps. A special value indicates the parameter is out of the range to be represented. The same SNRMus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT SNRMus and NEXT SNRMus.

NOTE – The SNRMus measurement at the xTU-C may take up to 10 s.

7.5.1.16.1 Far-end crosstalk upstream signal-to-noise ratio margin

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, upstream SNR margin (see clause 7.5.1.16) measured during $FEXT_C$ duration at ATU-C is specified as the FEXT upstream signal-to-noise ratio margin (FEXT SNRMus).

7.5.1.16.2 Near- end crosstalk Upstream signal-to-noise ratio margin

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, upstream SNR margin (see clause 7.5.1.16) measured during $NEXT_C$ duration at ATU-C is specified as the NEXT upstream signal-to-noise ratio margin (NEXT SNRMus).

7.5.1.17 Upstream signal-to-noise ratio margin per band

This parameter is specified per usable band. The upstream signal-to-noise ratio margin per band (SNRMpbus) is the maximum increase in decibels of the noise power received at the xTU-C, such that the BER requirements are met for all upstream bearer channels. The SNRMpbus ranges from –64 dB to +63 dB, with 0.1 dB steps. A special value indicates the parameter is out of the range to be represented.

NOTE – The SNRMpbus measurement at the xTU-C may take up to 10 s.

7.5.1.18 Actual upstream signal-to-noise ratio mode

The actual upstream signal-to-noise ratio mode (ACTSNRMODEus) parameter indicates the type of virtual noise that is active on the line in the upstream direction. If ACTSNRMODEus equals 1, the virtual noise is inactive. If ACTSNRMODEus equals 2, the transmitter referred virtual noise is active. If ACTSNRMODEus equals 3, the receiver referred virtual noise is active. If ACTSNRMODEus equals 4, the receiver referred virtual noise together with the virtual noise scaling factor is active.

7.5.1.19 Downstream maximum attainable data rate

The downstream maximum attainable data rate (ATTNDRds) parameter indicates the maximum downstream net data rate currently attainable by the xTU-C transmitter and the xTU-R receiver. The rate is coded in steps of 1 000 bit/s. The same ATTNDRds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT ATTNDRds and NEXT ATTNDRds.

7.5.1.19.1 Far-end crosstalk downstream maximum attainable data rate

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the maximum downstream net data rate (see clause 7.5.1.19) calculated from FEXT downstream SNR(*f*) (see clause 7.5.1.28.3.1) is specified as the FEXT downstream maximum attainable data rate (FEXT ATTNDRds).

7.5.1.19.2 Near- end crosstalk downstream maximum attainable data rate

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the maximum downstream net data rate (see clause 7.5.1.19) calculated from NEXT downstream SNR(*f*) (see clause 7.5.1.28.3.2) is specified as the NEXT downstream maximum attainable data rate (NEXT ATTNDRds).

7.5.1.20 Upstream maximum attainable data rate

The upstream maximum attainable data rate (ATTNDRus) parameter indicates the maximum upstream net data rate currently attainable by the xTU-R transmiter and the xTU-C receiver. The rate is coded in steps of 1 000 bit/s. The same ATTNDRus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT ATTNDRus and NEXT ATTNDRus.

7.5.1.20.1 Far-end crosstalk upstream maximum attainable data rate

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the maximum upstream net data rate (see clause 7.5.1.20) calculated from FEXT upstream SNR(*f*) (see clause 7.5.1.28.6.1) is specified as the FEXT upstream maximum attainable data rate (FEXT ATTNDRus).

7.5.1.20.2 Near- end crosstalk upstream maximum attainable data rate

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the maximum upstream net data rate (see clause 7.5.1.20) calculated from NEXT upstream SNR(*f*) (see clause 7.5.1.28.6.2) is specified as the NEXT upstream maximum attainable data rate (NEXT ATTNDRus).

7.5.1.21 Downstream actual power spectral density

The downstream actual power spectral density (ACTPSDds) parameter is the average downstream transmit PSD over the used subcarriers (subcarriers to which downstream user data are allocated) delivered by the xTU-C at the U-C reference point, at the instant of measurement. The PSD level ranges from –90 dBm/Hz to 0 dBm/Hz, with 0.1 dBm/Hz steps. A special value indicates the parameter is out of range to be represented. The same ACTPSDds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT ACTPSDds and NEXT ACTPSDds.

NOTE – The ACTPSDds is the sum, in decibels, of the REFPSDds and RMSGIds. See clause 8.5.1 of [ITU-T G.992.3].

7.5.1.21.1 Far-end crosstalk downstream actual power spectral density

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the average downstream transmit PSD over the used subcarriers (see clause 7.5.1.21) calculated from the REFPSDds and RMSGIds for $FEXT_R$ duration is specified as the FEXT downstream actual power spectrum density (FEXT ACTPSDds).

7.5.1.21.2 Near- end crosstalk downstream actual power spectral density

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the average downstream transmit PSD over the used subcarriers (see clause 7.5.1.21) calculated from the REFPSDds and RMSGIds for $NEXT_R$ duration is specified as the NEXT downstream actual power spectral density (NEXT ACTPSDds).

7.5.1.22 Upstream actual power spectral density

The upstream actual power spectral density (ACTPSDus) parameter is the average upstream transmit PSD over the used subcarriers (subcarriers to which upstream user data are allocated) delivered by the xTU-R at the U-R reference point, at the instant of measurement. The PSD level ranges from –90 dBm/Hz to 0 dBm/Hz, with 0.1 dBm/Hz steps. A special value indicates the parameter is out of the range to be represented. The same ACTPSDus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT ACTPSDus and NEXT ACTPSDus.

NOTE – The upstream actual power spectrum density is the sum, in deciBels, of the REFPSDus and RMSGIus. See clause 8.5.1 of [ITU-T G.992.3].

7.5.1.22.1 Far-end crosstalk upstream actual power spectral density

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the average upstream transmit PSD over the used subcarriers (see clause 7.5.1.22) calculated from the REFPSDus and RMSGIus for $FEXT_C$ duration is specified as the FEXT upstream actual power spectral density (FEXT ACTPSDus).

7.5.1.22.2 Near- end crosstalk upstream actual power spectral density

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the average downstream transmit PSD over the used subcarriers (see clause 7.5.1.22) calculated from the REFPSDus and RMSGIus for $NEXT_C$ duration is specified as the NEXT upstream actual power spectral density (NEXT ACTPSDus).

7.5.1.23 Estimated upstream power back-off electrical length

7.5.1.23.1 VTU-O estimated upstream power back-off electrical length

The VTU-O estimated upstream power back-off electrical length (UPBOKLE) parameter contains the estimated electrical length expressed in decibels at 1 MHz, kl_0 (see O-UPDATE in clause 12.3.3.2.1.2 of [ITU-T G.993.2]). This is the final electrical length that would have been sent from the VTU-O to the VTU-R if the electrical length was not forced by the CO-MIB. The value ranges from 0 dB to 128 dB, in steps of 0.1 dB.

7.5.1.23.2 VTU-R estimated upstream power back-off electrical length

The VTU-R estimated upstream power back-off electrical length (UPBOKLE-R) parameter contains the electrical length estimated by the VTU-R expressed in decibels at 1 MHz. This is the value contained in the message R-MSG1 (see clause 12.3.3.2.2.1 of [ITU-T G.993.2]). The value ranges from 0 dB to 128 dB, in steps of 0.1 dB.

7.5.1.23.3 VTU-O estimated upstream power back-off electrical length per band (UPBOKLE-pb)

This parameter is a vector of UPBO electrical length per-band estimates for each supported upstream band, expressed in decibels at 1 MHz (kl_0) calculated by the VTU-O, based on separate measurements in the supported upstream bands excluding US0. The value ranges from 0 dB to 128 dB in steps of 0.1 dB, with special value 204.7, which indicates that the estimate is greater than 128 dB. This parameter is required for the alternative electrical length estimation method (ELE-M1).

7.5.1.23.4 VTU-R estimated upstream power back-off electrical length per band (UPBOKLE-R-pb)

This parameter is a vector of UPBO electrical length per-band estimates for each supported downstream band, expressed in decibels at 1 MHz (kl_0) calculated by the VTU-R, based on separate measurements in the supported downstream bands. The value ranges from 0 dB to 128 dB in steps of 0.1 dB, with special value 204.7, which indicates that the estimate is greater than 128 dB. This parameter is required for the alternative electrical length estimation method (ELE-M1).

7.5.1.23.5 UPBO downstream receiver signal level threshold (RXTHRSHds)

This parameter reports the downstream received signal level threshold value used in the alternative electrical length estimation method (ELE-M1) in clause 7.2.1.3.2.2. This parameter represents an offset from –100 dBm/Hz, and ranges from –64 dB to 0 dB in steps of 1 dB.

7.5.1.23.6 UPBO upstream receiver signal level threshold (RXTHRSHus)

This parameter reports the upstream received signal level threshold value used in the alternative electrical length estimation method (ELE-M1) in clause 7.2.1.3.2.2. This parameter represents an offset from –100 dBm/Hz, and ranges from –64 dB to 0 dB in steps of 1 dB.

7.5.1.23.7 "Actual Alternative Electrical Length Estimation Mode" (ACT-AELE-MODE)

This parameter reports the actual AELE-MODE used in clause 7.2.1.3.2.1 of [ITU-T G.993.2]. The value of this parameter is 0, 1, 2 or 3.

7.5.1.24 Downstream actual aggregate transmit power (ACTATPds)

This parameter is the total amount of transmit power delivered by the xTU-C at the U-C reference point, at the instant of measurement. The total output power level ranges from –31 dBm to +31 dBm, with 0.1 dB steps. A special value indicates the parameter is out of the range to be represented. The same ACTATPds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT ACTATPds and NEXT ACTATPds.

NOTE – The downstream nominal aggregate transmit power may be taken as a best estimate of the parameter. See clause 8.12.3.8 of [ITU-T G.992.3] and clause 10.3.4.2.1 of [ITU-T G.993.2].

7.5.1.24.1 Far-end crosstalk downstream actual aggregate transmit power (FEXT ACTATPds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the total amount of transmit power (see clause 7.5.1.24) calculated from PSDds measured during $FEXT_R$ duration at ATU-R is specified as the FEXT downstream actual aggregate transmit power (FEXT ACTATPds).

7.5.1.24.2 Near- end crosstalk downstream actual aggregate transmit power (NEXT ACTATPds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the total amount of transmit power (see clause 7.5.1.24) calculated from PSDds measured during $NEXT_R$ duration at ATU-R is specified as the NEXT downstream actual aggregate transmit power (NEXT ACTATPds).

7.5.1.25 Upstream actual aggregate transmit power (ACTATPus)

This parameter is the total amount of transmit power delivered by the xTU-R at the U-R reference point, at the instant of measurement. The total output power level ranges from –31 dBm to +31 dBm, with 0.1 dB steps. A special value indicates the parameter is out of the range to be represented. The same ACTATPus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT ACTATPus and NEXT ACTATPus.

NOTE – The upstream nominal aggregate transmit power may be taken as a best estimate of the parameter. See clause 8.12.3.8 of [ITU-T G.992.3] and clause 10.3.4.2.1 of [ITU-T G.993.2].

7.5.1.25.1 Far-end crosstalk upstream actual aggregate transmit power (FEXT ACTATPus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the total amount of transmit power (see clause 7.5.1.25) calculated from PSDus measured during $FEXT_C$ duration at ATU-C is specified as the FEXT upstream actual aggregate transmit power (FEXT ACTATPus).

7.5.1.25.2 Near- end crosstalk upstream actual aggregate transmit power (NEXT ACTATPus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the total amount of transmit power (see clause 7.5.1.25) calculated from PSDus measured during $NEXT_C$ duration at ATU-C is specified as the NEXT upstream actual aggregate transmit power (NEXT ACTATPus).

7.5.1.26 Channel characteristics function per subcarrier

This function is specified in clauses 8.12.3.1 of [ITU-T G.992.3] and clause 11.4.1.1.1 of [ITU-T G.993.2].

NOTE – In case of ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, see clause C.8.12.3.1 of [ITU-T G.992.3], in addition to clause 8.12.3.1 of [ITU-T G.992.3].

For [ITU-T G.993.2], the value of NSus and NSds are the indices of the highest supported upstream and downstream subcarriers, respectively, according to the selected profile (see clause 6 of [ITU-T G.993.2]). For ADSL, NSus is equal to NSCus-1 and NSds is equal to NSCds-1.

7.5.1.26.1 Downstream H(*f*) linear representation scale (HLINSCds)

This parameter is the scale factor to be applied to the downstream Hlin(*f*) values. It is represented as an unsigned integer in the range from 1 to $2^{16} - 1$. This parameter is only available after a loop diagnostic procedure.

7.5.1.26.2 Downstream H(*f*) linear subcarrier group size (HLINGds)

This parameter is the number of subcarriers per group used to report HLINpsds. The valid values are 1, 2, 4, 8 and 16. For ADSL, this parameter is equal to one and, for VDSL2, it is equal to the size of a subcarrier group used to compute these parameters (see clause 11.4.1 of [ITU-T G.993.2]).

NOTE – The values of the subcarrier group size parameters (HLING, HLOGG, QLNG and SNRG) may not all be independent.

7.5.1.26.3 Downstream H(*f*) linear representation (HLINpsds)

This parameter is an array of complex values in linear scale for downstream Hlin(f). Each array entry represents the Hlin($f = i \times$ HLINGds $\times \Delta f$) value for a particular subcarrier group index i, ranging from 0 to MIN(NSds,511). The Hlin(f) is represented as ((HLINSCds/2^{15}) $\times$ (($a(i) + j \times b(i)$)/2^{15})), where $a(i)$ and $b(i)$ are signed integers in the ($-2^{15} + 1$) to ($+2^{15} - 1$) range. A special value indicates that no measurement could be done for this subcarrier group because it is out of the passband or that the attenuation is out of the range to be represented. This parameter is only available after a loop diagnostic procedure.

7.5.1.26.4 Downstream H(*f*) logarithmic measurement time (HLOGMTds)

This parameter contains the number of symbols used to measure the downstream Hlog(f) values. It is represented as an unsigned integer in the range from 1 to $2^{16} - 1$.

After a loop diagnostic procedure, this parameter shall contain the number of symbols used to measure the downstream Hlog(f). It should correspond to the value specified in the Recommendation (e.g., the number of symbols in a 1 s time interval for [ITU-T G.992.3]).

7.5.1.26.5 Downstream H(*f*) logarithmic subcarrier group size (HLOGGds)

This parameter is the number of subcarriers per group used to report HLOGpsds. The valid values are 1, 2, 4, 8 and 16. For ADSL, this parameter is equal to one and, for VDSL2, it is equal to the size of a subcarrier group used to compute these parameters (see clause 11.4.1 of [ITU-T G.993.2]).

7.5.1.26.6 Downstream H(*f*) logarithmic representation (HLOGpsds)

This parameter is an array of real values in decibels for downstream Hlog(f). Each array entry represents the real Hlog($f = i \times$ HLOGGds $\times \Delta f$) value for a particular subcarrier group subcarrier index i, ranging from 0 to MIN(NSds,511). The real Hlog(f) value is represented as ($6 - m(i)/10$), where $m(i)$ is an unsigned integer in the range from 0 to 1 022. A special value indicates that no measurement could be done for this subcarrier group because it is out of the passband or that the attenuation is out of range to be represented.

7.5.1.26.7 Upstream H(*f*) linear representation scale (HLINSCus)

This parameter is the scale factor to be applied to the upstream Hlin(f) values. It is coded in the same way as the related downstream parameter. This parameter is only available after a loop diagnostic procedure.

7.5.1.26.8 Upstream H(*f*) linear subcarrier group size (HLINGus)

This parameter is the number of subcarriers per group used to report HLINpsus. The valid values are 1, 2, 4 and 8. For ADSL, this parameter is equal to one and, for VDSL2, it is equal to the size of a subcarrier group used to compute these parameters (see clause 11.4.1 of [ITU-T G.993.2]).

7.5.1.26.9 Upstream H(*f*) linear representation (HLINpsus)

This parameter is an array of complex values in linear scale for upstream Hlin(f). It is coded in the same way as the related downstream parameter. This parameter is only available after a loop diagnostic procedure.

7.5.1.26.10 Upstream H(*f*) logarithmic measurement time (HLOGMTus)

This parameter contains the number of symbols used to measure the upstream Hlog(*f*) values. It is an unsigned integer in the range from 1 to $2^{16} – 1$.

After a loop diagnostic procedure, this parameter shall contain the number of symbols used to measure the upstream Hlog(*f*). It should correspond to the value specified in the Recommendation (e.g., the number of symbols in a 1 s time interval for [ITU-T G.992.3]).

7.5.1.26.11 Upstream H(*f*) logarithmic subcarrier group size (HLOGGus)

This parameter is the number of subcarriers per group used to report HLOGpsus. The valid values are 1, 2, 4 and 8. For ADSL, this parameter is equal to one and, for VDSL2, it is equal to the size of a subcarrier group used to compute these parameters (see clause 11.4.1 of [ITU-T G.993.2]).

7.5.1.26.12 Upstream H(*f*) logarithmic representation (HLOGpsus)

This parameter is an array of real values, in decibels, for upstream Hlog(*f*). It is coded in the same way as the related downstream parameter.

7.5.1.27 Quiet line noise power spectral density per subcarrier

This function is specified in clauses 8.12.3.2 of [ITU-T G.992.3] and 11.4.1.1.2 of [ITU-T G.993.2].

NOTE – In the case of ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, see clause C.8.12.3.2 of [ITU-T G.992.3], in addition to clause 8.12.3.2 of [ITU-T G.992.3].

7.5.1.27.1 Downstream quiet line noise power spectral density measurement time (QLNMTds)

This parameter contains the number of symbols used to measure the downstream QLN(*f*) values. It is an unsigned integer in the range from 1 to $2^{16} – 1$. The same QLNMTds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT QLNMTds and NEXT QLNMTds.

After a loop diagnostic procedure, this parameter shall contain the number of symbols used to measure the downstream QLN(*f*). It should correspond to the value specified in the Recommendation (e.g., the number of symbols in a 1 s time interval for [ITU-T G.992.3]).

7.5.1.27.1.1 Far-end crosstalk downstream quiet line noise power spectral density measurement time (FEXT QLNMTds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the number of symbols used to measured FEXT downstream QLN(*f*) (see clause 7.5.1.27.3.1) is specified as the FEXT downstream quiet line noise PSD measurement time (FEXT QLNMTds).

7.5.1.27.1.2 Near- end crosstalk downstream quiet line noise power spectral density measurement time (NEXT QLNMTds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the number of symbols used to measured NEXT downstream QLN(*f*) (see clause 7.5.1.27.3.2) is specified as the NEXT downstream quiet line noise PSD measurement time (NEXT QLNMTds).

7.5.1.27.2 Downstream QLN(*f*) subcarrier group size (QLNGds)

This parameter is the number of subcarriers per group used to report QLNpsds. The valid values are 1, 2, 4, 8 and 16. For ADSL, this parameter is equal to one and, for VDSL2, it is equal to the size of a subcarrier group used to compute these parameters (see clause 11.4.1 of [ITU-T G.993.2]).

7.5.1.27.3 Downstream QLN(*f*) (QLNpsds)

This parameter is an array of real values in decibels with reference to 1 mW per hertz for downstream QLN(*f*). Each array entry represents the QLN($f = i \times$ QLNGds $\times \Delta f$) value for a particular subcarrier group index i, ranging from 0 to MIN(NSds,511). The QLN(*f*) is represented as $(–23 – n(i)/2)$, where

$n(i)$ is an unsigned integer in the range from 0 to 254. A special value indicates that no measurement could be done for this subcarrier group because it is out of the passband or that the noise PSD is out of range to be represented. The same QLNpsds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT QLNpsds and NEXT QLNpsds.

7.5.1.27.3.1 Far-end crosstalk downstream QLN(*f*) (FEXT QLNpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, downstream QLN(*f*) (see clause 7.5.1.27.3) measured during $FEXT_R$ duration at ATU-R is specified as the FEXT downstream QLN(*f*) (FEXT QLNpsds).

7.5.1.27.3.2 Near- end crosstalk downstream QLN(*f*) (NEXT QLNpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, downstream QLN(*f*) (see clause 7.5.1.27.3) measured during $NEXT_R$ duration at ATU-R is specified as the NEXT downstream QLN(*f*) (NEXT QLNpsds).

7.5.1.27.4 Upstream quiet line noise power spectral density measurement time (QLNMTus)

This parameter contains the number of symbols used to measure the upstream QLN(*f*) values. It is an unsigned integer in the range from 1 to $2^{16} - 1$. The same QLNMTus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT QLNMTus and NEXT QLNMTus.

After a loop diagnostic procedure, this parameter shall contain the number of symbols used to measure the upstream QLN(*f*). It should correspond to the value specified in the Recommendation (e.g., the number of symbols in a 1 s time interval for [ITU-T G.992.3]).

7.5.1.27.4.1 Far-end crosstalk upstream quiet line noise power spectral density measurement time (FEXT QLNMTus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the number of symbols used to measure FEXT upstream QLN(*f*) (see clause 7.5.1.27.6.1) is specified as the FEXT upstream quiet line noise PSD measurement time (FEXT QLNMTus).

7.5.1.27.4.2 Near- end crosstalk upstream quiet line noise power spectral density measurement time (NEXT QLNMTus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the number of symbols used to measure NEXT upstream QLN(*f*) (see clause 7.5.1.27.6.2) is specified as the NEXT upstream quiet line noise PSD measurement time (NEXT QLNMTus).

7.5.1.27.5 Upstream QLN(*f*) subcarrier group size (QLNGus)

This parameter is the number of subcarriers per group used to report QLNpsus. The valid values are 1, 2, 4 and 8. For ADSL, this parameter is equal to one and, for VDSL2, it is equal to the size of a subcarrier group used to compute these parameters (see clause 11.4.1 of [ITU-T G.993.2]).

7.5.1.27.6 Upstream QLN(*f*) (QLNpsus)

This parameter is an array of real values in decibels with reference to 1 mW per hertz for upstream QLN(*f*). It is coded in the same way as the related downstream parameter. The same QLNpsus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT QLNpsus and NEXT QLNpsus.

7.5.1.27.6.1 Far-end crosstalk upstream QLN(*f*) (FEXT QLNpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, upstream QLN(*f*) (see clause 7.5.1.27.6) measured during $FEXT_C$ duration at ATU-C is specified as the FEXT upstream QLN(*f*) (FEXT QLNpsus).

7.5.1.27.6.2 Near- end crosstalk upstream QLN(*f*) (NEXT QLNpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, upstream QLN(*f*) (see clause 7.5.1.27.6) measured during $NEXT_C$ duration at ATU-C is specified as the NEXT upstream QLN(*f*) (NEXT QLNpsus).

7.5.1.28 Signal-to-noise ratio per subcarrier

This function is specified in clauses 8.12.3.3 of [ITU-T G.992.3] and 11.4.1.1.3 of [ITU-T G.993.2].

NOTE – In case of ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, see clause C.8.12.3.3 of [ITU-T G.992.3], in addition to clause 8.12.3.3 of [ITU-T G.992.3].

7.5.1.28.1 Downstream signal-to-noise ratio measurement time (SNRMTds)

This parameter contains the number of symbols used to measure the downstream SNR(*f*) values. It is an unsigned integer in the range from 1 to $2^{16} – 1$. The same SNRMTds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT SNRMTds and NEXT SNRMTds.

After a loop diagnostic procedure, this parameter shall contain the number of symbols used to measure the downstream SNR(*f*). It should correspond to the value specified in the Recommendation (e.g., the number of symbols in a 1 s time interval for [ITU-T G.992.3]).

7.5.1.28.1.1 Far-end crosstalk downstream signal-to-noise ratio measurement time (FEXT SNRMTds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the number of symbols used to measure FEXT downstream SNR(*f*) values (see clause 7.5.1.28.3.1) is specified as the FEXT downstream SNR measurement time (FEXT SNRMTds).

7.5.1.28.1.2 Near- end crosstalk downstream signal-to-noise ratio measurement time (NEXT SNRMTds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the number of symbols used to measure NEXT Downstream SNR(*f*) values (see clause 7.5.1.28.3.2) is specified as the NEXT downstream SNR measurement time (NEXT SNRMTds).

7.5.1.28.2 Downstream SNR(*f*) subcarrier group size (SNRGds)

This parameter is the number of subcarriers per group used to report SNRpsds. The valid values are 1, 2, 4, 8 and 16. For ADSL, this parameter is equal to one and, for VDSL2, it is equal to the size of a subcarrier group used to compute these parameters (see clause 11.4.1 of [ITU-T G.993.2]).

7.5.1.28.3 Downstream SNR(*f*) (SNRpsds)

This parameter is an array of real values in decibels for downstream SNR(*f*). Each array entry represents the SNR($f = i \times \text{SNRGds} \times \Delta f$) value for a particular subcarrier group index *i*, ranging from 0 to MIN(NSds,511). The SNR(*f*) is represented as ($–32 + \text{snr}(i)/2$), where snr(*i*) is an unsigned integer in the range from 0 to 254. A special value indicates that no measurement could be done for this subcarrier group because it is out of the passband or that the SNR is out of range to be represented. The same SNRpsds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT SNRpsds and NEXT SNRpsds.

7.5.1.28.3.1 Far-end crosstalk downstream SNR(*f*) (FEXT SNRpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, downstream SNR(*f*) (see clause 7.5.1.28.3) measured during $FEXT_R$ duration at ATU-R is specified as the FEXT downstream SNR(*f*) (FEXT SNRpsds).

7.5.1.28.3.2 Near-end crosstalk downstream SNR(*f*) (NEXT SNRpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, downstream SNR(*f*) (see clause 7.5.1.28.3) measured during $NEXT_R$ duration at ATU-R is specified as the NEXT downstream SNR(*f*) (NEXT SNRpsds).

7.5.1.28.4 Upstream signal-to-noise ratio measurement time (SNRMTus)

This parameter contains the number of symbols used to measure the upstream SNR(*f*) values. It is an unsigned integer in the range from 1 to $2^{16} - 1$. The same SNRMTus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT SNRMTus and NEXT SNRMTus.

After a loop diagnostic procedure, this parameter shall contain the number of symbols used to measure the upstream SNR(*f*). It should correspond to the value specified in the Recommendation (e.g., the number of symbols in a 1 s time interval for [ITU-T G.992.3]).

7.5.1.28.4.1 Far-end crosstalk upstream signal-to-noise ratio measurement time (FEXT SNRMTus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the number of symbols used to measure FEXT upstream SNR(*f*) values (see clause 7.5.1.28.6.1) is specified as the FEXT upstream SNR measurement time (FEXT SNRMTus).

7.5.1.28.4.2 Near- end crosstalk upstream signal-to-noise ratio measurement time (NEXT SNRMTus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the number of symbols used to measure NEXT upstream SNR(*f*) values (see clause 7.5.1.28.6.2) is specified as the NEXT upstream SNR measurement time (NEXT SNRMTus).

7.5.1.28.5 Upstream SNR(*f*) subcarrier group size (SNRGus)

This parameter is the number of subcarriers per group used to report SNRpsus. The valid values are 1, 2, 4 and 8. For ADSL, this parameter is equal to one and, for VDSL2, it is equal to the size of a subcarrier group used to compute these parameters (see clause 11.4.1 of [ITU-T G.993.2]).

7.5.1.28.6 Upstream SNR(*f*) (SNRpsus)

This parameter is an array of real values in decibels for upstream SNR(*f*). It is coded in the same way as the related downstream parameter. The same SNRpsus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT SNRpsus and NEXT SNRpsus.

7.5.1.28.6.1 Far-end crosstalk upstream SNR(*f*) (FEXT SNRpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, upstream SNR(*f*) (see clause 7.5.1.28.6) measured during $FEXT_C$ duration at ATU-C is specified as the FEXT upstream SNR(*f*) (FEXT SNRpsus).

7.5.1.28.6.2 Near- end crosstalk upstream SNR(*f*) (NEXT SNRpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, upstream SNR(*f*) (see clause 7.5.1.28.6) measured during $NEXT_C$ duration at ATU-C is specified as the NEXT upstream SNR(*f*) (NEXT SNRpsus).

7.5.1.29 Bits and gains allocation per subcarrier

7.5.1.29.1 Downstream bits allocation (BITSpsds)

This parameter defines the downstream bits allocation table per subcarrier. It is an array of integer values in the 0 to 15 range for subcarriers 0 to NSds. The same BITSpsds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT BITSpsds and NEXT BITSpsds.

The reported bits of subcarriers out of the downstream MEDLEY set shall be set to 0.

This parameter shall be reported with the most recent values when read over the Q-interface.

7.5.1.29.1.1 Far-end crosstalk downstream bits allocation (FEXT BITSpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the downstream bits allocation table per subcarrier (see clause 7.5.1.29.1) used during $FEXT_R$ duration is specified as the FEXT downstream bits allocation (FEXT BITSpsds).

7.5.1.29.1.2 Near- end crosstalk downstream bits allocation (NEXT BITSpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the downstream bits allocation table per subcarrier (see clause 7.5.1.29.1) used during $NEXT_R$ duration is specified as the NEXT downstream bits allocation (NEXT BITSpsds).

7.5.1.29.2 Upstream bits allocation (BITSpsus)

This parameter specifines the upstream bits allocation table per subcarrier. It is an array of integer values in the 0 to 15 range for subcarriers 0 to NSus. The same BITSpsus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT BITSpsus and NEXT BITSpsus.

The reported bits of subcarriers out of the upstream MEDLEY set shall be set to 0.

This parameter shall be reported with the most recent values when read over the Q-interface.

7.5.1.29.2.1 Far-end crosstalk upstream bits allocation (FEXT BITSpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the upstream bits allocation table per subcarrier (see clause 7.5.1.29.2) used during $FEXT_C$ duration is specified as the FEXT upstream bits allocation (FEXT BITSpsus).

7.5.1.29.2.1 Near- end crosstalk upstream bits allocation (NEXT BITSpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the upstream bits allocation table per subcarrier (see clause 7.5.1.29.2) used during $NEXT_C$ duration is specified as the NEXT upstream bits allocation (NEXT BITSpsus).

7.5.1.29.3 Downstream gains allocation (GAINSpsds)

This parameter specifies the downstream gains allocation table per subcarrier. It is an array of integer values in the 0 to 4 093 range for subcarriers 0 to NSds. The gain value is represented as a multiple of 1/512 on linear scale. The same GAINSpsds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT GAINSpsds and NEXT GAINSpsds.

The reported gains of subcarriers out of the downstream MEDLEY set shall be set to 0.

This parameter shall be reported with the most recent values when read over the Q-interface.

7.5.1.29.3.1 Far-end crosstalk downstream gains allocation (FEXT GAINSpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the downstream gains allocation table per subcarrier (see clause 7.5.1.29.3) used during $FEXT_R$ duration is specified as the FEXT downstream gains allocation (FEXT GAINSpsds).

7.5.1.29.3.2 Near- end crosstalk downstream gains allocation (NEXT GAINSpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the downstream gains allocation table per subcarrier (see clause 7.5.1.29.3) used during $NEXT_R$ duration is specified as the NEXT downstream gains allocation (NEXT GAINSpsds).

7.5.1.29.4 Upstream gains allocation (GAINSpsus)

This parameter specifies the upstream gains allocation table per subcarrier. It is an array of integer values in the 0 to 4093 range for subcarriers 0 to NSus. The gain value is represented as a multiple of 1/512 on linear scale. The same GAINSpsus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT GAINSpsus and NEXT GAINSpsus.

The reported gains of subcarriers out of the upstream MEDLEY set shall be set to 0.

This parameter shall be reported with the most recent values when read over the Q-interface.

7.5.1.29.4.1 Far-end crosstalk upstream gains allocation (FEXT GAINSpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the upstream gains allocation table per subcarrier (see clause 7.5.1.29.4) used during $FEXT_C$ duration is specified as the FEXT upstream gains allocation (FEXT GAINSpsus).

7.5.1.29.4.2 Near- end crosstalk upstream gains allocation (NEXT GAINSpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the upstream gains allocation table per subcarrier (see clause 7.5.1.29.4) used during $NEXT_C$ duration is specified as the NEXT upstream gains allocation (NEXT GAINSpsus).

7.5.1.29.5 Downstream transmit spectrum shaping (TSSpsds)

This parameter contains the downstream transmit spectrum shaping parameters expressed as the set of breakpoints exchanged during ITU-T G.994.1. Each breakpoint consists of a subcarrier index and the associated shaping parameter. The shaping parameter is an integer value in the 0 to 126 range. It is represented as a multiple of –0.5 dB. A special value indicates that the subcarrier is not transmitted. The same TSSpsds format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT TSSpsds and NEXT TSSpsds.

7.5.1.29.5.1 Far-end crosstalk downstream transmit spectrum shaping (FEXT TSSpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the downstream transmit spectrum shaping parameter set per subcarrier (see clause 7.5.1.29.5) used during FEXTR duration is specified as the FEXT downstream transmit spectrum shaping (FEXT TSSpsds).

7.5.1.29.5.2 Near- end crosstalk downstream transmit spectrum shaping (NEXT TSSpsds)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the downstream transmit spectrum shaping parameter set per subcarrier (see clause 7.5.1.29.5) used during $NEXT_R$ duration is specified as the NEXT downstream transmit spectrum shaping (NEXT TSSpsds).

7.5.1.29.6 Upstream transmit spectrum shaping (TSSpsus)

This parameter contains the upstream transmit spectrum shaping parameters expressed as the set of breakpoints exchanged during ITU-T G.994.1. Each breakpoint consists of a subcarrier index and the associated shaping parameter. The shaping parameter is an integer value in the 0 to 126 range. It is represented as a multiple of –0.5 dB. A special value indicates that the subcarrier is not transmitted. The same TSSpsus format shall be applied to ITU-T G.992.3 and ITU-T G.992.5 Annex C FEXT TSSpsus and NEXT TSSpsus.

7.5.1.29.6.1 Far-end crosstalk upstream transmit spectrum shaping (FEXT TSSpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the upstream transmit spectrum shaping parameter set per subcarrier (see clause 7.5.1.29.6) used during $FEXT_C$ duration is specified as the FEXT upstream transmit spectrum shaping (FEXT TSSpsus).

7.5.1.29.6.2 Near- end crosstalk upstream transmit spectrum shaping (NEXT TSSpsus)

For ITU-T G.992.3 (ADSL2) Annex C and ITU-T G.992.5 (ADSL2plus) Annex C, the upstream transmit spectrum shaping parameter set per subcarrier (see clause 7.5.1.29.6) used during $NEXT_C$ duration is specified as the NEXT upstream transmit spectrum shaping (NEXT TSSpsus).

7.5.1.29.7 Downstream MEDLEY reference power spectral density (MREFPSDds)

This parameter shall contain the set of breakpoints exchanged in the MREFPSDds fields of the O-PRM message of ITU-T G.993.2. The format shall be as specified in [ITU-T G.993.2].

7.5.1.29.8 Upstream MEDLEY reference power spectral density (MREFPSDus)

This parameter shall contain the set of breakpoints exchanged in the MREFPSDus fields of the R-PRM message of [ITU-T G.993.2]. The format shall be as specified in [ITU-T G.993.2].

7.5.1.30 Downstream trellis use (TRELLISds)

This parameter reports whether trellis coding is in use in the downstream direction. It is represented as one bit coded as 0 if the trellis is not used and as 1 if the trellis is used.

7.5.1.31 Upstream trellis use (TRELLISus)

This parameter reports whether trellis coding is in use in the upstream direction. It is represented as one bit coded as 0 if the trellis is not used and as 1 if the trellis is used.

7.5.1.32 Actual cyclic extension (ACTUALCE)

This parameter reports the cyclic extension used on the line. It is coded as an unsigned integer from 2 to 16 in units of $N/32$ samples, where $2N$ is the IDFT size.

7.5.1.33 Actual rate adaptation mode

7.5.1.33.1 Actual downstream rate adaptation mode (ACT-RA-MODEds)

This parameter indicates the actual active RA-MODE in the downstream direction.

If ACT-RA-MODEds equals 1, the link is operating in RA-MODE 1 (MANUAL).

If ACT-RA-MODEds equals 2, the link is operating in RA-MODE 2 (AT_INIT).

If ACT-RA-MODEds equals 3, the link is operating in RA-MODE 3 (DYNAMIC).

NOTE 1 – In [ITU-T G.992.3] ACT-RA-MODEds=3 corresponds to SRA supported. In [ITU-T G.993.2] ACT-RA-MODEds=3 corresponds to SRA supported by both XTUs in the downstream direction, but SOS not supported by both XTUs in the downstream direction.

If ACT-RA-MODEds equals 4, the link is operating in RA-MODE 4 (DYNAMIC with SOS).

NOTE 2 – In [ITU-T G.992.3] ACT-RA-MODEds=4 is not defined. In [ITU-T G.993.2] ACT-RA-MODEds=4 corresponds to SOS and SRA supported by both XTUs in the downstream direction.

7.5.1.33.2 Actual upstream rate adaptation mode (ACT-RA-MODEus)

This parameter indicates the actual active RA-MODE in the upstream direction.

If ACT-RA-MODEus equals 1, the link is operating in RA-MODE 1 (MANUAL).

If ACT-RA-MODEus equals 2, the link is operating in RA-MODE 2 (AT_INIT).

If ACT-RA-MODEus equals 3, the link is operating in RA-MODE 3 (DYNAMIC).

NOTE 1 – In [ITU-T G.992.3] ACT-RA-MODEus=3 corresponds to SRA supported. In [ITU-T G.993.2] ACT-RA-MODEus=3 corresponds to SRA supported by both XTUs in the upstream direction, but SOS not supported by both XTUs in the upstream direction.

If ACT-RA-MODEus equals 4, the link is operating in RA-MODE 4 (DYNAMIC with SOS).

NOTE 2 – In [ITU-T G.992.3] ACT-RA-MODEus=4 is not specified. In [ITU-T G.993.2] ACT-RA-MODEus=4 corresponds to SOS and SRA supported by both XTUs in the upstream direction.

7.5.1.34 Actual impulse noise protection of the robust overhead channel

7.5.1.34.1 Downstream actual impulse noise protection of the robust overhead channel (ACTINP-ROC-ds)

This parameter reports the actual INP of the ROC in the downstream direction expressed in multiples of T_{4k} in the L0 state.

In the L1 or L2 states, the parameter contains the value in the previous L0 state.

The value is coded in fractions of T_{4k} with a granularity of 0.1. The range is from 0 to 25.4. A special value indicates an ACTINP-ROC-ds higher than 25.4.

7.5.1.34.2 Upstream actual impulse noise protection of robust overhead channel (ACTINP-ROC-us)

This parameter reports the actual INP of the ROC in the upstream direction expressed in multiples of T_{4k} in the L0 state.

In the L1 or L2 states, the parameter contains the value in the previous L0 state.

The value is coded in fractions of T_{4k} with a granularity of 0.1. The range is from 0 to 25.4. A special value indicates an ACTINP-ROC-us higher than 25.4.

7.5.1.35 Actual signal-to-noise ratio margin of robust overhead channel

7.5.1.35.1 Downstream actual signal-to-noise ratio margin of robust overhead channel (SNRM-ROC-ds)

This parameter reports the actual signal-to-noise margin of the ROC in the downstream direction. The format is identical to the format of the line status parameter SNRM (see clause 7.5.1.13).

7.5.1.35.2 Upstream actual signal-to-noise ratio margin of robust overhead channel (SNRM-ROC-us)

This parameter reports the actual signal-to-noise margin of the ROC in the upstream direction. The format is identical to the format of the line status parameter SNRM (see clause 7.5.1.16).

7.5.1.36 Update request flags and time stamps of test parameters

7.5.1.36.1 Update request flag for near-end test parameters (UPDATE-TEST-NE)

This parameter is defined to force an update of the near-end test parameters that can be updated during showtime. The parameter is configurable over the Q-interface and the valid values are 0 and 1. When this parameter is set (its value is changed from 0 to 1), the near-end test parameters shall be updated in the AN MIB within 10 s. The update request flag for the near-end test parameters is defined in the AN MIB and is independent of any autonomous update process in the system. The parameter shall be reset (its value changed back to 0) by the AN after a period shorter than 3 min to allow reception of another update request. The 3 min period starts since the last time the flag was set (externally or by an autonomous process in the system). This applies only to the elements maintained in the AN (see the last paragraph of clause 7).

7.5.1.36.2 Update request flag for far-end test parameters (UPDATE-TEST-FE)

This parameter is specified to force an update of the far-end test parameters that can be updated during showtime. The parameter is configurable over the Q-interface and the valid values are 0 and 1. When this parameter is set (its value is changed from 0 to 1), the far-end test parameters shall be updated in the AN MIB within 30 s. The update request flag for the far-end test parameters is specified in the AN MIB and is independent of any autonomous update process in the system. The parameter shall be reset (its value changed back to 0) by the AN after a period shorter than 3 min to allow reception of another update request. The 3 min period starts since the last time the flag was set (externally or by an autonomous process in the system). This applies only to the elements maintained in the AN (see the last paragraph of clause 7).

7.5.1.36.3 Date/time-stamping of near-end test parameters (STAMP-TEST-NE)

This parameter is specified in the AN MIB and indicates the date/time when the near-end test parameters that can change during showtime were last updated. This date/time-stamp shall include information on the year, month, day, hour, minute and second of the last update.

7.5.1.36.4 Date/time-stamping of far-end test parameters (STAMP-TEST-FE)

This parameter is specified in the AN MIB and indicates the date/time when the far-end test parameters that can change during showtime were last updated. This date/time-stamp shall include information on the year, month, day, hour, minute and second of the last update.

7.5.1.37 On-line reconfiguration time stamps

7.5.1.37.1 Date/time-stamping of last successful downstream on-line reconfiguration operation (STAMP-OLR-ds)

This parameter indicates the date/time of the last successful OLR execution in the downstream direction that has modified the bits or gains. This date/time-stamp shall include information on the year, month, day, hour, minute and second of the last OLR.

7.5.1.37.2 Date/time-stamping of last successful upstream on-line reconfiguration operation (STAMP-OLR-us)

This parameter indicates the date/time of the last successful OLR execution in the upstream direction that has modified the bits or gains. This date/time-stamp shall include information on the year, month, day, hour, minute and second of the last OLR.

7.5.1.38 Retransmission used (RTX_USED)

This parameter specifies whether ITU-T G.998.4 retransmission is used (i.e., active in showtime) in a given transmit direction. The parameter in downstream is RTX_USED_ds, and the parameter in upstream is RTX_USED_us. In [ITU-T G.992.3] and [ITU-T G.992.5] only the downstream parameter RTX_USED_ds is relevant, the value in the upstream direction shall be ignored. In [ITU-T G.993.2], both parameters are relevant.

1: RTX in use

2: RTX not in use, due to RTX_MODE = FORBIDDEN

3: RTX not in use, because it is not supported by the XTU-C

4: RTX not in use, because it is not supported by the XTU-R

5: RTX not in use, because it is not supported by the XTU-C and XTU-R

This parameter shall also be reported in the case of RTX_MODE = RTX_FORCED with INIT FAILURE or with RTX_MODE = RTX_TESTMODE with INIT FAILURE.

NOTE – In the latter case, this parameter will give detailed information on top of the INIT FAILURE reason code.

7.5.1.39 Test parameters for [ITU-T G.993.5]

7.5.1.39.1 Downstream XLIN scale (XLINSCds)

This parameter is the scale factor to be applied to the downstream Xlinpsds values. It is represented as an unsigned integer in the range from 1 to $2^{16} – 1$.

7.5.1.39.2 Downstream XLIN subcarrier group size (XLINGds)

This parameter is the number of subcarriers per group used to report Xlinpsds. The valid values are 1, 2, 4, 8, 16, 32, and 64. XLINGds should equal the sub-sampling factor used to estimate the crosstalk channel for cancellation. This value may be different from *F_sub* (see [ITU-TG.993.5] for the definition of *F_sub*).

7.5.1.39.3 Downstream XLIN bandedges (XLINBANDSds)

XLINBANDSds contains pairs of (start_subcarrier_index, stop_subcarrier_index) for every band in which XLINpsds is reported.

7.5.1.39.4 Downstream far-end crosstalk coupling (XLINpsds)

For each given VCE port index k, this parameter is a one-dimensional array of complex values in linear scale for downstream FEXT coupling coefficients Xlinds(f) originating from the loop connected to the VCE port k into the loop for which Xlinds(f) is being reported. Each array entry represents the Xlinds($f = n \times \Delta f$) value for a particular subcarrier index n. The Xlinds($f = n \times \Delta f$) value is represented as ((XLINSCds/2^{15}) × (($a(n) + j \times b(n)$)/2^{15})), where $a(n)$ and $b(n)$ are signed integers in the ($-2^{15} + 1$) to ($+2^{15} - 1$) range. A special value indicates that no measurement could be done from line k into this line for subcarrier n. Another special value indicates that there is no phase information and the magnitude of Xlinds($f = n \times \Delta f$) is ((XLINSCds/2^{15}) × ($a(n)$/2^{15})).

The format of XLINpsds is defined in [ITU-T G.993.5].

7.5.1.39.5 Upstream XLIN scale (XLINSCus)

This parameter is the scale factor to be applied to the upstream Xlinpsus values. It is represented as an unsigned integer in the range from 1 to $2^{16} - 1$.

7.5.1.39.6 Upstream XLIN subcarrier group size (XLINGus)

This parameter is the number of subcarriers per group used to report Xlinpsus. The valid values are 1, 2, 4, 8, 16, 32, and 64.

7.5.1.39.7 Upstream XLIN bandedges (XLINBANDSus)

XLINBANDSus contains pairs of (start_subcarrier_index, stop_subcarrier_index) for every band in which XLINpsus is reported.

7.5.1.39.8 Upstream far-end crosstalk coupling (XLINpsus)

For each given VCE port index k, this parameter is a one-dimensional array of complex values in linear scale for upstream FEXT coupling coefficients Xlinus(f) originating from the loop connected to the VCE port k into the loop for which Xlinus(f) is being reported. Each array entry represents the Xlinus($f = n \times \Delta f$) value for a particular subcarrier index n. The Xlinus($f = n \times \Delta f$) value is represented as ((XLINSCus/2^{15}) × (($a(n) + j \times b(n)$)/2^{15})), where $a(n)$ and $b(n)$ are signed integers in the ($-2^{15} + 1$) to ($+2^{15} - 1$) range. A special value indicates that no measurement could be done from line k into this line for subcarrier n. Another special value indicates that there is no phase information and the magnitude of Xlinus($f = n \times \Delta f$) is ((XLINSCus/2^{15}) × ($a(n)$/2^{15})).

The format of XLINpsus is defined in [ITU-T G.993.5].

7.5.1.40 Actual re-initialization policy (ACT RIPOLICY)

7.5.1.40.1 Actual downstream re-initialization policy (ACTRIPOLICYds)

This parameter indicates the actual RIPOLICY in use in the downstream direction.

A value of 0 indicates the line is operating in RIPOLICYds 0, a value of 1 indicates the line is operating in RIPOLICYds 1.

7.5.1.40.2 Actual upstream re-initialization policy (ACTRIPOLICYus)

This parameter indicates the actual RIPOLICY in use in the upstream direction.

A value of 0 indicates the line is operating in RIPOLICYus 0, a value of 1 indicates the line is operating in RIPOLICYus 1.

7.5.1.41 Attainable net data rate diagnostic parameters

7.5.1.41.1 Attainable net data rate actual method (ATTNDR_ACTMETHOD)

This parameter indicates the actual ATTNDR method used for calculation of the ATTNDR in the downstream and upstream direction.

The valid values are identical to the values of the line configuration parameter ATTNDR_METHOD.

7.5.1.41.2 Attainable net data rate downstream actual impulse noise protection (ATTNDR_ACTINPds)

If retransmission is not used in the downstream direction, this parameter indicates the actual INP used in the improved calculation of the ATTNDR in the downstream direction.

If retransmission is used in the downstream direction, this parameter indicates the actual INP against SHINE used in the improved calculation of the ATTNDR in the downstream direction.

The format and valid values are identical to the values of the channel status parameter ACTINP.

7.5.1.41.3 Attainable net data rate upstream actual impulse noise protection (ATTNDR_ACTINPus)

If retransmission is not used in the upstream direction, this parameter indicates the actual INP used in the improved calculation of the ATTNDR in the upstream direction.

If retransmission is used in the upstream direction, this parameter indicates the actual INP against SHINE used in the improved calculation of the ATTNDR in the upstream direction.

The format and valid values are identical to the values of the channel status parameter ACTINP.

7.5.1.41.4 Attainable net data rate downstream actual impulse noise protection against repetitive electrical impulse noise (ATTNDR_ACTINP_REINds)

If retransmission is used in the downstream direction, this parameter reports the actual INP against REIN used in the improved calculation of the ATTNDR in the downstream direction.

The format and valid values are identical to the values of the channel status parameter ACTINP_REIN.

7.5.1.41.5 Attainable net data rate upstream actual impulse noise protection against repetitive electrical impulse noise (ATTNDR_ACTINP_REINus)

If retransmission is used in the upstream direction, this parameter reports the actual INP against REIN used in the improved calculation of the ATTNDR in the upstream direction.

The format and valid values are identical to the values of the channel status parameter ACTINP_REIN.

7.5.1.41.6 Attainable net data rate downstream actual delay (ATTNDR_ACTDELAYds)

This parameter indicates the actual delay used in the improved calculation of the ATTNDR in the downstream direction.

The value is coded in with a granularity of 0.1 ms. The range is from 0 ms to 25.4 ms. A special value indicates an actual delay higher than 25.4 ms.

7.5.1.41.7 Attainable net data rate upstream actual delay (ATTNDR_ACTDELAYus)

This parameter indicates the actual delay used in the improved calculation of the ATTNDR in the upstream direction.

The value is coded in with a granularity of 0.1 ms. The range is from 0 ms to 25.4 ms. A special value indicates an actual delay higher than 25.4 ms.

7.5.1.42 Aggregate achievable net data rate

7.5.1.42.1 Near-end aggregate achievable net data rate (AGGACHNDR_NE)

This parameter reports the aggregate achievable net data rate of the VTU-O as specified in [ITU-T G.998.4]. The value is coded in steps of 1 000 bit/s. A special value indicates that the aggregate achievable net data rate value is reported as being undefined.

7.5.1.42.2 Far-end aggregate achievable net data rate (AGGACHNDR_FE)

This parameter reports the aggregate achievable net data rate of the VTU-R as specified in [ITU-T G.998.4]. The value is coded in steps of 1 000 bit/s. A special value indicates that the aggregate achievable net data rate value is reported as being undefined.

7.5.1.43 Line status parameters for G.993.5

7.5.1.43.1 Actual vectoring mode (ACTVECTORMODE)

This parameter reports the vectoring initialization type of the line.

If ACTVECTORMODE equals 0, the line is initialized in a mode different from that of Annex X or Annex Y of [ITU-T G.993.2].

If ACTVECTORMODE equals 1, the line is initialized in Annex X of [ITU-T G.993.2].

If ACTVECTORMODE equals 2, the line is initialized in Annex Y of [ITU-T G.993.2].

If ACTVECTORMODE equals 3, the line is initialized in [ITU-T G.993.5].

7.5.1.44 Line status parameter for VDSL2-LR

7.5.1.44.1 VDSL2-LR actual operation type (VDSL2-LR_ACTOPTYPE)

This parameter reports the actual operation type of VDSL2-LR.

If VDSL2-LR_ACTOPTTYPE equals 0, the line does not operate in VDSL2-LR mode.

If VDSL2-LR_ACTOPTYPE equals 1, the line operates according to the short loop operation type of VDSL2-LR.

If VDSL2-LR_ACTOPTYPE equals 2, the line operates according to the medium loop operation type of VDSL2-LR.

If VDSL2-LR_ACTOPTYPE equals 3, the line operates according to the long loop operation type of VDSL2-LR.

For detailed specification of this parameter, see clause B.10.2.1 of [ITU-T G.993.5].

7.5.1.45 Line status parameter for STRONGFEXT MODE

7.5.1.45.1 Actual STRONGFEXT mode (STRONGFEXT_ACTMODE)

This parameter reports the use of STRONGFEXT mode.

If STRONGFEXT_ACTMODE equals 0, the line is not initialized with operation according to [ITU-T G.993.5] Annex A.

If STRONGFEXT_ACTMODE equals 1, the line is initialized with operation according to [ITU-T G.993.5] Annex A.

7.5.1.46 Loop diagnostics mode status

The LDS parameter reports the status of the loop diagnostics mode procedures.

The parameter is of type enumeration, with the following valid values:

– inactive: the loop diagnostics mode procedures are inhibited, failed or successfully completed;

– loop-diagnostics-ongoing: the loop diagnostics mode procedures are ongoing.

Upon the near-end xTU being forced to perform the loop diagnostic mode procedures, LDS shall become "loop-diagnostics-ongoing".

Upon failure or successful completion of the loop diagnostics mode procedures, LDS shall become "inactive" and the AN/data processing unit (DPU) ME shall send a notification to the NMS.

7.5.1.47 Loop diagnostics mode results status

The loop diagnostics mode results status (LDR) parameter reports the status of the loop diagnostics mode results.

The parameter is of type enumeration, with the following valid values:

– no-loop-diagnostics-results-available: no measurement results are available when no loop diagnostics mode procedures has been performed yet or after loop diagnostics mode results have been deleted;

– loop-diagnostics-failed-results-invalid: loop diagnostics mode results are invalid after the most recent loop diagnostics mode procedures failed;

– loop-diagnostics-succeeded-results-valid: loop diagnostics mode results are valid after the most recent loop diagnostics mode procedures succeeded.

7.5.2 Channel status parameters

7.5.2.1 Actual data rate

If retransmission is not used in a given transmit direction:

– in the L0 state, this parameter reports the actual net data rate at which the bearer channel is operating at;

– in the L1 or L2 states, the parameter contains the net data rate in the previous L0 state.

If retransmission is used in a given transmit direction:

– in the L0 state, this parameter reports the ETR (as specified in [ITU-T G.998.4]) at which the bearer channel is operating;

– in the L2 state, the parameter contains the ETR (as specified in [ITU-T G.998.4]) in the previous L0 state.

The data rate is coded in steps of 1 000 bit/s.

This parameter shall be reported with the most recent values when read over the Q-interface.

7.5.2.2 Previous data rate

If retransmission is not used in a given transmit direction, this parameter reports the previous net data rate the bearer channel was operating at just before the latest net data rate change event occurred, excluding all transitions between L0 state and L1 or L2 states.

If retransmission is used in a given transmit direction, this parameter reports the previous ETR (as specified in [ITU-T G.998.4]) the bearer channel was operating at just before the latest ETR change event occurred, excluding all transitions between L0 state and L1 or L2 states.

A rate change can occur at a power management state transition, e.g., at full or short initialization, fast retrain or power down or at a dynamic rate adaptation. The rate is coded in steps of 1 000 bit/s.

7.5.2.3 Actual delay

If retransmission is not used in a given transmit direction, this parameter is the actual one-way interleaving delay introduced by the PMS-TC between the α and β reference points excluding delay in the L1 and L2 state. In the L1 and L2 state, the parameter contains the interleaving delay in the previous L0 state. For ADSL, this parameter is derived from the *S* and *D* parameters as $\lceil S \times D \rceil /4$ ms, where *S* is the symbols per codeword, and *D* is the interleaving depth and the ceiling brackets $\lceil \ldots \rceil$ denote rounding to the higher integer. For [ITU-T G.993.2], this parameter shall be computed according to the formula in clause 9.7 of [ITU-T G.993.2].

If retransmission is used in a given transmit direction, this parameter specifies the actual value of the time-independent component of the delay due to retransmission only (see [ITU-T G.998.4] for detailed specification).

The actual delay is coded in milliseconds (rounded to the nearest millisecond).

7.5.2.4 Actual impulse noise protection (ACTINP)

If retransmission is not used in a given transmit direction, this parameter reports the actual INP on the bearer channel in the L0 state. In the L1 or L2 state, the parameter contains the INP in the previous L0 state.

For [ITU-T G.992.1], this value is computed according to the formula specified in this Recommendation based on the actual framing parameters. For [ITU-T G.992.3] and [ITU-T G.992.5], this value is estimated by the xTU receiver. It is identical to the INP_act_n for the corresponding bearer channel as defined in these Recommendations (clauses K.1.7, K.2.7 and K.3.7 of [ITU-T G.992.3]). For [ITU-T G.993.2], the method of reporting this value is according to the INPREPORT parameter.

The value is coded in fractions of DMT symbols with a granularity of 0.1 symbols. The range is from 0 to 25.4. A special value indicates an ACTINP higher than 25.4.

If retransmission is used in a given transmit direction, this parameter reports the actual INP against SHINE (under specific conditions detailed in [ITU-T G.998.4]) on the bearer channel in the L0 state. In the L2 state, the parameter contains the INP in the previous L0 state.

The value is coded in fractions of DMT symbols with a granularity of 0.1 symbols.

The range is from 0 to 204.6. A special value indicates an ACTINP of 204.7 or higher.

7.5.2.4.1 Special requirements for [ITU-T G.992.1]

For [ITU-T G.992.1], the reporting of ACTINP is optional. If reported, the ACTINP value of a bearer mapped in the interleaved path shall be computed by the formula:

$$\text{ACTINP} = \left(\frac{1}{2}\right) \times \left(S \times D\right) \times \left(\frac{R_I}{N_I}\right)$$

where *S*, *D*, R_I and N_I are defined in [ITU-T G.992.1]. The ACTINP value of a bearer mapped in the fast path shall be 0.

7.5.2.5 Impulse noise protection reporting mode (INPREPORT)

This parameter reports the method used to compute the ACTINP. If set to 0, the ACTINP is computed according to the INP_no_erasure formula (see clause 9.6 of [ITU-T G.993.2]). If set to 1, the ACTINP is the value estimated by the xTU receiver.

7.5.2.6 Actual framer settings

7.5.2.6.1 Actual size of Reed-Solomon codeword (NFEC)

This parameter reports the actual Reed-Solomon codeword size used in the latency path in which the bearer channel is transported. The value is coded in bytes. It ranges from 0 to 255.

7.5.2.6.2 Actual number of Reed-Solomon redundancy bytes (RFEC)

This parameter reports the actual number of Reed-Solomon redundancy bytes per codeword used in the latency path in which the bearer channel is transported. The value is coded in bytes. It ranges from 0 to 16. The value 0 indicates no Reed-Solomon coding.

7.5.2.6.3 Actual number of bits per symbol (LSYMB)

This parameter reports the actual number of bits per symbol assigned to the latency path in which the bearer channel is transported. This value does not include trellis overhead. The value is coded in bits. The range of valid values is from 0 to 131071.

7.5.2.6.4 Actual interleaving depth (INTLVDEPTH)

This parameter reports the actual depth of the interleaver used in the latency path in which the bearer channel is transported. The value ranges from 1 to 4 096 in steps of 1. The value 1 indicates no interleaving.

7.5.2.6.5 Actual interleaving block length (INTLVBLOCK)

This parameter reports the actual block length of the interleaver used in the latency path in which the bearer channel is transported. The value ranges from 4 to 255 in steps of 1.

7.5.2.6.6 Actual number of Reed-Solomon codewords per data transfer unit (RSPERDTU)

This parameter reports the actual number of Reed-Solomon codewords per DTU used in the latency path in which the bearer channel is transported. The value ranges from 1 to 64 in steps of 1.

7.5.2.7 Actual latency path (LPATH)

This parameter reports the index of the actual latency path in which the bearer is transported. The valid values are 0, 1, 2, 3. For [ITU-T G.992.1], the FAST path shall be mapped to the latency index 0, and the INTERLEAVED path shall be mapped to the latency index 1.

7.5.2.8 Actual net data rate (ACTNDR)

Independent whether retransmission is used or not in a given transmit direction:

– in the L0 state, this parameter reports the net data rate (as specified in [ITU-T G.992.3], [ITU-T G.992.5] or [ITU-T G.993.2]) at which the bearer channel is operating;

– in the L2 state, the parameter contains the net data rate (as specified in [ITU-T G.992.3], [ITU-T G.992.5] or [ITU-T G.993.2]) in the previous L0 state.

The data rate is coded in steps of 1 000 bit/s.

This parameter shall be reported with the most recent values when read over the Q-interface.

This parameter is optional if [ITU-T G.998.4] is not supported.

7.5.2.9 Actual impulse noise protection against repetitive electrical impulse noise (ACTINP_REIN)

If retransmission is used in a given transmit direction, this parameter reports the actual INP against REIN (under specific conditions detailed in [ITU-T G.998.4]) on the bearer channel in the L0 state. In the L2 state, the parameter contains the INP in the previous L0 state.

The value is coded in fractions of DMT symbols with a granularity of 0.1 symbols.

The range is from 0 to 25.4. A special value indicates an ACTINP_REIN of 25.5 or higher.

7.5.3 Data gathering line test, diagnostic and status parameters

7.5.3.1 Logging depth – VTU-O (LOGGING_DEPTH_O)

This parameter is the maximum depth of the entire data gathering event buffer at the VTU-O, in number of 6-byte data gathering records.

7.5.3.2 Logging depth – VTU-R (LOGGING_DEPTH_R)

This parameter is the maximum depth of the entire data gathering event buffer at the VTU-R, in number of 6-byte data gathering records.

7.5.3.3 Actual logging depth for reporting – VTU-O (ACT_logging_depth_reporting_O)

This parameter is actual logging depth that is used for reporting the VTU-O event trace buffer in the CO-MIB, in number of 6-byte data gathering records.

7.5.3.4 Actual logging depth for reporting – VTU-R (ACT_logging_depth_reporting_R)

This parameter is actual logging depth that is used for reporting the VTU-R event trace buffer over the eoc channel, in number of 6-byte data gathering records.

7.5.3.5 Event trace buffer – VTU-O (EVENT_TRACE_BUFFER_O)

This parameter is the event trace buffer containing the event records that originated at the VTU-O.

7.5.3.6 Event trace buffer – VTU-R (EVENT_TRACE_BUFFER_R)

This parameter is the event trace buffer containing the event records that originated at the VTU-R.

7.6 Network management elements partitioning

This clause specifies the network management elements which correspond to the specific management interfaces.

Q-interface: Management interface towards the xTU-C, from the network side perspective. The xTU-C provides its near-end (at xTU-C) and far-end (at xTU-R) parameters for the system operator to read and write

U-C-interface: Management interface towards the xTU-C, from the xTU-R perspective. The xTU-C provides its near-end parameters (xTU-R far-end) for the xTU-R to read

U-R-interface: Management interface towards the xTU-R, from the xTU-C perspective. The xTU-R provides its near-end parameters (xTU-C far-end) for the xTU-C to read

T/S-interface: Management interface towards the xTU-R, from the premises side perspective. The xTU-R provides its near-end (at xTU-R) and far-end (at xTU-C) parameters for the subscriber to read and write

G-interface: Management interface towards the xTU-R, from the NMS perspective. The xTU-R provides its near-end (at xTU-R) and far-end (at xTU-C) parameters for the NMS to read

The U-C and U-R management interfaces represent the network management elements to be supported through the OAM communications channel specified in this Recommendation (see clause 6). The exchange between the xTU-C and xTU-R of some or all of these network management elements may already be obtained by the EOC commands defined in the respective Recommendations.

The parameters at the management interfaces are described in two categories. Each category is presented by two tables. The first table (e.g., Table 7-10 for line failures) indicates the status of the parameter at the corresponding management interface as:

- R: read only
- W: write only
- R/W: read and write
- (M): mandatory
- (O): optional

If the status of the parameter over the G-interface is not explicitly stated, it is identical to the status of the same parameter over the T/S-interface.

NOTE – Some management elements are useful only when optional features of the physical layer Recommendation are supported by the xTUs.

The far-end fault and PM over the Q-interface is equivalent to the near-end fault and PM over the T/S-interface. The near-end fault and PM over the Q-interface is equivalent to the far-end fault and PM over the T/S-interface. Over the Q-interface, near-end fault and PM applies to the upstream direction only and far-end PM applies to the downstream direction only. Over the T/S-interface, near-end fault and PM applies to the downstream direction only and far-end PM applies to the upstream direction only.

The second table for each category (e.g., Table 7-11 for line failures) indicates for which Recommendations the management element is relevant. A "Y" in a column means that this MIB element is relevant for the specified Recommendation over at least one of the interfaces. The column labelled with [ITU-T G.998.4] indicates the MIB elements that are relevant in addition to those relevant to the xDSL Recommendation associated with [ITU-T G.998.4].

Table 7-10 – Line failures

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Near-end (xTU-C) failures					
Loss of signal (LOS)	7.1.1.1.1	R (M)	R (O)		R (O)
Loss of frame (LOF)	7.1.1.1.2	R (M)	R (O)		R (O)
Loss of power (LPR)	7.1.1.1.3	R (M)	R (O)		R (O)
Loss of margin (LOM)	7.1.1.1.4	R (M)	R (O)		R (O)
Far-end (xTU-R) failures					
Loss of signal (LOS-FE) failure	7.1.1.2.1	R (M)		R (O)	R (O)
Loss of frame (LOF-FE) failure	7.1.1.2.2	R (M)		R (O)	R (O)
Loss of power (LPR-FE) failure	7.1.1.2.3	R (M)		R (O)	R (O)
Loss of margin (LOM-FE) failure	7.1.1.2.4	R (M)		R (O)	R (O)
Initialization failures					
Line init (LINIT) failure	7.1.1.3	R (M)			R (O)

Table 7-11 – Support of line failures per Recommendation

Category/ element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]
Near-end failures						
Loss of signal (LOS)	Y	Y	Y	Y	Y	Y
Loss of frame (LOF)	Y	Y	Y	Y	Y	Y
Loss of power (LPR)	Y	Y	Y	Y	Y	Y
Loss of margin (LOM)	Y	Y	Y	Y	Y	Y
Far-end failures						
Loss of signal (LOS-FE) failure	Y	Y	Y	Y	Y	Y
Loss of frame (LOF-FE) failure	Y	Y	Y	Y	Y	Y
Loss of power (LPR-FE) failure	Y	Y	Y	Y	Y	Y
Loss of margin (LOM-FE) failure	Y	Y	Y	Y	Y	Y
Initialization failures						
Line init (LINIT) failure	Y	Y	Y	Y	Y	Y

Table 7-12 – Asynchronous transfer mode data path failures

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Near-end (xTU-C) failures					
No cell delineation (NCD) failure	7.1.4.1.1	R (M)	R (O)		
Loss of cell delineation (LCD) failure	7.1.4.1.2	R (M)	R (O)		
Far-end (xTU-R) failures					
No cell delineation (NCD-FE) failure	7.1.4.2.1	R (M)		R (O)	
Loss of cell delineation (LCD-FE) failure	7.1.4.2.2	R (M)		R (O)	

Table 7-13 – Support of Asynchronous transfer mode data path failures per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]
Near-end failures						
No cell delineation (NCD) failure	Y	Y	Y	Y	Y	Y
Loss of cell delineation (LCD) failure	Y	Y	Y	Y	Y	Y
Far-end failures						
No cell delineation (NCD-FE) failure	Y	Y	Y	Y	Y	Y
Loss of cell delineation (LCD-FE) failure	Y	Y	Y	Y	Y	Y

Table 7-14 – Line configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Line/xTU state					
xTU transmission system enabling (XTSE)	7.3.1.1.1	R/W (M)			R (O)
ATU impedance state forced (AISF)	7.3.1.1.2				R/W (M)
Power management state forced (PMSF)	7.3.1.1.3	R/W (M)			R/W (M)
Power management state enabling (PMMode)	7.3.1.1.4	R/W (M)			
L0-TIME	7.3.1.1.5	R/W (M)	R (O)		
L2-TIME	7.3.1.1.6	R/W (M)	R (O)		
L2-ATPR	7.3.1.1.7	R/W (M)	R (O)		
L2-ATPRT	7.3.1.1.9	R/W (M)	R (O)		
Loop diagnostic mode forced (LDSF)	7.3.1.1.8	R/W (M)			R/W (M)
Automode cold start forced	7.3.1.1.10	R/W (M)			R/W (O)
VDSL2 profiles enabling (PROFILES)	7.3.1.1.11	R/W (M)			R (O)
RIPOLICYds	7.3.1.1.12.1	R/W (O)	R(O)		
RIPOLICYus	7.3.1.1.12.2	R/W (O)			
REINIT_TIME_THRESHOLDds	7.3.1.1.13.1	R/W (O)	R(O)		
REINIT_TIME_THRESHOLDus	7.3.1.1.13.2	R/W (O)			
Power and spectrum usage					
MAXNOMPSD ds	7.3.1.2.1	R/W (M)	R (O)		
MAXNOMPSD us	7.3.1.2.2	R/W (M)	R (O)		
MAXNOMATP ds	7.3.1.2.3	R/W (M)	R (O)		
MAXNOMATP us	7.3.1.2.4	R/W (M)	R (O)		
MAXRXPWR us	7.3.1.2.5	R/W (M)	R (O)		
CARMASK ds	7.3.1.2.6	R/W (M)	R (O)		
CARMASK us	7.3.1.2.7	R/W (M)	R (O)		
VDSL2-CARMASK	7.3.1.2.8	R/W (M)	R (O)		
PSDMASK ds	7.3.1.2.9	R/W (M)	R (O)		
RFIBANDS	7.3.1.2.10	R/W (M)	R (O)		
Upstream PSD mask selection	7.3.1.2.11	R/W (M)	R (O)		
PSDMASK us	7.3.1.2.12	R/W (M)	R (O)		
DPBOSHAPED	7.3.1.2.13	R/W (M)	R (O)		
UPBOSHAPED (UPBOPSD-pb, UPBOKL, UPBOKLF)	7.3.1.2.14	R/W (M)	R (O)		
UPBOSHAPED (UPBOKLREF-pb)	7.3.1.2.14	R/W (O)	R (O)		
UPBOSHAPED (AELE-MODE, UPBOELMT)	7.3.1.2.14	R/W (O)	R(O)		
VDSL2 PSD mask class selection (CLASSMASK)	7.3.1.2.15	R/W (M)			
VDSL2 limit PSD masks and band plans enabling (LIMITMASK)	7.3.1.2.16	R/W (M)			R (O)
VDSL2 US0 disabling (US0DISABLE)	7.3.1.2.17	R/W (M)			
VDSL2 US0 PSD masks (US0MASK)	7.3.1.2.18	R/W (M)			R (O)
Noise margins					
TARSNRM ds	7.3.1.3.1	R/W (M)	R (O)		

Table 7-14 – Line configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
TARSNRM us	7.3.1.3.2	R/W (M)	R (O)		
MAXSNRM ds	7.3.1.3.3	R/W (M)	R (O)		
MAXSNRM us	7.3.1.3.4	R/W (M)	R (O)		
MINSNRM ds	7.3.1.3.5	R/W (M)	R (O)		
MINSNRM us	7.3.1.3.6	R/W (M)	R (O)		
Rate adaptation					
RA-MODE ds	7.3.1.4.1	R/W (M)	R (O)		
RA-MODE us	7.3.1.4.2	R/W (M)	R (O)		
RA-USNRM ds	7.3.1.4.3	R/W (O)	R (O)		
RA-USNRM us	7.3.1.4.4	R/W (O)	R (O)		
RA-UTIME ds	7.3.1.4.5	R/W (O)	R (O)		
RA-UTIME us	7.3.1.4.6	R/W (O)	R (O)		
RA-DSNRM ds	7.3.1.4.7	R/W (O)	R (O)		
RA-DSNRM us	7.3.1.4.8	R/W (O)	R (O)		
RA-DTIME ds	7.3.1.4.9	R/W (O)	R (O)		
RA-DTIME us	7.3.1.4.10	R/W (O)	R (O)		
Overhead					
MSGMIN us	7.3.1.5.1	R/W (O)	R (O)		
MSGMIN ds	7.3.1.5.2	R/W (O)	R (O)		
Cyclic extension					
CEFLAG	7.3.1.6.1	R/W (M)	R (O)		
Transmitter referred virtual noise					
SNRMODEds	7.3.1.7.1	R/W (M)	R (O)		R (M)
SNRMODEus	7.3.1.7.2	R/W (M)	R (O)		
VNds	7.3.1.7.3	R/W (O)	R (O)		R (M)
FEXT TXREFVNds	7.3.1.7.3.1	R/W (O)	R (O)		R (M)
NEXT TXREFVNds	7.3.1.7.3.2	R/W (O)	R (O)		R (M)
VNus	7.3.1.7.4	R/W (O)	R (O)		R (M)
RXREFVNSFus	7.3.1.7.5	R/W (O)			
TXREFVNSFds	7.3.1.7.6	R/W (O)			
Near-end (xTU-C) performance monitoring thresholds (15 min interval)					
FECS-L threshold 15 min	7.3.1.8	R/W (O)	R (O)		
ES-L threshold 15 min	7.3.1.8	R/W (M)	R (O)		
SES-L threshold 15 min	7.3.1.8	R/W (M)	R (O)		
LOSS-L threshold 15 min	7.3.1.8	R/W (O)	R (O)		
UAS-L threshold 15 min	7.3.1.8	R/W (M)	R (O)		
"leftr" defect seconds threshold 15 min	7.3.1.8	R/W (M)			
Near-end (xTU-C) performance monitoring thresholds (24 h interval)					
FECS-L threshold 24 h	7.3.1.8	R/W (O)	R (O)		
ES-L threshold 24 h	7.3.1.8	R/W (M)	R (O)		
SES-L threshold 24 h	7.3.1.8	R/W (M)	R (O)		

Table 7-14 – Line configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
LOSS-L threshold 24 h	7.3.1.8	R/W (O)	R (O)		
UAS-L threshold 24 h	7.3.1.8	R/W (M)	R (O)		
"leftr" defect seconds threshold 24 h	7.3.1.8	R/W (M)			
Far-end (xTU-R) performance monitoring thresholds (15 min interval)					
FECS-LFE threshold 15 min	7.3.1.8	R/W (O)	R (O)		
ES-LFE threshold 15 min	7.3.1.8	R/W (M)	R (O)		
SES-LFE threshold 15 min	7.3.1.8	R/W (M)	R (O)		
LOSS-LFE threshold 15 min	7.3.1.8	R/W (O)	R (O)		
UAS-LFE threshold 15 min	7.3.1.8	R/W (M)	R (O)		
"leftr" defect seconds threshold 15 min	7.3.1.8	R/W (M)			
Far-end (xTU-R) performance monitoring thresholds (24 h interval)					
FECS-LFE threshold 24 h	7.3.1.8	R/W (O)	R (O)		
ES-LFE threshold 24 h	7.3.1.8	R/W (M)	R (O)		
SES-LFE threshold 24 h	7.3.1.8	R/W (M)	R (O)		
LOSS-LFE threshold 24 h	7.3.1.8	R/W (O)	R (O)		
UAS-LFE threshold 24 h	7.3.1.8	R/W (M)	R (O)		
"leftr" defect seconds threshold 24 h	7.3.1.8	R/W (M)			
Initialization performance monitoring thresholds (15 min interval)					
Full inits threshold 15 min	7.3.1.8	R (M)	R (O)		
Failed full inits threshold 15 min	7.3.1.8	R (M)	R (O)		
Short inits threshold 15 min	7.3.1.8	R (O)	R (O)		
Failed short inits threshold 15 min	7.3.1.8	R (O)	R (O)		
Initialization performance monitoring thresholds (24 h interval)					
Full inits threshold 24 h	7.3.1.8	R (M)	R (O)		
Failed full inits threshold 24 h	7.3.1.8	R (M)	R (O)		
Short inits threshold 24 h	7.3.1.8	R (O)	R (O)		
Failed short inits threshold 24 h	7.3.1.8	R (O)	R (O)		
Short interruption performance monitoring thresholds (24 h interval)					
SPONT_INTRPT threshold 24 h	7.3.1.8	R(O)	R(O)		
INM configuration parameters					
INMIATOds	7.3.1.9.1	R/W (O)		R/W (O)	R (O)
INMIATOus	7.3.1.9.1	R/W (O)			
INMIATSds	7.3.1.9.2	R/W (O)		R/W (O)	R (O)
INMIATSus	7.3.1.9.2	R/W (O)			
INMCCds	7.3.1.9.3	R/W (O)		R/W (O)	R (O)
INMCCus	7.3.1.9.3	R/W (O)			
INM_INPEQ_MODEds	7.3.1.9.4	R/W (O)		R/W (O)	R (O)
INM_INPEQ_MODEus	7.3.1.9.4	R/W (O)			
INM_INPEQ_FORMATds	7.3.1.9.5	R/W (O)			
INM_INPEQ_FORMATus	7.3.1.9.5	R/W (O)			
INM_ENABLE	7.3.1.9.6	R/W (O)			

Table 7-14 – Line configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
SOS configuration parameters					
SOS-TIME-ds	7.3.1.10.1	R/W (O)	R (O)		
SOS-TIME-us	7.3.1.10.2	R/W (O)			
SOS-NTONES-ds	7.3.1.10.3	R/W (O)	R (O)		
SOS-NTONES-us	7.3.1.10.4	R/W (O)			
SOS-CRC-ds	7.3.1.10.5	R/W (O)	R (O)		
SOS-CRC-us	7.3.1.10.6	R/W (O)			
MAX-SOS-ds	7.3.1.10.7	R/W (O)	R (O)		
MAX-SOS-us	7.3.1.10.8	R/W (O)			
SNRMOFFSET-ROC-ds	7.3.1.10.9	R/W (O)	R (O)		
SNRMOFFSET-ROC-us	7.3.1.10.10	R/W (O)			
INPMIN-ROC-ds	7.3.1.10.11	R/W (O)	R (O)		
INPMIN-ROC-us	7.3.1.10.12	R/W (O)			
Retransmission					
RTX_MODE	7.3.1.11	R/W (M)			
LEFTR_THRESH	7.3.1.12	R/W (M)			
ITU-T G.993.5 specific (Vectoring)					
Vectoring frequency-band control upstream (VECTOR_BAND_CONTROLus)	7.3.1.13.1	R/W (M)			
Vectoring frequency-band control downstream (VECTOR_BAND_CONTROLds)	7.3.1.13.2	R/W (M)			
FEXT cancellation line priorities upstream (FEXT_CANCEL_PRIORITYus)	7.3.1.13.3	R/W (O)			
FEXT cancellation line priorities downstream (FEXT_CANCEL_PRIORITYds)	7.3.1.13.4	R/W (O)			
FEXT cancellation enabling/disabling upstream (FEXT_CANCEL_ENABLEus)	7.3.1.13.5	R/W (M)			
FEXT cancellation enabling/disabling downstream (FEXT_CANCEL_ENABLEds)	7.3.1.13.6	R/W (M)			
XLINGREQds	7.3.1.13.7	R/W(M)			
XLINGREQus	7.3.1.13.8	R/W(M)			
VECTORMODE_ENABLE	7.3.1.13.9	R/W(O)			
MAXDELAYOCTET split					
MDOSPLIT	7.3.1.14	R/W(O)			
ATTNDR configuration parameters					
ATTNDR_METHOD	7.3.1.15.1	R/W(O)			
ATTNDR_MDOSPLIT	7.3.1.15.2	R/W(O)			
VDSL2-LR configuration parameter					
VDSL2-LR_ENABLE	7.3.1.16.1	R/W(M)			
STRONGFEXT MODE configuration parameter					
STRONGFEXT_MODE	7.3.1.17.1	R/W(M)			

Table 7-15 – Support of line configuration parameters per Recommendation

Category/ element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
Line/xTU state								
xTU transmission system enabling (XTSE)	Y	Y	Y	Y	Y	Y		
ATU impedance state forced (AISF)			Y (Annex A)	Y (Annex A)	Y (Annex A)			
Power management state forced (PMSF)	Y	Y	Y	Y	Y	Y		
Power management state enabling (PMMode)	Y	Y	Y	Y	Y	Y		
L0-TIME			Y	Y	Y			
L2-TIME			Y	Y	Y			
L2-ATPR			Y	Y	Y			
L2-ATPRT			Y	Y	Y			
Loop diagnostic mode forced (LDSF)			Y	Y	Y	Y		
Automode cold start forced			Y	Y	Y	Y		
VDSL2 profiles enabling (PROFILES)						Y		
RIPOLICYds						Y		
RIPOLICYus						Y		
REINIT_TIME_THRESH OLDds						Y		
REINIT_TIME_THRESH OLDus						Y		
Power and spectrum usage								
MAXNOMPSD ds			Y	Y	Y	Y (Note 5)		Y (Note 4)
MAXNOMPSD us			Y	Y	Y	Y (Note 5)		Y (Note 4)
MAXNOMATP ds			Y	Y	Y	Y		
MAXNOMATP us			Y	Y	Y			
MAXRXPWR us			Y	Y	Y			
CARMASK ds			Y	Y	Y			
CARMASK us			Y	Y	Y			
VDSL2-CARMASK						Y		
PSDMASK ds					Y	Y		
RFIBANDS					Y	Y		
Upstream PSD mask selection			Y		Y			
PSDMASK us			Y (Annexes J/M)		Y (Annexes J/M)	Y		
DPBOSHAPED					Y	Y		
UPBOSHAPED (UPBOPSD-pb, UPBOKL, UPBOKLF)						Y		
UPBOSHAPED (UPBOKLREF-pb)						Y		

Table 7-15 – Support of line configuration parameters per Recommendation

Category/ element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
UPBOSHAPED (AELE-MODE, UPBOELMT)						Y		
VDSL2 PSD mask class selection (CLASSMASK)						Y		
VDSL2 limit PSD masks and band plans enabling (LIMITMASK)						Y		
VDSL2 US0 disabling (US0DISABLE)						Y		
VDSL2 US0 masks enabling (US0MASK)						Y (Annex A)		
Noise margins								
TARSNRM ds	Y	Y	Y	Y	Y	Y		
TARSNRM us	Y	Y	Y	Y	Y	Y		
MAXSNRM ds	Y	Y	Y	Y	Y	Y		
MAXSNRM us	Y	Y	Y	Y	Y	Y		
MINSNRM ds	Y	Y	Y	Y	Y	Y		
MINSNRM us	Y	Y	Y	Y	Y	Y		
Rate adaptation								
RA-MODE ds		Y	Y	Y	Y	Y		
RA-MODE us		Y	Y	Y	Y	Y		
RA-USNRM ds		Y	Y	Y	Y	Y		
RA-USNRM us		Y	Y	Y	Y	Y		
RA-UTIME ds		Y	Y	Y	Y	Y		
RA-UTIME us		Y	Y	Y	Y	Y		
RA-DSNRM ds		Y	Y	Y	Y	Y		
RA-DSNRM us		Y	Y	Y	Y	Y		
RA-DTIME ds		Y	Y	Y	Y	Y		
RA-DTIME us		Y	Y	Y	Y	Y		
Overhead								
MSGMIN us			Y	Y	Y	Y		
MSGMIN ds			Y	Y	Y	Y		
Cyclic extension								
CEFLAG						Y		
Transmitter referred virtual noise								
SNRMODEds			Y		Y	Y		
SNRMODEus			Y		Y	Y		
VNds			Y		Y	Y		
FEXT TXREFVNds			Y		Y			
NEXT TXREFVNds			Y		Y			
VNus			Y (Note 1)		Y (Note 1)	Y (Note 1)		
RXREFVNSFus						Y		
TXREFVNSFds						Y		

Table 7-15 – Support of line configuration parameters per Recommendation

Category/ element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
Near-end performance monitoring thresholds (15 min interval)								
FECS-L threshold 15 min	Y	Y	Y	Y	Y	Y		
ES-L threshold 15 min	Y	Y	Y	Y	Y	Y		
SES-L threshold 15 min	Y	Y	Y	Y	Y	Y		
LOSS-L threshold 15 min	Y	Y	Y	Y	Y	Y		
UAS-L threshold 15 min	Y	Y	Y	Y	Y	Y		
"leftr" defect seconds threshold 15 min							Y	
Near-end performance monitoring thresholds (24 h interval)								
FECS-L threshold 24 h	Y	Y	Y	Y	Y	Y		
ES-L threshold 24 h	Y	Y	Y	Y	Y	Y		
SES-L threshold 24 h	Y	Y	Y	Y	Y	Y		
LOSS-L threshold 24 h	Y	Y	Y	Y	Y	Y		
UAS-L threshold 24 h	Y	Y	Y	Y	Y	Y		
"leftr" defect seconds threshold 24 h							Y	
Far-end performance monitoring thresholds (15 min interval)								
FECS-LFE threshold 15 min	Y	Y	Y	Y	Y	Y		
ES-LFE threshold 15 min	Y	Y	Y	Y	Y	Y		
SES-LFE threshold 15 min	Y	Y	Y	Y	Y	Y		
LOSS-LFE threshold 15 min	Y	Y	Y	Y	Y	Y		
UAS-LFE threshold 15 min	Y	Y	Y	Y	Y	Y		
"leftr" defect seconds threshold 15 min							Y	
Far-end performance monitoring thresholds (24 h interval)								
FECS-LFE threshold 24 h	Y	Y	Y	Y	Y	Y		
ES-LFE threshold 24 h	Y	Y	Y	Y	Y	Y		
SES-LFE threshold 24 h	Y	Y	Y	Y	Y	Y		
LOSS-LFE threshold 24 h	Y	Y	Y	Y	Y	Y		
UAS-LFE threshold 24 h	Y	Y	Y	Y	Y	Y		
"leftr" defect seconds threshold 24 h							Y	
Initialization performance monitoring thresholds (15 min interval)								
Full inits threshold 15 min	Y	Y	Y		Y	Y		
Failed full inits threshold 15 min	Y	Y	Y	Y	Y	Y		
Short inits threshold 15 min		Y	Y	Y	Y	Y		
Failed short inits threshold 15 min		Y	Y	Y	Y	Y		
Initialization performance monitoring thresholds (24 h interval)								
Full inits threshold 24 h	Y	Y	Y	Y	Y	Y		
Failed full inits threshold 24 h	Y	Y	Y	Y	Y	Y		
Short inits threshold 24 h		Y	Y	Y	Y	Y		

Table 7-15 – Support of line configuration parameters per Recommendation

Category/ element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
Failed short inits threshold 24 h		Y	Y	Y	Y	Y		
Short interruption performance monitoring thresholds (24 h interval)								
SPONT_INTRPT threshold 24 h						Y		
INM configuration parameters								
INMIATOds			Y		Y	Y		
INMIATOus						Y		
INMIATSds			Y		Y	Y		
INMIATSus						Y		
INMCCds			Y		Y	Y		
INMCCus						Y		
INM_INPEQ_ MODEds			Y		Y	Y		
INM_INPEQ_ MODEus						Y		
INM_INPEQ_FORMATds						Y		
INM_INPEQ_FORMATus						Y		
INM_ENABLE						Y		
SOS configuration parameters								
SOS-TIME-ds						Y		
SOS-TIME-us						Y		
SOS-NTONES-ds						Y		
SOS-NTONES-us						Y		
SOS-CRC-ds						Y		
SOS-CRC-us						Y		
MAX-SOS-ds						Y		
MAX-SOS-us						Y		
SNRMOFFSET-ROC-ds						Y		
SNRMOFFSET-ROC-us						Y		
INPMIN-ROC-ds						Y		
INPMIN-ROC-us						Y		
Retransmission								
RTX_MODE							Y	
LEFTR_THRESH							Y	
ITU-T G.993.5 specific (Vectoring)								
VECTOR_BAND_ CONTROLus								Y
VECTOR_BAND_ CONTROLds								Y
FEXT_CANCEL_ PRIORITYus								Y
FEXT_CANCEL_ PRIORITYds								Y
FEXT_CANCEL_ ENABLEus								Y

Table 7-15 – Support of line configuration parameters per Recommendation

Category/ element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
FEXT_CANCEL_ ENABLEds								Y
XLINGREQds								Y
XLINGREQus								Y
VECTORMODE_ ENABLE						Y (Note 3)		Y
MAXDELAYOCTET split								
MDOSPLIT						Y		
ATTNDR configuration parameters								
ATTNDR_ METHOD						Y		Y (Note 2)
ATTNDR_ MDOSPLIT						Y		Y (Note 2)
VDSL2-LR configuration parameter								
VDSL2-LR_ENABLE						Y (Note 5)		Y (Note 4)
STRONGFEXT MODE configuration parameter								
STRONGFEXT_MODE								Y (Note 6)

NOTE 1 – In SNRM_MODE = 3 or 4 (Receiver referred virtual noise), this parameter is only defined for [ITU-T G.993.2].
NOTE 2 – Those parameters apply only to ITU-T G.998.4 when used in conjunction with ITU-T G.993.2.
NOTE 3 – This parameter applies only when Annex X or Annex Y is supported.
NOTE 4 – This parameter applies only when Annex B is supported.
NOTE 5 – This parameter applies only when Annex D is supported.
NOTE 6 – This parameter applies only when Annex A is supported.

Table 7-16 – Channel configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Data Rate					
Minimum data rate	7.3.2.1.1	R/W (M)	R (O)		
Minimum reserved data rate	7.3.2.1.2	R/W (O)	R (O)		
Maximum data rate	7.3.2.1.3	R/W (M)	R (O)		
Rate adaptation ratio	7.3.2.1.4	R/W (O)	R (O)		
Minimum data rate in low power state	7.3.2.1.5	R/W (M)	R (O)		
MIN-SOS-DR	7.3.2.1.6	R/W (O)	R (O)		
MINETR_RTX	7.3.2.1.8	R/W (M)			
MAXETR_RTX	7.3.2.1.9	R/W (M)			
MAXNDR_RTX	7.3.2.1.10	R/W (M)			
DELAYMAX_RTX	7.3.2.11	R/W (M)			
DELAYMIN_RTX	7.3.2.12	R/W (M)			
INPMIN_SHINE_RTX	7.3.2.13	R/W (M)			
INPMIN8_SHINE_RTX	7.3.2.14	R/W (M)			
SHINERATIO_RTX	7.3.2.15	R/W (M)			

Table 7-16 – Channel configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
INPMIN_REIN_RTX	7.3.2.16	R/W (M)			
INPMIN8_REIN_RTX	7.3.2.17	R/W (M)			
IAT_REIN_RTX	7.3.2.18	R/W (M)			
Maximum interleaving delay	7.3.2.2	R/W (M)	R (O)		
Minimum impulse noise protection (INPMIN)	7.3.2.3	R/W (M/O) (Note 1)	R (O)		
Minimum impulse noise protection 8 kHz (INPMIN8)	7.3.2.4	R/W (M)	R (O)		
FORCEINP	7.3.2.5	R/W (M/O) (Note 2)			
Maximum bit error ratio	7.3.2.6	R/W (M)	R (O)		
Data rate threshold upshift	7.3.2.8.1	R/W (M)			
Data rate threshold downshift	7.3.2.8.2	R/W (M)			
Maximum delay variation (DVMAX)	7.3.2.9	R/W (O)			
Channel initialization policy selection (CIPOLICY)	7.3.2.10	R/W (O)			
Near-end (xTU-C) performance monitoring thresholds (15 min interval)					
CV-C threshold 15 min	7.3.2.7	R/W (O)	R (O)		
FEC-C threshold 15 min	7.3.2.7	R/W (O)	R (O)		
Near-end (xTU-C) performance monitoring thresholds (24 h interval)					
CV-C threshold 24 h	7.3.2.7	R/W (O)	R (O)		
FEC-C threshold 24 h	7.3.2.7	R/W (O)	R (O)		
Far-end (xTU-R) performance monitoring thresholds (15 min interval)					
CV-CFE threshold 15 min	7.3.2.7	R/W (O)	R (O)		
FEC-CFE threshold 15 min	7.3.2.7	R/W (O)	R (O)		
Far-end (xTU-R) performance monitoring thresholds (24 h interval)					
CV-CFE threshold 24 h	7.3.2.7	R/W (O)	R (O)		
FEC-CFE threshold 24 h	7.3.2.7	R/W (O)	R (O)		
ITU-T G.993.5 specific (Vectoring)					
Target net data rate (TARGET_NDR)	7.3.2.19.1	R/W (M)			
Target expected throughput (TARGET_ETR)	7.3.2.19.2	R/W (M)			
NOTE 1 – This parameter is R/W (O) on the Q-interface for [ITU-T G.992.1] and R/W (M) for all other ITU-T Recommendations that support it. NOTE 2 – This parameter is R/W (M) on the Q-interface for [ITU-T G.993.2] and R/W (O) for all other ITU-T Recommendations that support it.					

Table 7-17 – Support of channel configuration parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
Data rate								
Minimum data rate (Note)	Y	Y	Y	Y	Y	Y		
Minimum reserved data rate (Note)		Y	Y	Y	Y	Y		
Maximum data rate (Note)	Y	Y	Y	Y	Y	Y		
Rate adaptation ratio	Y	Y	Y	Y	Y	Y		
Minimum data rate in low power state (Note)		Y	Y	Y	Y			
MIN-SOS-DR (Note)						Y		
Maximum interleaving delay (Note)	Y	Y	Y	Y	Y	Y		
Minimum impulse noise protection (INPMIN) (Note)	Y		Y	Y	Y	Y		
Minimum impulse noise protection 8 kHz (INPMIN8) (Note)						Y		
FORCEINP (Note)			Y		Y	Y		
Maximum bit error ratio (Note)			Y	Y	Y			
Data rate threshold upshift (Note)	Y	Y	Y	Y	Y			
Data rate threshold downshift (Note)	Y	Y	Y	Y	Y			
Maximum delay variation (DVMAX) (Note)						Y		
Channel initialization policy selection (CIPOLICY) (Note)			Y		Y	Y		
MINETR_RTX							Y	
MAXETR_RTX							Y	
MAXNDR_RTX							Y	
DELAYMAX_RTX							Y	
DELAYMIN_RTX							Y	
INPMIN_SHINE_RTX							Y	
INPMIN8_SHINE_RTX							Y	
SHINERATIO_RTX							Y	
INPMIN_REIN_RTX							Y	

Table 7-17 – Support of channel configuration parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
INPMIN8_REIN_ RTX							Y	
IAT_REIN_RTX							Y	
Near-end performance monitoring thresholds (15 min interval)								
CV-C threshold 15 min	Y	Y	Y	Y	Y	Y		
FEC-C threshold 15 min	Y	Y	Y	Y	Y	Y		
Near-end performance monitoring thresholds (24 h interval)								
CV-C threshold 24 h	Y	Y	Y	Y	Y	Y		
FEC-C threshold 24 h	Y	Y	Y	Y	Y	Y		
Far-end performance monitoring thresholds (15 min interval)								
CV-CFE threshold 15 min	Y	Y	Y	Y	Y	Y		
FEC-CFE threshold 15 min	Y	Y	Y	Y	Y	Y		
Far-end performance monitoring thresholds (24 h interval)								
CV-CFE threshold 24 h	Y	Y	Y	Y	Y	Y		
FEC-CFE threshold 24 h	Y	Y	Y	Y	Y	Y		
ITU-T G.993.5 specific (Vectoring)								
TARGET_NDR								Y
TARGET_ETR								Y
NOTE – The parameter is not applicable to [ITU-T G.992.3] or [ITU-T G.992.5] and [ITU-T G.993.2] when retransmission is enabled.								

Table 7-18 – Asynchronous transfer mode data path configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
IMA configuration					
IMA operation mode enable parameter	7.3.4.1	R/W (M)			
Near-end (xTU-C) performance monitoring thresholds (15 min interval)					
HEC-P threshold 15 min	7.3.4.2	R/W (O)	R (O)		
CD-P threshold 15 min	7.3.4.2	R/W (O)	R (O)		
CU-P threshold 15 min	7.3.4.2	R/W (O)	R (O)		
IBE-P threshold 15 min	7.3.4.2	R/W (O)	R (O)		
Near-end (xTU-C) performance monitoring thresholds (24 h interval)					
HEC-P threshold 24 h	7.3.4.2	R/W (O)	R (O)		
CD-P threshold 24 h	7.3.4.2	R/W (O)	R (O)		
CU-P threshold 24 h	7.3.4.2	R/W (O)	R (O)		
IBE-P threshold 24 h	7.3.4.2	R/W (O)	R (O)		

Table 7-18 – Asynchronous transfer mode data path configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Far-end (xTU-R) performance monitoring thresholds (15 min interval)					
HEC-PFE threshold 15 min	7.3.4.2	R/W (O)	R (O)		
CD-PFE threshold 15 min	7.3.4.2	R/W (O)	R (O)		
CU-PFE threshold 15 min	7.3.4.2	R/W (O)	R (O)		
IBE-PFE threshold 15 min	7.3.4.2	R/W (O)	R (O)		
Far-end (xTU-R) performance monitoring thresholds (24 h interval)					
HEC-PFE threshold 24 h	7.3.4.2	R/W (O)	R (O)		
CD-PFE threshold 24 h	7.3.4.2	R/W (O)	R (O)		
CU-PFE threshold 24 h	7.3.4.2	R/W (O)	R (O)		
IBE-PFE threshold 24h	7.3.4.2	R/W (O)	R (O)		

Table 7-19 – Support of asynchronous transfer mode data path configuration parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]
IMA configuration						
IMA operation mode enable parameter			Y	Y	Y	
Near-end performance monitoring thresholds (15 min interval)						
HEC-P threshold 15 min	Y	Y	Y	Y	Y	Y
CD-P threshold 15 min	Y	Y	Y	Y	Y	Y
CU-P threshold 15 min	Y	Y	Y	Y	Y	Y
IBE-P threshold 15 min	Y	Y	Y	Y	Y	Y
Near-end performance monitoring thresholds (24 h interval)						
HEC-P threshold 24 h	Y	Y	Y	Y	Y	Y
CD-P threshold 24 h	Y	Y	Y	Y	Y	Y
CU-P threshold 24 h	Y	Y	Y	Y	Y	Y
IBE-P threshold 24 h	Y	Y	Y	Y	Y	Y
Far-end performance monitoring thresholds (15 min interval)						
HEC-PFE threshold 15 min	Y	Y	Y	Y	Y	Y
CD-PFE threshold 15 min	Y	Y	Y	Y	Y	Y
CU-PFE threshold 15 min	Y	Y	Y	Y	Y	Y
IBE-PFE threshold 15 min	Y	Y	Y	Y	Y	Y
Far-end performance monitoring thresholds (24 h interval)						
HEC-PFE threshold 24 h	Y	Y	Y	Y	Y	Y
CD-PFE threshold 24 h	Y	Y	Y	Y	Y	Y
CU-PFE threshold 24 h	Y	Y	Y	Y	Y	Y
IBE-PFE threshold 24 h	Y	Y	Y	Y	Y	Y

Table 7-20 – Line inventory

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
xTU-C ITU-T G.994.1 vendor ID	7.4.1	R (M)	R (O)		R (O)
xTU-R ITU-T G.994.1 vendor ID	7.4.2	R (M)		R (O)	R (O)
xTU-C system vendor ID	7.4.3	R (M)	R (O)		R (O)
xTU-R system vendor ID	7.4.4	R (M)		R (O)	R (O)
xTU-C version number	7.4.5	R (M)	R (O)		R (O)
xTU-R version number	7.4.6	R (M)		R (O)	R (O)
xTU-C serial number	7.4.7	R (M)	R (O)		R (O)
xTU-R serial number	7.4.8	R (M)		R (O)	R (O)
xTU-C self-test result	7.4.9	R (M)	R (O)		R (O)
xTU-R self-test result	7.4.10	R (M)		R (O)	R (O)
xTU-C transmission system capabilities	7.4.11	R (M)	R (O)		R (O)
xTU-R transmission system capabilities	7.4.12	R (M)		R (O)	R (O)
ITU-T G.993.5 specific (Vectoring)					
VCE ID (VCE_ID)	7.4.13.1	R (M)			
VCE port index (VCE_port_index)	7.4.13.2	R (M)			
VDSL2-LR specific					
VTU-O VDSL2-LR_SUPPORT	7.4.14.1	R(M)			
VTU-R VDSL2-LR_SUPPORT	7.4.14.2	R(M)			
STRONGFEXT MODE specific					
VTU-O STRONGFEXT MODE support	7.4.15.1	R(M)			
VTU-R STRONGFEXT MODE support	7.4.15.2	R(M)			

Table 7-21 – Support of line inventory information per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.993.5]
xTU-C ITU-T G.994.1 vendor ID	Y	Y	Y	Y	Y	Y	
xTU-R ITU-T G.994.1 vendor ID	Y	Y	Y	Y	Y	Y	
xTU-C system vendor ID	Y	Y	Y	Y	Y	Y	
xTU-R system vendor ID	Y	Y	Y	Y	Y	Y	
xTU-C version number	Y	Y	Y	Y	Y	Y	
xTU-R version number	Y	Y	Y	Y	Y	Y	
xTU-C serial number	Y	Y	Y	Y	Y	Y	
xTU-R serial number	Y	Y	Y	Y	Y	Y	
xTU-C self-test result	Y	Y	Y	Y	Y	Y	
xTU-R self-test result	Y	Y	Y	Y	Y	Y	
xTU-C transmission system capabilities	Y	Y	Y	Y	Y	Y	
xTU-R transmission system capabilities	Y	Y	Y	Y	Y	Y	

Table 7-21 – Support of line inventory information per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.993.5]
ITU-T G.993.5 specific (Vectoring)							
VCE_ID							Y
VCE_port_index							Y
VDSL2-LR specific							
VTU-O VDSL2-LR_SUPPORT						Y (Note 2)	Y (Note 1)
VTU-R VDSL2-LR_SUPPORT						Y (Note 2)	Y (Note 1)
STRONGFEXT MODE specific							
VTU-O STRONGFEXT MODE SUPPORT							Y (Note 3)
VTU-R STRONGFEXT MODE SUPPORT							Y (Note 3)
NOTE 1 – This parameter applies only when Annex B is supported. NOTE 2 – This parameter applies only when Annex D is supported. NOTE 3 – This parameter applies only when Annex A is supported.							

Table 7-22 – Line performance monitoring parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Near-end (xTU-C) performance monitoring parameters (current and previous 15 min interval)					
FECS-L counter 15 min	7.2.1.1.1	R (M)	R (O)		
ES-L counter 15 min	7.2.1.1.2	R (M)	R (O)		R (O)
SES-L counter 15 min	7.2.1.1.3	R (M)	R (O)		R (O)
LOSS-L counter 15 min	7.2.1.1.4	R (M)	R (O)		
UAS-L counter 15 min	7.2.1.1.5	R (M)	R (O)		
"leftr" defect seconds counter 15 min	7.2.1.1.6	R (M)			
Error-free bits counter 15 min	7.2.1.1.7	R (M)			
MINEFTR 15 min	7.2.1.1.8	R (M)			
MAXEFTR 15 min	7.2.1.1.9	R (O)			
Near-end (xTU-C) performance monitoring parameters (current and previous 24 h interval)					
FECS-L counter 24 h	7.2.1.1.1	R (M)	R (O)		
ES-L counter 24 h	7.2.1.1.2	R (M)	R (O)		R (O)
SES-L counter 24 h	7.2.1.1.3	R (M)	R (O)		R (O)
LOSS-L counter 24 h	7.2.1.1.4	R (M)	R (O)		
UAS-L counter 24 h	7.2.1.1.5	R (M)	R (O)		
"leftr" defect seconds counter 24 h	7.2.1.1.6	R (M)			
Error-free bits counter 24 h	7.2.1.1.7	R (M)			
MINEFTR 24 h	7.2.1.1.8	R (M)			
MAXEFTR 24 h	7.2.1.1.9	R (O)			

Table 7-22 – Line performance monitoring parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Far-end (xTU-R) performance monitoring parameters (current and previous 15 min interval)					
FECS-LFE counter 15 min	7.2.1.2.1	R (M)		R (O)	
ES-LFE counter 15 min	7.2.1.2.2	R (M)		R (O)	R (O)
SES-LFE counter 15 min	7.2.1.2.3	R (M)		R (O)	R (O)
LOSS-LFE counter 15 min	7.2.1.2.4	R (M)		R (O)	
UAS-LFE counter 15 min	7.2.1.2.5	R (M)		R (O)	
"leftr" defect seconds counter 15 min	7.2.1.2.6	R (M)			
Error-free bits counter 15 min	7.2.1.2.7	R (M)			
MINEFTR 15 min	7.2.1.2.8	R (M)			
MAXEFTR 15 min	7.2.1.2.9	R (O)			
Far-end (xTU-R) performance monitoring parameters (current and previous 24 h interval)					
FECS-LFE counter 24 h	7.2.1.2.1	R (M)		R (O)	
ES-LFE counter 24 h	7.2.1.2.2	R (M)		R (O)	R (O)
SES-LFE counter 24 h	7.2.1.2.3	R (M)		R (O)	R (O)
LOSS-LFE counter 24 h	7.2.1.2.4	R (M)		R (O)	
UAS-LFE counter 24 h	7.2.1.2.5	R (M)		R (O)	
"leftr" defect seconds counter 24 h	7.2.1.2.6	R (M)			
Error-free bits counter 24 h	7.2.1.2.7	R (M)			
MINEFTR 24 h	7.2.1.2.8	R (M)			
MAXEFTR 24 h	7.2.1.2.9	R (O)			
Initialization performance monitoring counters (current and previous 15 min interval)					
Full inits counter 15 min	7.2.1.3.1	R (M)	R (O)		
Failed full inits counter 15 min	7.2.1.3.2	R (M)	R (O)		
Short inits counter 15 min	7.2.1.3.3	R (O)	R (O)		
Failed short inits counter 15 min	7.2.1.3.4	R (O)	R (O)		
Initialization performance monitoring counters (current and previous 24 h interval)					
Full inits counter 24 h	7.2.1.3.1	R (M)	R (O)		
Failed full inits counter 24 h	7.2.1.3.2	R (M)	R (O)		
Short inits counter 24 h	7.2.1.3.3	R (O)	R (O)		
Failed short inits counter 24 h	7.2.1.3.4	R (O)	R (O)		
Short interruption performance monitoring counters (current and previous 24 h interval)					
LPR_INTRPT counter 24 h	7.2.1.8.1	R (O)			
HRI_INTRPT counter 24 h	7.2.1.8.2	R (O)			
SPONT_INTRPT counter 24 h	7.2.1.8.3	R (O)			
Near-end (xTU-C) impulse noise performance monitoring counters (current and previous 15 min interval)					
INMINPEQ1..17-L counter 15 min	7.2.1.4.1	R (O)			
INMIAT0..7-L counter 15 min	7.2.1.4.3	R (O)			
INMME-L counter 15 min	7.2.1.4.2	R (O)			
Near-end (xTU-C) impulse noise performance monitoring counters (current and previous 24 h interval)					
INMINPEQ1..17-L counter 24 h	7.2.1.4.1	R (O)			
INMIAT0..7-L counter 24 h	7.2.1.4.3	R (O)			

Table 7-22 – Line performance monitoring parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
INMME-L counter 24 h	7.2.1.4.2	R (O)			
Far-end (xTU-R) impulse noise performance monitoring counters (current and previous 15 min interval)					
INMINPEQ1..17-LFE counter 15 min	7.2.1.5.1	R (O)		R (O)	
INMIAT0..7-LFE counter 15 min	7.2.1.5.3	R (O)		R (O)	
INMME-LFE counter 15 min	7.2.1.5.2	R (O)		R (O)	
Far-end (xTU-R) impulse noise performance monitoring counters (current and previous 24 h interval)					
INMINPEQ1..17-LFE counter 24 h	7.2.1.5.1	R (O)		R (O)	
INMIAT0..7-LFE counter 24 h	7.2.1.5.3	R (O)		R (O)	
INMME-LFE counter 24 h	7.2.1.5.2	R (O)		R (O)	
Near-end (xTU-C) initiated OLR performance monitoring counters (current and previous 15 min interval)					
SOS-SUCCESS-NE counter 15 min	7.2.1.6.1	R (O)			
SRA-SUCCESS-NE counter 15 min	7.2.1.6.2	R (O)			
Near-end (xTU-C) initiated OLR performance monitoring counters (current and previous 24 h interval)					
SOS-SUCCESS-NE counter 24 h	7.2.1.6.1	R (O)			
SRA-SUCCESS-NE counter 24 h	7.2.1.6.2	R (O)			
Far-end (xTU-R) initiated OLR performance monitoring counters (current and previous 15 min interval)					
SOS-SUCCESS-FE counter 15 min	7.2.1.7.1	R (O)			
SRA-SUCCESS-FE counter 15 min	7.2.1.7.2	R (O)			
Far-end (xTU-R) initiated OLR performance monitoring counters (current and previous 24 h interval)					
SOS-SUCCESS-FE counter 24 h	7.2.1.7.1	R (O)			
SRA-SUCCESS-FE counter 24 h	7.2.1.7.2	R (O)			

Table 7-23 – Support of line performance monitoring parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]
Near-end performance monitoring parameters (current and previous 15 min interval)							
FECS-L counter 15 min	Y	Y	Y	Y	Y	Y	
ES-L counter 15 min	Y	Y	Y	Y	Y	Y	
SES-L counter 15 min	Y	Y	Y	Y	Y	Y	
LOSS-L counter 15 min	Y	Y	Y	Y	Y	Y	
UAS-L counter 15 min	Y	Y	Y	Y	Y	Y	
"leftr" defect seconds counter 15 min							Y
Error-free bits counter 15 min							Y
MINEFTR 15 min							Y
MAXEFTR 15 min							Y
Near-end performance monitoring parameters (current and previous 24 h interval)							
FECS-L counter 24 h	Y	Y	Y	Y	Y	Y	

Table 7-23 – Support of line performance monitoring parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]
ES-L counter 24 h	Y	Y	Y	Y	Y	Y	
SES-L counter 24 h	Y	Y	Y	Y	Y	Y	
LOSS-L counter 24 h	Y	Y	Y	Y	Y	Y	
UAS-L counter 24 h	Y	Y	Y	Y	Y	Y	
"leftr" defect seconds counter 24 h							Y
Error-free bits counter 24 h							Y
MINEFTR 24 h							Y
MAXEFTR 24 h							Y
Far-end performance monitoring parameters (current and previous 15 min interval)							
FECS-LFE counter 15 min	Y	Y	Y	Y	Y	Y	
ES-LFE counter 15 min	Y	Y	Y	Y	Y	Y	
SES-LFE counter 15 min	Y	Y	Y	Y	Y	Y	
LOSS-LFE counter 15 min	Y	Y	Y	Y	Y	Y	
UAS-LFE counter 15 min	Y	Y	Y	Y	Y	Y	
"leftr" defect seconds counter 15 min							Y
Error-free bits counter 15 min							Y
MINEFTR 15 min							Y
MAXEFTR 15 min							Y
Far-end performance monitoring parameters (current and previous 24 h interval)							
FECS-LFE counter 24 h	Y	Y	Y	Y	Y	Y	
ES-LFE counter 24 h	Y	Y	Y	Y	Y	Y	
SES-LFE counter 24 h	Y	Y	Y	Y	Y	Y	
LOSS-LFE counter 24 h	Y	Y	Y	Y	Y	Y	
UAS-LFE counter 24 h	Y	Y	Y	Y	Y	Y	
"leftr" defect seconds counter 24 h							Y
Error-free bits counter 24 h							Y
MINEFTR 24 h							Y
MAXEFTR 24 h							Y
Initialization performance monitoring counters (current and previous 15 min interval)							
Full inits counter 15 min	Y	Y	Y	Y	Y	Y	
Failed full inits counter 15 min	Y	Y	Y	Y	Y	Y	
Short inits counter 15 min		Y	Y	Y	Y	Y	
Failed short inits counter 15 min		Y	Y	Y	Y	Y	

Table 7-23 – Support of line performance monitoring parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]
Initialization performance monitoring counters (current and previous 24 h interval)							
Full inits counter 24 h	Y	Y	Y	Y	Y	Y	
Failed full inits counter 24 h	Y	Y	Y	Y	Y	Y	
Short inits counter 24 h		Y	Y	Y	Y	Y	
Failed short inits counter 24 h		Y	Y	Y	Y	Y	
Short interruption performance monitoring counters (current and previous 24 h interval)							
LPR_INTRPT counter 24 h						Y	
HRI_INTRPT counter 24 h						Y	
SPONT_INTRPT counter 24 h						Y	
Near-end impulse noise performance monitoring counters (current and previous 15 min interval)							
INMINPEQ$_{1..17}$-L counter 15 min						Y	
INMIAT$_{0..7}$-L counter 15 min						Y	
INMME-L counter 15 min						Y	
Near-end impulse noise performance monitoring counters (current and previous 24 h interval)							
INMINPEQ$_{1..17}$-L counter 24 h						Y	
INMIAT$_{0..7}$-L counter 24 h						Y	
INMME-L counter 24 h						Y	
Far-end impulse noise performance monitoring counters (current and previous 15 min interval)							
INMINPEQ$_{1..17}$-LFE counter 15 min			Y		Y	Y	
INMIAT$_{0..7}$-LFE counter 15 min			Y		Y	Y	
INMME-LFE counter 15 min			Y		Y	Y	
Far-end impulse noise performance monitoring counters (current and previous 24 h interval)							
INMINPEQ$_{1..17}$-LFE counter 24 h			Y		Y	Y	
INMIAT$_{0..7}$-LFE counter 24 h			Y		Y	Y	
INMME-LFE counter 24 h			Y		Y	Y	
Near-end (xTU-C) initiated OLR performance monitoring counters (current and previous 15 min interval)							
SOS-SUCCESS-NE counter 15 min						Y	
SRA-SUCCESS-NE counter 15 min						Y	

Table 7-23 – Support of line performance monitoring parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]
Near-end (xTU-C) initiated OLR performance monitoring counters (current and previous 24 h interval)							
SOS-SUCCESS-NE counter 24 h						Y	
SRA-SUCCESS-NE counter 24 h						Y	
Far-end (xTU-R) initiated OLR performance monitoring counters (current and previous 15 min interval)							
SOS-SUCCESS-FE counter 15 min						Y	
SRA-SUCCESS-FE counter 15 min						Y	
Far-end (xTU-R) initiated OLR performance monitoring counters (current and previous 24 h interval)							
SOS-SUCCESS-FE counter 24 h						Y	
SRA-SUCCESS-FE counter 24 h						Y	

Table 7-24 – Channel performance monitoring parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Near-end (xTU-C) performance monitoring counters (current and previous 15 min interval)					
CV-C counter 15 min	7.2.2.1.1	R (M)	R (O)		
FEC-C counter 15 min	7.2.2.1.2	R (M)	R (O)		
RTXUC-C counter 15 min	7.2.2.1.3	R (M)	R (O)		
RTXTX-C counter 15 min	7.2.2.1.4	R (M)	R (O)		
Near-end (xTU-C) performance monitoring counters (current and previous 24 h interval)					
CV-C counter 24 h	7.2.2.1.1	R (M)	R (O)		
FEC-C counter 24 h	7.2.2.1.2	R (M)	R (O)		
RTXUC-C counter 24 h	7.2.2.1.3	R (M)	R (O)		
RTXTX-C counter 24 h	7.2.2.1.4	R (M)	R (O)		
Far-end (xTU-R) performance monitoring counters (current and previous 15 min interval)					
CV-CFE counter 15 min	7.2.2.2.1	R (M)		R (O)	
FEC-CFE counter 15 min	7.2.2.2.2	R (M)		R (O)	
RTXUC-CFE counter 15 min	7.2.2.2.3	R (M)		R (O)	
RTXTX-CFE counter 15 min	7.2.2.2.4	R (M)		R (O)	
Far-end (xTU-R) performance monitoring counters (current and previous 24 h interval)					
CV-CFE counter 24 h	7.2.2.2.1	R (M)		R (O)	
FEC-CFE counter 24 h	7.2.2.2.2	R (M)		R (O)	
RTXUC-CFE counter 24 h	7.2.2.2.3	R (M)		R (O)	
RTXTX-CFE counter 24 h	7.2.2.2.4	R (M)		R (O)	

Table 7-25 – Support of channel performance monitoring parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]
Near-end performance monitoring counters (current and previous 15 min interval)							
CV-C counter 15 min	Y	Y	Y	Y	Y	Y	
FEC-C counter 15 min	Y	Y	Y	Y	Y	Y	
RTXUC-C counter 15 min							Y
RTXTX-C counter 15 min							Y
Near-end performance monitoring counters (current and previous 24 h interval)							
CV-C counter 24 h	Y	Y	Y	Y	Y	Y	
FEC-C counter 24 h	Y	Y	Y	Y	Y	Y	
RTXUC-C counter 24 h							Y
RTXTX-C counter 24 h							Y
Far-end performance monitoring counters (current and previous 15 min interval)							
CV-CFE counter 15 min	Y	Y	Y	Y	Y	Y	
FEC-CFE counter 15 min	Y	Y	Y	Y	Y	Y	
RTXUC-CFE counter 15 min							Y
RTXTX-CFE counter 15 min							Y
Far-end performance monitoring counters (current and previous 24 h interval)							
CV-CFE counter 24 h	Y	Y	Y	Y	Y	Y	
FEC-CFE counter 24 h	Y	Y	Y	Y	Y	Y	
RTXUC-CFE counters 24 h							Y
RTXTX-CFE counters 24 h							Y

Table 7-26 – Asynchronous transfer mode data path performance monitoring parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Near-end (xTU-C) performance monitoring counters (current and previous 15 min interval)					
HEC-P counter 15 min	7.2.4.1.1	R (M)	R (O)		
CD-P counter 15 min	7.2.4.1.2	R (M)	R (O)		
CU-P counter 15 min	7.2.4.1.3	R (M)	R (O)		
IBE-P counter 15 min	7.2.4.1.4	R (M)	R (O)		R (O)
Near-end (xTU-C) performance monitoring counters (current and previous 24 h interval)					
HEC-P counter 24 h	7.2.4.1.1	R (M)	R (O)		
CD-P counter 24 h	7.2.4.1.2	R (M)	R (O)		
CU-P counter 24 h	7.2.4.1.3	R (M)	R (O)		
IBE-P counter 24 h	7.2.4.1.4	R (M)	R (O)		R (O)
Far-end (xTU-R) performance monitoring counters (current and previous 15 min interval)					
HEC-PFE counter 15 min	7.2.4.2.1	R (M)		R (O)	
CD-PFE counter 15 min	7.2.4.2.2	R (M)		R (O)	
CU-PFE counter 15 min	7.2.4.2.3	R (M)		R (O)	
IBE-PFE counter 15 min	7.2.4.2.4	R (M)		R (O)	R (O)

Table 7-26 – Asynchronous transfer mode data path performance monitoring parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Far-end (xTU-R) performance monitoring counters (current and previous 24 h interval)					
HEC-PFE counter 24 h	7.2.4.2.1	R (M)		R (O)	
CD-PFE counter 24 h	7.2.4.2.2	R (M)		R (O)	
CU-PFE counter 24 h	7.2.4.2.3	R (M)		R (O)	
IBE-PFE counter 24 h	7.2.4.2.4	R (M)		R (O)	R (O)

Table 7-27 – Support of asynchronous transfer mode data path performance monitoring parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]
Near-end performance monitoring counters (current and previous 15 min interval)						
HEC-P counter 15 min	Y	Y	Y	Y	Y	Y
CD-P counter 15 min	Y	Y	Y	Y	Y	Y
CU-P counter 15 min	Y	Y	Y	Y	Y	Y
IBE-P counter 15 min	Y	Y	Y	Y	Y	Y
Near-end performance monitoring counters (current and previous 24 h interval)						
HEC-P counter 24 h	Y	Y	Y	Y	Y	Y
CD-P counter 24 h	Y	Y	Y	Y	Y	Y
CU-P counter 24 h	Y	Y	Y	Y	Y	Y
IBE-P counter 24 h	Y	Y	Y	Y	Y	Y
Far-end performance monitoring counters (current and previous 15 min interval)						
HEC-PFE counter 15 min	Y	Y	Y	Y	Y	Y
CD-PFE counter 15 min	Y	Y	Y	Y	Y	Y
CU-PFE counter 15 min	Y	Y	Y	Y	Y	Y
IBE-PFE counter 15 min	Y	Y	Y	Y	Y	Y
Far-end performance monitoring counters (current and previous 24 h interval)						
HEC-PFE counter 24 h	Y	Y	Y	Y	Y	Y
CD-PFE counter 24 h	Y	Y	Y	Y	Y	Y
CU-PFE counter 24 h	Y	Y	Y	Y	Y	Y
IBE-PFE counter 24 h	Y	Y	Y	Y	Y	Y

Table 7-28 – Line test, diagnostic and status parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
xDSL transmission system	7.5.1.1	R (M)			R (O)	R (O)
VDSL2 profile	7.5.1.2	R (M)			R (O)	R (O)
VDSL2 limit PSD mask and band plan	7.5.1.3	R (M)			R (O)	R (O)
VDSL2 US0 PSD mask	7.5.1.4	R (M)			R (O)	R (O)

Table 7-28 – Line test, diagnostic and status parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
Power management state	7.5.1.5	R (M)			R (O)	R (O)
RTX_USED_ds	7.5.1.38	R (M)				
RTX_USED_us	7.5.1.38	R (M)				
Initialization						
Success/Failure cause	7.5.1.6	R (M)			R (M)	R (M)
Last state transmitted downstream	7.5.1.7	R (M)			R (M)	R (M)
Last state transmitted upstream	7.5.1.8	R (M)			R (M)	R (M)
Attenuation						
LATNds	7.5.1.9	R (M)		R (O)	R (M)	R (M)
LATNus	7.5.1.10	R (M)	R (O)		R (M)	R (M)
SATNds	7.5.1.11	R (M)		R (O)	R (M)	R (M)
SATNus	7.5.1.12	R (M)	R (O)		R (M)	R (M)
Signal-to-noise ratio margin						
SNRMds	7.5.1.13	R (M)		R (O)	R (M)	R (M)
FEXT SNRMds	7.5.1.13.1	R (M)		R (O)	R (M)	R (M)
NEXT SNRMds	7.5.1.13.2	R (M)		R (O)	R (M)	R (M)
SNRMpbds	7.5.1.14	R (M)		R (O)	R (M)	R (M)
ACTSNRMODEds	7.5.1.15	R (M)		R (O)	R (M)	R (M)
SNRMus	7.5.1.16	R (M)	R (O)		R (M)	R (M)
FEXT SNRMus	7.5.1.16.1	R (M)	R (O)		R (M)	R (M)
NEXT SNRMus	7.5.1.16.2	R (M)	R (O)		R (M)	R (M)
SNRMpbus	7.5.1.17	R (M)	R (O)		R (M)	R (M)
ACTSNRMODEus	7.5.1.18	R (M)	R (O)		R (M)	R (M)
Attainable data rate						
ATTNDRds	7.5.1.19	R (M)	R (O)		R (M)	R (M)
FEXT ATTNDRds	7.5.1.19.1	R (M)	R (O)		R (M)	R (M)
NEXT ATTNDRds	7.5.1.19.2	R (M)	R (O)		R (M)	R (M)
ATTNDRus	7.5.1.20	R (M)		R (O)	R (M)	R (M)
FEXT ATTNDRus	7.5.1.20.1	R (M)		R (O)	R (M)	R (M)
NEXT ATTNDRus	7.5.1.20.2	R (M)		R (O)	R (M)	R (M)
Actual power spectral density						
ACTPSDds	7.5.1.21	R (M)	R (O)			R (O)
FEXT ACTPSDds	7.5.1.21.1	R (M)	R (O)			R (O)
NEXT ACTPSDds	7.5.1.21.2	R (M)	R (O)			R (O)
ACTPSDus	7.5.1.22	R (M)		R (O)		R (O)
FEXT ACTPSDus	7.5.1.22.1	R (M)		R (O)		R (O)
NEXT ACTPSDus	7.5.1.22.2	R (M)		R (O)		R (O)
Upstream power back-off						
UPBOKLE	7.5.1.23.1	R (M)	R (O)			R (O)
UPBOKLE-R	7.5.1.23.2	R (O)	R (O)			R (O)

Table 7-28 – Line test, diagnostic and status parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
UPBOKLE-pb	7.5.1.23.3	R (O)	R (O)			
UPBOKLE-R-pb	7.5.1.23.4	R (O)	R (O)			R (O)
RXTHRSHds	7.5.1.23.5	R (O)	R (O)			R (O)
RXTHRSHus	7.5.1.23.6	R (O)	R (O)			
ACT-AELE-MODE	7.5.1.23.7	R (O)				
Actual aggregate transmit power						
ACTATPds	7.5.1.24	R (M)		R (O)	R (M)	R (M)
FEXT ACTATPds	7.5.1.24.1	R (M)		R (O)	R (M)	R (M)
NEXT ACTATPds	7.5.1.24.2	R (M)		R (O)	R (M)	R (M)
ACTATPus	7.5.1.25	R (M)	R (O)		R (M)	R (M)
FEXT ACTATPus	7.5.1.25.1	R (M)	R (O)		R (M)	R (M)
NEXT ACTATPus	7.5.1.25.2	R (M)	R (O)		R (M)	R (M)
Channel characteristics per subcarrier						
HLINSCds	7.5.1.26.1	R (M)	R (O)		R (M)	R (M)
HLINGds	7.5.1.26.2	R (M)	R (O)		R (M)	R (M)
HLINpsds	7.5.1.26.3	R (M)	R (O)		R (M)	R (M)
HLOGMTds	7.5.1.26.4	R (M)	R (O)		R (M)	R (M)
HLOGGds	7.5.1.26.5	R (M)	R (O)		R (M)	R (M)
HLOGpsds	7.5.1.26.6	R (M)	R (O)		R (M)	R (M)
HLINSCus	7.5.1.26.7	R (M)		R (O)	R (M)	R (M)
HLINGus	7.5.1.26.8	R (M)		R (O)	R (M)	R (M)
HLINpsus	7.5.1.26.9	R (M)		R (O)	R (M)	R (M)
HLOGMTus	7.5.1.26.10	R (M)		R (O)	R (M)	R (M)
HLOGGus	7.5.1.26.11	R (M)		R (O)	R (M)	R (M)
HLOGpsus	7.5.1.26.12	R (M)		R (O)	R (M)	R (M)
Quiet line noise PSD per subcarrier						
QLNMTds	7.5.1.27.1	R (M)	R (O)		R (M)	R (M)
FEXT QLNMTds	7.5.1.27.1.1	R (M)	R (O)		R (M)	R (M)
NEXT QLNMTds	7.5.1.27.1.2	R (M)	R (O)		R (M)	R (M)
QLNGds	7.5.1.27.2	R (M)	R (O)		R (M)	R (M)
QLNpsds	7.5.1.27.3	R (M)	R (O)		R (M)	R (M)
FEXT QLNpsds	7.5.1.27.3.1	R (M)	R (O)		R (M)	R (M)
NEXT QLNpsds	7.5.1.27.3.2	R (M)	R (O)		R (M)	R (M)
QLNMTus	7.5.1.27.4	R (M)		R (O)	R (M)	R (M)
FEXT QLNMTus	7.5.1.27.4.1	R (M)		R (O)	R (M)	R (M)
NEXT QLNMTus	7.5.1.27.4.2	R (M)		R (O)	R (M)	R (M)
QLNGus	7.5.1.27.5	R (M)		R (O)	R (M)	R (M)
QLNpsus	7.5.1.27.6	R (M)		R (O)	R (M)	R (M)
FEXT QLNpsus	7.5.1.27.6.1	R (M)		R (O)	R (M)	R (M)
NEXT QLNpsus	7.5.1.27.6.2	R (M)		R (O)	R (M)	R (M)

Table 7-28 – Line test, diagnostic and status parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
Signal-to-noise ratio per subcarrier						
SNRMTds	7.5.1.28.1	R (M)	R (O)		R (M)	R (M)
FEXT SNRMTds	7.5.1.28.1.1	R (M)	R (O)		R (M)	R (M)
NEXT SNRMTds	7.5.1.28.1.2	R (M)	R (O)		R (M)	R (M)
SNRGds	7.5.1.28.2	R (M)	R (O)		R (M)	R (M)
SNRpsds	7.5.1.28.3	R (M)	R (O)		R (M)	R (M)
FEXT SNRpsds	7.5.1.28.3.1	R (M)	R (O)		R (M)	R (M)
NEXT SNRpsds	7.5.1.28.3.2	R (M)	R (O)		R (M)	R (M)
SNRMTus	7.5.1.28.4	R (M)		R (O)	R (M)	R (M)
FEXT SNRMTus	7.5.1.28.4.1	R (M)		R (O)	R (M)	R (M)
NEXT SNRMTus	7.5.1.28.4.2	R (M)		R (O)	R (M)	R (M)
SNRGus	7.5.1.28.5	R (M)		R (O)	R (M)	R (M)
SNRpsus	7.5.1.28.6	R (M)		R (O)	R (M)	R (M)
FEXT SNRpsus	7.5.1.28.6.1	R (M)		R (O)	R (M)	R (M)
NEXT SNRpsus	7.5.1.28.6.2	R (M)		R (O)	R (M)	R (M)
Bit allocation per subcarrier						
BITSpsds	7.5.1.29.1	R (M)	R (O)			R (O)
FEXT BITSpsds	7.5.1.29.1.1	R (M)	R (O)			R (O)
NEXT BITSpsds	7.5.1.29.1.2	R (M)	R (O)			R (O)
BITSpsus	7.5.1.29.2	R (M)		R (O)		R (O)
FEXT BITSpsus	7.5.1.29.2.1	R (M)		R (O)		R (O)
NEXT BITSpsus	7.5.1.29.2.2	R (M)		R (O)		R (O)
Gain scaling per subcarrier						
GAINSpsds	7.5.1.29.3	R (M)	R (O)			
FEXT GAINSpsds	7.5.1.29.3.1	R (M)	R (O)			
NEXT GAINSpsds	7.5.1.29.3.2	R (M)	R (O)			
GAINSpsus	7.5.1.29.4	R (M)		R (O)		
FEXT GAINSpsus	7.5.1.29.4.1	R (M)		R (O)		
NEXT GAINSpsus	7.5.1.29.4.2	R (M)		R (O)		
TSSpsds	7.5.1.29.5	R (M)	R (O)			
FEXT TSSpsds	7.5.1.29.5.1	R (M)	R (O)			
NEXT TSSpsds	7.5.1.29.5.2	R (M)	R (O)			
TSSpsus	7.5.1.29.6	R (M)	R (O)			
FEXT TSSpsus	7.5.1.29.6.1	R (M)	R (O)			
NEXT TSSpsus	7.5.1.29.6.2	R (M)	R (O)			
MREFPSDds	7.5.1.29.7	R (M)	R (O)			R (O)
MREFPSDus	7.5.1.29.8	R (M)	R (O)			R (O)
Trellis use						
TRELLISds	7.5.1.30	R (M/O) (Note)		R (O)	R (M/O) (Note)	R (M/O) (Note)

Table 7-28 – Line test, diagnostic and status parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
TRELLISus	7.5.1.31	R (M/O) (Note)	R (O)		R (M/O) (Note)	R (M/O) (Note)
Cyclic extension						
ACTUALCE	7.5.1.32	R (M)				R (M)
Actual rate adaptation mode						
ACT-RA-MODEds	7.5.1.33.1	R (O)				R (O)
ACT-RA-MODEus	7.5.1.33.2	R (O)				R (O)
Actual impulse noise protection of ROC						
ACTINP-ROC-ds	7.5.1.34.1	R (O)				R (O)
ACTINP-ROC-us	7.5.1.34.2	R (O)				R (O)
Actual SNR margin of ROC						
SNRM-ROC-ds	7.5.1.35.1	R (O)				R (O)
SNRM-ROC-us	7.5.1.35.2	R (O)				R (O)
Update request flags and time stamps of test parameter						
UPDATE-TEST-NE	7.5.1.36.1	R/W (O)				
UPDATE-TEST-FE	7.5.1.36.2	R/W (O)				
STAMP-TEST-NE	7.5.1.36.3	R (O)				
STAMP-TEST-FE	7.5.1.36.4	R (O)				
OLR time stamps						
STAMP-OLR-ds	7.5.1.37.1	R (O)				
STAMP-OLR-us	7.5.1.37.2	R (O)				
ITU-T G.993.5 specific (Vectoring)						
XLINSCds	7.5.1.38.1	R (M)				
XLINGds	7.5.1.38.2	R (M)				
XLINBANDSds	7.5.1.38.3	R (M)				
XLINpsds	7.5.1.38.4	R (M)				
XLINSCus	7.5.1.38.5	R (M)				
XLINGus	7.5.1.38.6	R (M)				
XLINBANDSus	7.5.1.38.7	R (M)				
XLINpsus	7.5.1.38.8	R (M)				
Actual RI_POLICY						
ACTRIPOLICYus	7.5.1.40.1	R(O)				
ACTRIPOLICYds	7.5.1.40.2	R(O)				
ATTNDR Diagnostic parameters						
ATTNDR_ACT_METHOD	7.5.1.41.1	R(O)				
ATTNDR_ACTINPds	7.5.1.41.2	R(O)		R(O)		
ATTNDR_ACTINPus	7.5.1.41.3	R(O)	R(O)			
ATTNDR_ACTINP_REINds	7.5.1.41.4	R(O)		R(O)		
ATTNDR_ACTINP_REINus	7.5.1.41.5	R(O)	R(O)			
ATTNDR_ACTDELAYds	7.5.1.41.6	R(O)		R(O)		
ATTNDR_ACTDELAYus	7.5.1.41.7	R(O)	R(O)			

Table 7-28 – Line test, diagnostic and status parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
Aggregate Achievable Net Data Rate						
AGGACHNDR_NE	7.5.1.42.1	R(O)				
AGGACHNDR_FE	7.5.1.42.2	R(O)			R(O)	
Line status parameters for ITU-T G.993.5						
ACTVECTORMODE	7.5.1.43.1	R(O)			R(O)	
VDSL2-LR status parameter						
VDSL2-LR_ACTOPTTYPE	7.5.1.44.1	R(M)			R(M)	
STRONGFEXT MODE status parameter						
STRONGFEXT_ACTMODE	7.5.1.45.1	R(M)			R(M)	
Loop diagnostic parameters						
Loop diagnostic mode status (LDS)	7.5.1.46	R(O)			R(O)	R(O)
Loop diagnostic mode results status (LDR)	7.5.1.47	R(O)			R(O)	R(O)
NOTE – These parameters are R (M) on the Q-interface for [ITU-T G.993.2] and R (O) for all other ITU-T Recommendations which support them.						

Table 7-29 – Support of line test, diagnostic and status parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
xDSL transmission system	Y	Y	Y	Y	Y	Y		
VDSL2 profile						Y		
VDSL2 limit PSD mask and band plan						Y		
VDSL2 US0 PSD mask						Y (Annex A)		
Power management state	Y	Y	Y	Y	Y	Y		
RTX_USED_ds							Y	
RTX_USED_us							Y	
Initialization								
Success/Failure cause	Y	Y	Y	Y	Y	Y		
Last state transmitted downstream			Y	Y	Y	Y		
Last state transmitted upstream			Y	Y	Y	Y		
Attenuation								
LATNds	Y	Y	Y	Y	Y	Y		
LATNus	Y	Y	Y	Y	Y	Y		
SATNds			Y	Y	Y	Y		

Table 7-29 – Support of line test, diagnostic and status parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
SATNus			Y	Y	Y	Y		
Signal-to-noise ratio margin								
SNRMds	Y	Y	Y	Y	Y	Y		
FEXT SNRMds			Y		Y			
NEXT SNRMds			Y		Y			
SNRMpbds						Y		
ACTSNRMODEds			Y		Y	Y		
SNRMus	Y	Y	Y	Y	Y	Y		
FEXT SNRMus			Y		Y			
NEXT SNRMus			Y		Y			
SNRMpbus						Y		
ACTSNRMODEus						Y		
Attainable data rate								
ATTNDRds	Y	Y	Y	Y	Y	Y		
FEXT ATTNDRds			Y		Y			
NEXT ATTNDRds			Y		Y			
ATTNDRus	Y	Y	Y	Y	Y	Y		
FEXT ATTNDRus			Y		Y			
NEXT ATTNDRus			Y		Y			
Actual power spectral density								
ACTPSDds			Y	Y	Y			
FEXT ACTPSDds			Y		Y			
NEXT ACTPSDds			Y		Y			
ACTPSDus			Y	Y	Y			
FEXT ACTPSDus			Y		Y			
NEXT ACTPSDus			Y		Y			
Upstream power back-off								
UPBOKLE						Y		
UPBOKLE-R						Y		
UPBOKLE-pb						Y		
UPBOKLE-R-pb						Y		
RXTHRSHds						Y		
RXTHRSHus						Y		
ACT-AELE-MODE						Y		
Actual aggregate transmit power								
ACTATPds	Y	Y	Y	Y	Y	Y		
FEXT ACTATPds			Y		Y			
NEXT ACTATPds			Y		Y			
ACTATPus	Y	Y	Y	Y	Y	Y		
FEXT ACTATPus			Y		Y			

Table 7-29 – Support of line test, diagnostic and status parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
NEXT ACTATPus			Y		Y			
Channel characteristics per subcarrier								
HLINSCds			Y	Y	Y	Y		
HLINGds						Y		
HLINpsds			Y	Y	Y	Y		
HLOGMTds			Y	Y	Y	Y		
HLOGGds						Y		
HLOGpsds			Y	Y	Y	Y		
HLINSCus			Y	Y	Y	Y		
HLINGus						Y		
HLINpsus			Y	Y	Y	Y		
HLOGMTus			Y	Y	Y	Y		
HLOGGus						Y		
HLOGpsus			Y	Y	Y	Y		
Quiet line noise PSD per subcarrier								
QLNMTds			Y	Y	Y	Y		
FEXT QLNMTds			Y		Y			
NEXT QLNMTds			Y		Y			
QLNGds						Y		
QLNpsds			Y	Y	Y	Y		
FEXT QLNpsds			Y		Y			
NEXT QLNpsds			Y		Y			
QLNMTus			Y	Y	Y	Y		
FEXT QLNMTus			Y		Y			
NEXT QLNMTus			Y		Y			
QLNGus						Y		
QLNpsus			Y	Y	Y	Y		
FEXT QLNpsus			Y		Y			
NEXT QLNpsus			Y		Y			
Signal-to-noise ratio per subcarrier								
SNRMTds			Y	Y	Y	Y		
FEXT SNRMTds			Y		Y			
NEXT SNRMTds			Y		Y			
SNRGds						Y		
SNRpsds			Y	Y	Y	Y		
FEXT SNRpsds			Y		Y			
NEXT SNRpsds			Y		Y			
SNRMTus			Y	Y	Y	Y		
FEXT SNRMTus			Y		Y			
NEXT SNRMTus			Y		Y			

Table 7-29 – Support of line test, diagnostic and status parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
SNRGus						Y		
SNRpsus			Y	Y	Y	Y		
FEXT SNRpsus			Y		Y			
NEXT SNRpsus			Y		Y			
Bit allocation per subcarrier								
BITSpsds			Y	Y	Y	Y		
FEXT BITSpsds			Y		Y			
NEXT BITSpsds			Y		Y			
BITSpsus			Y	Y	Y	Y		
FEXT BITSpsus			Y		Y			
NEXT BITSpsus			Y		Y			
Gain scaling per subcarrier								
GAINSpsds			Y	Y	Y	Y		
FEXT GAINSpsds			Y		Y			
NEXT GAINSpsds			Y		Y			
GAINSpsus			Y	Y	Y	Y		
FEXT GAINSpsus			Y		Y			
NEXT GAINSpsus			Y		Y			
TSSpsds			Y	Y	Y			
FEXT TSSpsds			Y		Y			
NEXT TSSpsds			Y		Y			
TSSpsus			Y	Y	Y			
FEXT TSSpsus			Y		Y			
NEXT TSSpsus			Y		Y			
MREFPSDds						Y		
MREFPSDus						Y		
Trellis use								
TRELLISds	Y		Y	Y	Y	Y		
TRELLISus	Y		Y	Y	Y	Y		
Cyclic extension								
ACTUALCE						Y		
Actual rate adaptation mode								
ACT-RA-MODEds						Y		
ACT-RA-MODEus						Y		
Actual impulse noise protection of ROC								
ACTINP-ROC-ds						Y		
ACTINP-ROC-us						Y		
Actual SNR margin of ROC								
SNRM-ROC-ds						Y		
SNRM-ROC-us						Y		

Table 7-29 – Support of line test, diagnostic and status parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
Update request flags and time stamps of test parameter								
UPDATE-TEST-NE						Y		
UPDATE-TEST-FE						Y		
STAMP-TEST-NE						Y		
STAMP-TEST-FE						Y		
OLR time stamps								
STAMP-OLR-ds						Y		
STAMP-OLR-us						Y		
ITU-T G.993.5 specific (Vectoring)								
XLINSCds								Y
XLINGds								Y
XLINBANDSds								Y
XLINpsds								Y
XLINSCus								Y
XLINGus								Y
XLINBANDSus								Y
XLINpsus								Y
Actual RI POLICY								
ACTRIPOLICYus						Y		
ACTRIPOLICYds						Y		
ATTNDR Diagnostic parameters								
ATTNDR_ACTMETHOD						Y		Y (Note 1)
ATTNDR_ACTINPds						Y		Y (Note 1)
ATTNDR_ACTINPus						Y		Y (Note 1)
ATTNDR_ACTINP_REINds						Y		Y (Note 1)
ATTNDR_ACTINP_REINus						Y		Y (Note 1)
ATTNDR_ACTDELAYds						Y		Y (Note 1)
ATTNDR_ACTDELAYus						Y		Y (Note 1)
Aggregate Achievable Net Data Rate								
AGGACHNDR_NE								Y (Note 2)
AGGACHNDR_FE								Y (Note 2)
Line status parameters G.993.5								
ACTVECTORMODE						Y (Note 3)		Y

Table 7-29 – Support of line test, diagnostic and status parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
VDSL2-LR status parameter								
VDSL2-LR_ACTOPTTYPE						Y (Note 5)		Y (Note 4)
STRONGFEXT MODE status parameter								
STRONGFEXT_ACTMODE								Y (Note 6)
Loop diagnostic parameters								
Loop diagnostic mode status (LDS)			**Y**	**Y**	**Y**	**Y**		
Loop diagnostic mode results status (LDR)			**Y**	**Y**	**Y**	**Y**		

NOTE 1 – Those parameters apply only to ITU-T G.998.4 when used in conjunction with ITU-T G.993.2.
NOTE 2 – Those parameters apply only to ITU-T G.998.4 when ITU-T G.993.5 is selected.
NOTE 3 – This parameter applies only when Annex X or Annex Y is supported.
NOTE 4 – This parameter applies only when Annex B is supported.
NOTE 5 – This parameter applies only when Annex D is supported.
NOTE 6 – This parameter applies only when Annex A is supported.

Table 7-30 – Channel test, diagnostic and status parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
Actual data rate	7.5.2.1	R (M)			R (O)	R (O)
Previous data rate	7.5.2.2	R (M)			R (O)	R (O)
Actual interleaving delay	7.5.2.3	R (M)		R (O)	R (O)	R (O)
ACTINP	7.5.2.4	R (M/O) (Note 2)		R (O)	R (O)	R (O)
INPREPORT	7.5.2.5	R (M)		R (O)	R (O)	R (O)
ACTNDR	7.5.2.8	R (M)		R (O)	R (O)	R (O)
ACTINP_REIN	7.5.2.9	R (M)		R (O)	R (O)	R (O)
Actual framer setting						
NFEC	7.5.2.6.1	R (M/O) (Note 1)		R (O)		R (O)
RFEC	7.5.2.6.2	R (M/O) (Note 1)		R (O)		R (O)
LSYMB	7.5.2.6.3	R (M/O) (Note 1)		R (O)		R (O)
INTLVDEPTH	7.5.2.6.4	R (M/O) (Note 1)		R (O)		R (O)
INTLVBLOCK	7.5.2.6.5	R (M)		R (O)		R (O)
RSPERDTU	7.5.2.6.6	R (M)		R (O)		R (O)

Table 7-30 – Channel test, diagnostic and status parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
Actual latency path						
LPATH	7.5.2.7	R (M/O) (Note 1)		R (O)		R (O)
NOTE 1 – These parameters are R (M) on the Q-interface for [ITU-T G.993.2] and R (O) for all other ITU-T Recommendations, which support them. NOTE 2 – This parameter is R (O) on the Q-interface for [ITU-T G.992.1] and R (M) for all other ITU-T Recommendations that support it.						

Table 7-31 – Support of channel test, diagnostic and status parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]
Actual data rate	Y	Y	Y	Y	Y	Y	
Previous data rate	Y	Y	Y	Y	Y	Y	
Actual interleaving delay	Y	Y	Y	Y	Y	Y	
ACTINP	Y		Y	Y	Y	Y	
INPREPORT						Y	
ACTNDR							Y
ACTINP_REIN							Y
Actual framer setting							
NFEC	Y	Y	Y	Y	Y	Y	
RFEC	Y	Y	Y	Y	Y	Y	
LSYMB	Y	Y	Y	Y	Y	Y	
INTLVDEPTH	Y	Y	Y	Y	Y	Y	
INTLVBLOCK						Y	
RSPERDTU							Y
Actual latency path							
LPATH	Y	Y	Y	Y	Y	Y	

Table 7-32 – Packet transfer mode data path failures

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Near-end (xTU-C) failures					
Out of sync (OOS) failure	7.1.5.1.1	R (M)	R (O)		
Far-end (xTU-R) failures					
Far-end out of sync (OOS-FE) failure	7.1.5.2.1	R (M)		R (O)	

Table 7-33 – Support of packet transfer mode data path failures per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]
Near-end failures						
Out of sync (OOS) failure			Y		Y	Y
Far-end failures						
Far-end out of sync (OOS-FE) failure			Y		Y	Y

Table 7-34 – Packet transfer mode data path performance monitoring parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Near-end (xTU-C) performance monitoring counters (current and previous 15 min interval)					
CRC-P counter 15 min	7.2.5.1.1	R (M)	R (O)		
CRCP-P counter 15 min	7.2.5.1.1	R (M)	R (O)		
CV-P counter 15 min	7.2.5.1.2	R (M)	R (O)		
CVP-P counter 15 min	7.2.5.1.2	R (M)	R (O)		
Near-end (xTU-C) performance monitoring counters (current and previous 24 h interval)					
CRC-P counter 24 h	7.2.5.1.1	R (M)	R (O)		
CRCP-P counter 24 h	7.2.5.1.1	R (M)	R (O)		
CV-P counter 24 h	7.2.5.1.2	R (M)	R (O)		
CVP-P counter 24 h	7.2.5.1.2	R (M)	R (O)		
Far-end (xTU-R) performance monitoring counters (current and previous 15 min interval)					
CRC-PFE counter 15 min	7.2.5.2.1	R (M)		R (O)	
CRCP-PFE counter 15 min	7.2.5.2.1	R (M)		R (O)	
CV-PFE counter 15 min	7.2.5.2.2	R (M)		R (O)	
CVP-PFE counter 15 min	7.2.5.2.2	R (M)		R (O)	
Far-end (xTU-R) performance monitoring counters (current and previous 24 h interval)					
CRC-PFE counter 24 h	7.2.5.2.1	R (M)		R (O)	
CRCP-PFE counter 24 h	7.2.5.2.1	R (M)		R (O)	
CV-PFE counter 24 h	7.2.5.2.2	R (M)		R (O)	
CVP-PFE counter 24 h	7.2.5.2.2	R (M)		R (O)	

Table 7-35 – Support of packet transfer mode data path performance monitoring parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]
Near-end performance monitoring counters (current and previous 15 min interval)						
CRC-P counter 15 min			Y		Y	Y
CRCP-P counter 15 min			Y		Y	Y
CV-P counter 15 min			Y		Y	Y
CVP-P counter 15 min			Y		Y	Y

Table 7-35 – Support of packet transfer mode data path performance monitoring parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]
Near-end performance monitoring counters (current and previous 24 h interval)						
CRC-P counter 24 h			Y		Y	Y
CRCP-P counter 24 h			Y		Y	Y
CV-P counter 24 h			Y		Y	Y
CVP-P counter 24 h			Y		Y	Y
Far-end performance monitoring counters (current and previous 15 min interval)						
CRC-PFE counter 15 min			Y		Y	Y
CRCP-PFE counter 15 min			Y		Y	Y
CV-PFE counter 15 min			Y		Y	Y
CVP-PFE counter 15 min			Y		Y	Y
Far-end performance monitoring counters (current and previous 24 h interval)						
CRC-PFE counter 24 h			Y		Y	Y
CRCP-PFE counter 24 h			Y		Y	Y
CV-PFE counter 24 h			Y		Y	Y
CVP-PFE counter 24 h			Y		Y	Y

Table 7-36 – Packet transfer mode data path configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T-/S-interface
Near-end (xTU-C) performance monitoring thresholds (15 min interval)					
CRC-P threshold 15 min	7.3.5.1	R/W (O)	R (O)		
CRCP-P threshold 15 min	7.3.5.1	R/W (O)	R (O)		
CV-P threshold 15 min	7.3.5.1	R/W (O)	R (O)		
CVP-P threshold 15 min	7.3.5.1	R/W (O)	R (O)		
Near-end (xTU-C) performance monitoring thresholds (24 h interval)					
CRC-P threshold 24 h	7.3.5.1	R/W (O)	R (O)		
CRCP-P threshold 24 h	7.3.5.1	R/W (O)	R (O)		
CV-P threshold 24 h	7.3.5.1	R/W (O)	R (O)		
CVP-P threshold 24 h	7.3.5.1	R/W (O)	R (O)		
Far-end (xTU-R) performance monitoring thresholds (15 min interval)					
CRC-PFE threshold 15 min	7.3.5.1	R/W (O)	R (O)		
CRCP-PFE threshold 15 min	7.3.5.1	R/W (O)	R (O)		
CV-PFE threshold 15 min	7.3.5.1	R/W (O)	R (O)		
CVP-PFE threshold 15 min	7.3.5.1	R/W (O)	R (O)		
Far-end (xTU-R) performance monitoring thresholds (24 h interval)					
CRC-PFE threshold 24 h	7.3.5.1	R/W (O)	R (O)		
CRCP-PFE threshold 24 h	7.3.5.1	R/W (O)	R (O)		
CV-PFE threshold 24 h	7.3.5.1	R/W (O)	R (O)		
CVP-PFE threshold 24 h	7.3.5.1	R/W (O)	R (O)		

Table 7-37 – Support packet transfer mode data path configuration parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]
Near-end performance monitoring thresholds (15 min interval)						
CRC-P threshold 15 min			Y		Y	Y
CRCP-P threshold 15 min			Y		Y	Y
CV-P threshold 15 min			Y		Y	Y
CVP-P threshold 15 min			Y		Y	Y
Near-end performance monitoring thresholds (24 h interval)						
CRC-P threshold 24 h			Y		Y	Y
CRCP-P threshold 24 h			Y		Y	Y
CV-P threshold 24 h			Y		Y	Y
CVP-P threshold 24 h			Y		Y	Y
Far-end performance monitoring thresholds (15 min interval)						
CRC-PFE threshold 15 min			Y		Y	Y
CRCP-PFE threshold 15 min			Y		Y	Y
CV-PFE threshold 15 min			Y		Y	Y
CVP-PFE threshold 15 min			Y		Y	Y
Far-end performance monitoring thresholds (24 h interval)						
CRC-PFE threshold 24 h			Y		Y	Y
CRCP-PFE threshold 24 h			Y		Y	Y
CV-PFE threshold 24 h			Y		Y	Y
CVP-PFE threshold 24 h			Y		Y	Y

Table 7-38 – Data gathering configuration profile

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface
Data gathering					
LOGGING_DEPTH_EVENT_PERCENTAGE_Oi	7.3.6.1	R/W (O)			
LOGGING_DEPTH_EVENT_PERCENTAGE_Ri	7.3.6.2	R/W (O)		R/W (O)	
LOGGING_DEPTH_REPORTING_O	7.3.6.3	R/W (O)			
LOGGING_DEPTH_REPORTING_R	7.3.6.4	R/W (O)		R/W (O)	
LOGGING_REPORT_NEWER_FIRST	7.3.6.5	R/W (O)		R/W (O)	

Table 7-39 – Support of data gathering configuration parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
Data gathering								
LOGGING_DEPTH_ EVENT_PERCENTAGE_Oi						Y		
LOGGING_DEPTH_ EVENT_PERCENTAGE_Ri						Y		
LOGGING_DEPTH_ REPORTING_O						Y		
LOGGING_DEPTH_ REPORTING_R						Y		
LOGGING_REPORT_ NEWER_FIRST						Y		

Table 7-40 – Data gathering reporting parameters

Category/element	Specified in clause	Q-interface	U-C interface	U-R interface	T/S interface	G-interface
LOGGING_DEPTH_O	7.5.3.1	R (O)				
LOGGING_DEPTH_R	7.5.3.2	R (O)		R (O)		R (O)
ACT_logging_depth_reporting_O	7.5.3.3	R (O)				
ACT_logging_depth_reporting_R	7.5.3.4	R (O)				R (O)
EVENT_TRACE_BUFFER_O	7.5.3.5	R (O)				
EVENT_TRACE_BUFFER_R	7.5.3.6	R (O)		R (O)		R (O)

Table 7-41 – Support of data gathering reporting parameters per Recommendation

Category/element	[ITU-T G.992.1]	[ITU-T G.992.2]	[ITU-T G.992.3]	[ITU-T G.992.4]	[ITU-T G.992.5]	[ITU-T G.993.2]	[ITU-T G.998.4]	[ITU-T G.993.5]
LOGGING_DEPTH_O						Y		
LOGGING_DEPTH_R						Y		
ACT_logging_depth_ reporting_O						Y		
ACT_logging_depth_ reporting_R						Y		
EVENT_TRACE_BUFFER_O						Y		
EVENT_TRACE_BUFFER_R						Y		

Appendix I

Processing examples

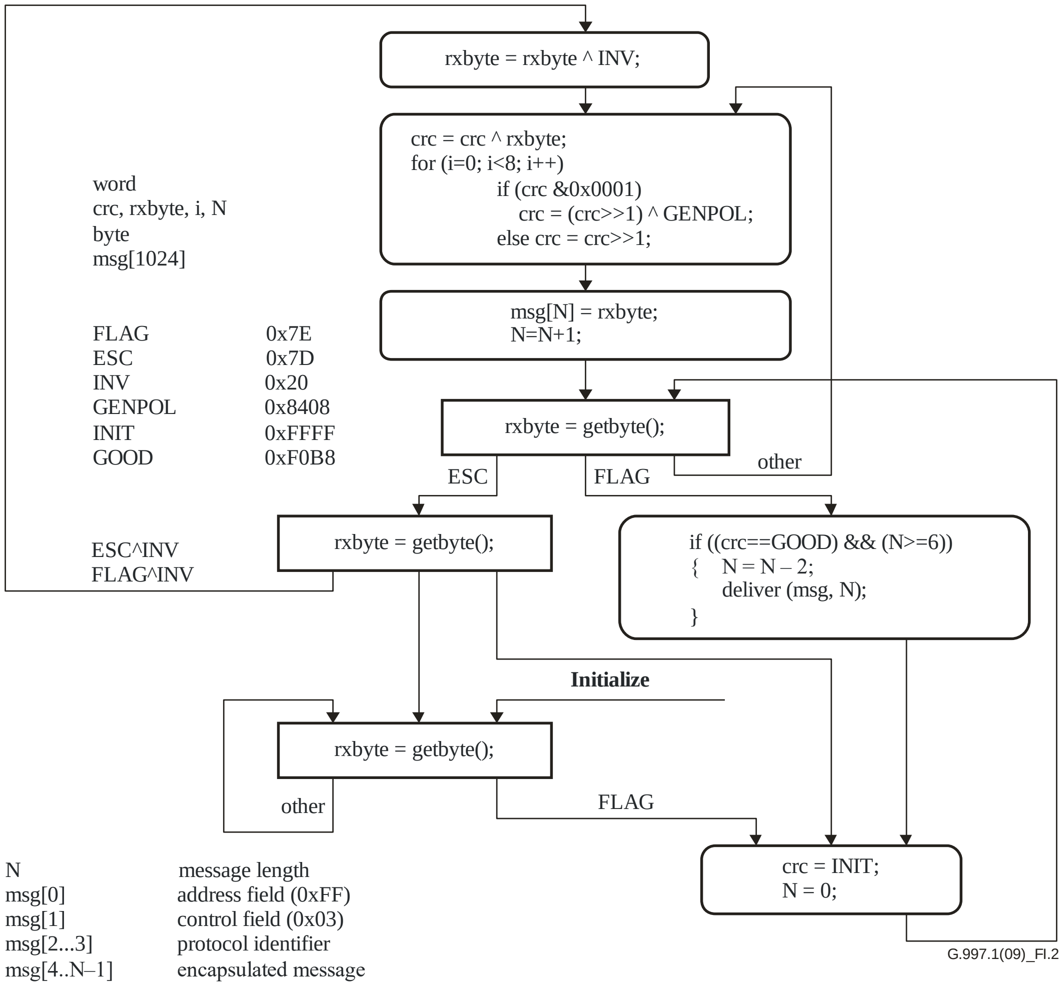
(This appendix does not form an integral part of this Recommendation.)

I.1 Illustration of transmitter processing

```
#define       INIT     0xFFFF
#define       FLAG     0x7E
#define       ESC      0x7D
#define       INV      0x20
#define       GENPOL   0x8408
unsigned char     msg[1024], temp;   /* 8 bit unsigned char   */
unsigned short int crc;              /* 16 bit unsigned integer */
int           N, j, msglen;
{
     crc = INIT;
     msg[0] = 0xFF;
     crc = update_crc(msg[0], crc);
     msg[1] = 0x03;
     crc = update_crc(msg[1], crc);
     N = 2;
     j = 0;
     while (j < msglen)
     {
          temp = xmit_msg_byte(j++);
          crc = update_crc(temp, crc);
          if ( (temp = FLAG) || (temp = ESC) )
          {
               msg[N] = ESC;
               msg[N+1] = temp ^ INV;
               N = N + 2;
          }
          else
          {
               msg[N] = temp;
               N = N + 1;
          }
     }
     crc = ~crc;
     msg [N] = crc & 0x00FF;
     msg[N+1] = (crc >> 8) & 0x00FF;
     xmit_msg();
}

unsigned short int update_crc(unsigned char new_byte, unsigned short int
crc_reg)
{
int  i;
     crc_reg = crc_reg ^ new_byte;
     for (i=0; i<8; i++)
          if (crc_reg & 0x0001)
               crc_reg = (crc_reg>>1) ^ GENPOL;
          else
               crc_reg = crc_reg >> 1;
     return (crc_reg);
}
```

I.2 Illustration of receiver processing



Appendix II

Downstream power back-off

(This appendix does not form an integral part of this Recommendation.)

II.1 Introduction

Figure II.1 shows a physical layer reference model that illustrates the application of DPBO. The objective of the method is to reduce the downstream power injected by the xTU-C at a flexibility point (remote node, cabinet) to the same level as would be expected to be found at the same point in the cable if the signal was injected at the exchange. So the degree of DPBO is controlled by a frequency dependent function of the electrical length of the cable (E-side length) from the exchange to the flexibility point. The method applies power back-off over a range of frequencies, but excludes higher frequencies that the exchange-hosted systems cannot reliably exploit.

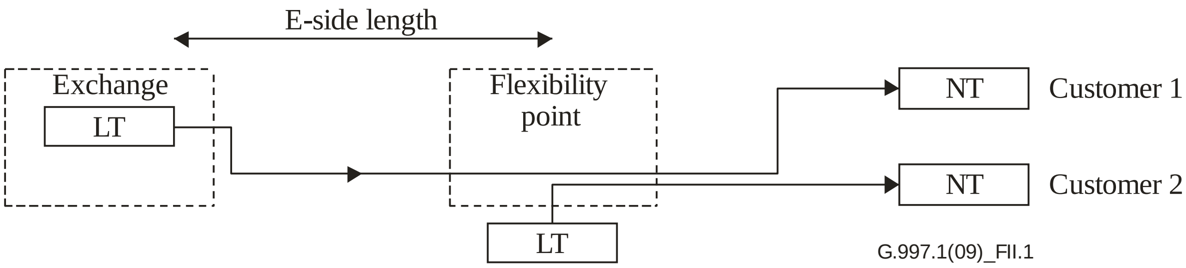


Figure II.1 – Physical layer reference model

This method does not exclude other methods of DPBO, using direct configuration of the parameter PSDMASKds.

A three parameters model of the loop insertion loss has been found to be satisfactory, i.e., $H(f,L) = \left(a + b \times \sqrt{f} + c \times f\right) \times L$ dB where L is a metric of electrical length of the E-side cable. Using this model, it has been found possible to track the insertion loss of the predominant gauges of E-side copper pairs with one set of parameters.

The resulting PSD mask for cabinet-based transmitters is a function of a number of parameters that are set by the NMS. The DPBO control information flows for generating the PSD mask are illustrated in Figure II.2. The modification of the downstream PSD mask is done in the ME of the access node. Without DPBO, the mask (PSDMASKds) used at the cabinet is the appropriate remote PSD mask specified in the relevant xDSL standard. With DPBO, a modified PSDMASKds is generated as a function of the E-side electrical length, maximum useful signal, the cable model parameters and the exchange PSD mask. Additionally, the modified PSD mask is subject to a low frequency override PSD mask that applies independently of DPBOESEL.

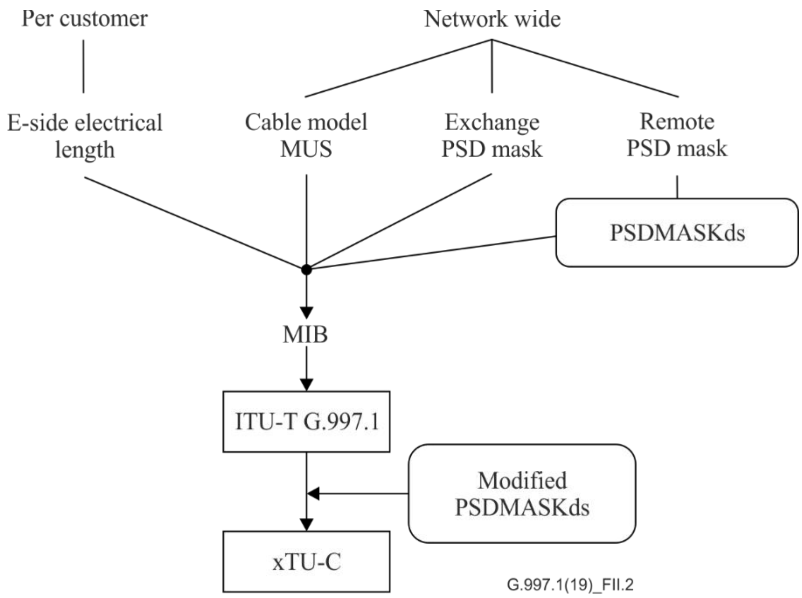


Figure II.2 – Downstream power back-off control information flows

II.2 Description of the downstream power back-off method

The configuration parameters of the DPBO defined in this Recommendation are summarized in Table II.1.

Table II.1 – Downstream power back-off configuration parameters

Parameter	Description
DPBOEPSD	Exchange site maximum PSD mask
DPBOPSDMASKds	Overall maximum PSD mask limit when DPBO is applied
DPBOESEL	Electrical length of exchange to cabinet cable
DPBOESCMA	E-side cable model parameter A
DPBOESCMB	E-side cable model parameter B
DPBOESCMC	E-side cable model parameter C
DPBOMUS	Assumed minimum usable PSD mask of exchange signals at remote site
DPBOFMIN	Lower bound on the DPBO frequency span
DPBOFMAX	Upper bound on the DPBO frequency span
DPBOLFO	Low frequency PSD mask override

If there exists a violation of monotonic frequency sequence in the set of breakpoints PSDMASKds(t_i, PSD_i), such that $t_d > t_{d+1}$, then the first step is to derive DPBOPSDMASKds and DPBOLFO from the set of breakpoints PSDMASKds where:

$$\text{DPBOPSDMASKds}(t_i, \text{PSD}_i) = \text{PSDMASKds}(t_i, \text{PSD}_i), \quad 0 < i \le d$$

$$\text{DPBOLFO}(t_i, \text{PSD}_i) = \text{PSDMASKds}(t_i, \text{PSD}_i), \quad d < i \le 32$$

If the frequency sequence in the set of breakpoints PSDMASKds(t_i, PSD$_i$) is monotonic, then DPBOLFO is assumed to be everywhere ≤–91.5 dBm/Hz.

The next step in generating the backed-off transmit PSD mask is to generate the predicted downstream exchange signal PSD mask (PEPSD(f)) at the remote site:

$$\text{PEPSD}(f) = \text{DPBOEPSD}(f) - \left(\text{DPBOESCMA} + \text{DPBOESCMB} \cdot \sqrt{f} + \text{DPBOESCMC} \cdot f\right) \cdot \text{DPBOESEL}$$

The assumed MUF from the exchange is the highest frequency *f* such that:

$$\text{PEPSD}(f) > \text{DPBOMUS}$$

Applying the DPBO mechanism directly will result in a practically difficult brick wall transition at the MUF. This is alleviated by introducing a minimum PSD mask between DPBOFMIN and DPBOFMAX with a smoother transition at the MUF and an overall noise floor of –91.5 dBm on the low frequency. The minimum PSD mask also implements the low frequency PSD mask override by taking the maximum of the DPBOLFO and the noise floor. The minimum PSD mask (DPBOMPSD(*f*)) is therefore defined between DPBOFMIN and F_1 = min(DPBOFMAX,MUF) as:

$$\text{DPBOMPSD}(f) = \begin{cases} \max\left[\text{DPBOLFO}(f), -91.5\right] \text{ dBm/Hz} & \text{for } f \le F_1 - 175 \text{ kHz} \\ \max\left[\text{DPBOLFO}(f), \frac{11.5}{175}\left(f - F_1\right) - 80\right] \text{ dBm/Hz} & \text{for } F_1 - 175 \text{ kHz} < f < F_1 \end{cases}$$

where *f* is expressed in kilohertz.

DPBO is then applied to PSDMASKds(*f*) in this band to create the overall downstream PSD mask for equipment at the remote flexibility point.

$$\text{RESULTMASKds}(f) = \begin{cases} \max[\min(\text{DPBOPSDMASKds}(f), \text{PEPSD}(f)), \text{DPBOMPSD}(f)] & \text{DPBOFMIN} \le f \le F_1 \\ \text{DPBOPSDMASKds}(f) & \text{Otherwise} \end{cases}$$

Figure II.3 shows the PSD mask and the resultant mask with DPBO applied.

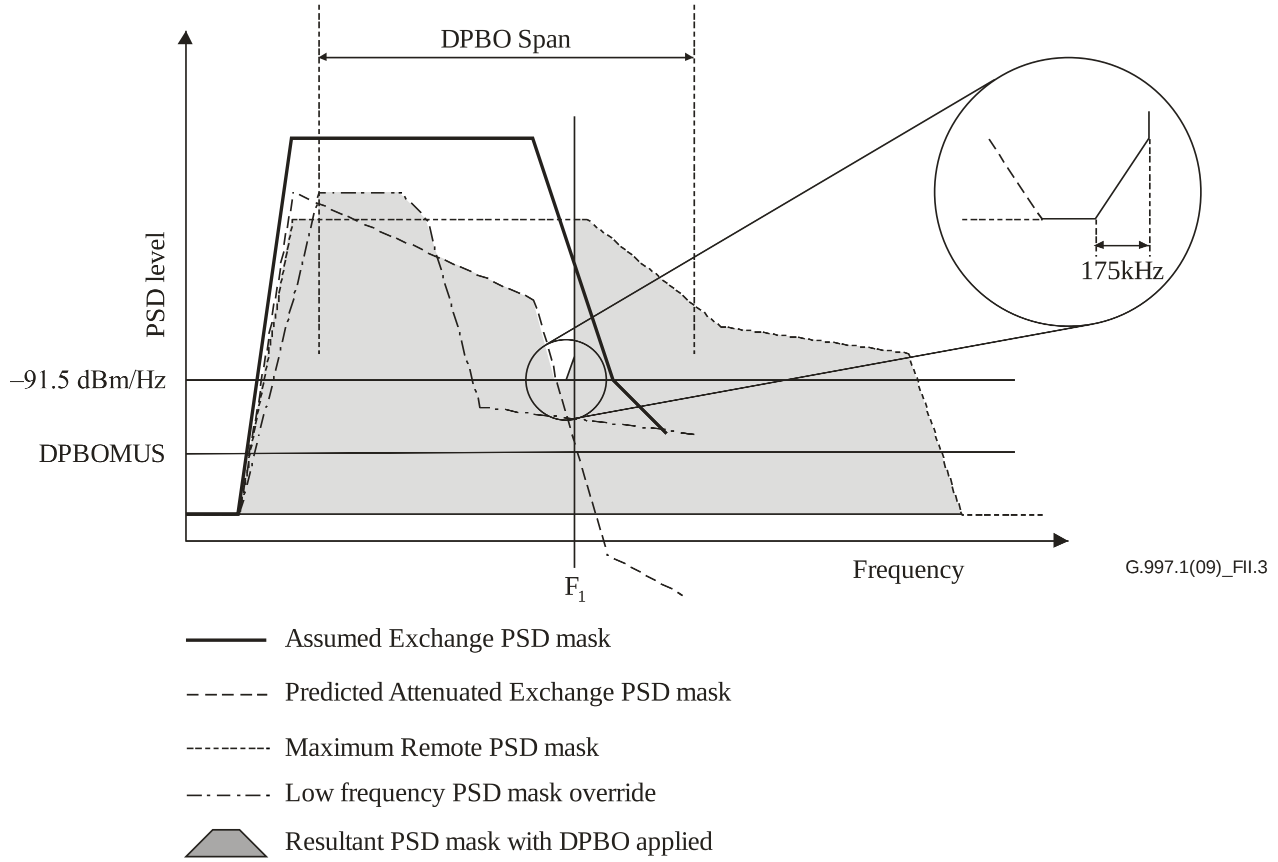


Figure II.3 – Creation of the mask with downstream power back-off

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