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**Amendment 2**  
(07/2016)

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

Digital sections and digital line system – Metallic access  
networks

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Physical layer management for G.fast transceivers  
**Amendment 2**

Recommendation ITU-T G.997.2 (2015) –  
Amendment 2

ITU-T



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# Recommendation ITU-T G.997.2

## Physical layer management for G.fast transceivers

### Amendment 2

#### Summary

Recommendation ITU-T G.997.2 specifies the physical layer management for fast access to subscriber terminals (G.fast) transmission systems. It specifies managed objects for configuration, fault, status, inventory and performance management.

Amendment 1 includes:

- New managed objects to support the test parameters of Amendment 1 to Recommendation ITU-T G.9701 (2014).
- New managed objects to support the low power modes of Amendment 1 to Recommendation ITU-T G.9701 (2014).
- Correction to the valid range of DELAYMAXds/us.
- Clarification regarding the generation of near-end failure.
- Fixes to several editorial typographical errors.

#### History

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1.2	ITU-T G.997.2 (2015) Amd. 1	2016-05-07	15	<a href="http://handle.itu.int/11.1002/1000/12555">11.1002/1000/12555</a>
1.3	ITU-T G.997.2 (2015) Amd. 2	2016-07-22	15	<a href="http://handle.itu.int/11.1002/1000/12799">11.1002/1000/12799</a>

#### Keywords

Distribution point unit, DPU, G.fast transceivers, management, performance monitoring.

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\* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

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# Recommendation ITU-T G.997.2

## Physical layer management for G.fast transceivers

### Amendment 2

*Editorial note: This is a complete-text publication. Modifications introduced by this amendment are shown in revision marks relative to Recommendation ITU-T G.997.2 (2015) plus its Cor.1 (2016) and Amd.1 (2016).*

#### 1 Scope

This Recommendation specifies the physical layer management for fast access to subscriber terminals (G.fast) transmission systems.

It specifies managed objects for configuration, fault, status, inventory and performance management. The list of managed objects applies at the distribution point unit-Northbound (DPU-NB) interface, relating to the "DPU-MIB" nomenclature used in [ITU-T G.9701]. The managed objects are defined to provide, at least, all the information necessary for translation into a YANG data model [b-IETF RFC 6020], although this does not exclude translation to other formats such as an abstract syntax notation one (ASN.1) (ITU-T X.680 series) management information base (MIB) description used in connection with the simple network management protocol (SNMP) [b-IETF RFC 1157]. The definition of the YANG data model for G.fast-managed objects is outside the scope of this Recommendation.

#### 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.994.1] Recommendation ITU-T G.994.1 (2012), *Handshake procedures for digital subscriber line transceivers*.
- [ITU-T G.9700] Recommendation ITU-T G.9700 (2014), *Fast access to subscriber terminals (G.fast) – Power spectral density specification*.
- [ITU-T G.9701] Recommendation ITU-T G.9701 (2014), *Fast access to subscriber terminals (G.fast) – Physical layer specification*.

#### 3 Definitions

##### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 managed resource** [b-ITU-T M.3010]: The abstraction of those aspects of a telecommunication resource (logical or physical) required for telecommunications management.

## 3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

**3.2.1 AdminStatus:** (Based on clause 12.1.1.7 of [ITU-T G.9701]) The AdminStatus represents the configured, desired state of the interface. The AdminStatus "up" is equivalent with the interface "enabled=true", where the desired link state is L0, L2.1N, L2.1B, or L2.2. The AdminStatus "down" is equivalent with the interface "enabled=false", where the desired link state is L3.

NOTE – The relation between the AdminStatus ("up" or "down") and the interface (enabled="true" or "false") is defined in the IETF YANG Data Model for Interface Management [b-IETF RFC 7223].

**3.2.2 anomaly:** 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.

**3.2.3 defect:** 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.

**3.2.4 empty array:** An array whose number of elements is zero.

**3.2.5 failure:** A 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".

**3.2.6 managed object:** The management view of a managed resource.

**3.2.7 DPU-NB interface:** The interface between the persistent management agent and the management entity of the distribution point unit.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ASN.1	Abstract Syntax Notation one
CV	Code Violation
CV-C	Code Violation – Channel
DPU	Distribution Point Unit
DPU-NB	DPU Northbound
DRA	Dynamic Resource Allocation
ES	Errored Second
FAST	Fast Access to Subscriber Terminals
FE	Far-End
FRA	Fast Rate Adaptation
FTTdp	Fibre To The distribution point
FTTx	Fibre To The x
FTU	FAST Transceiver Unit
FTU-O	FAST Transceiver Unit – Central office end (i.e., network operator end of the loop)
FTU-R	FAST Transceiver Unit – Remote side (i.e., subscriber end of the loop)

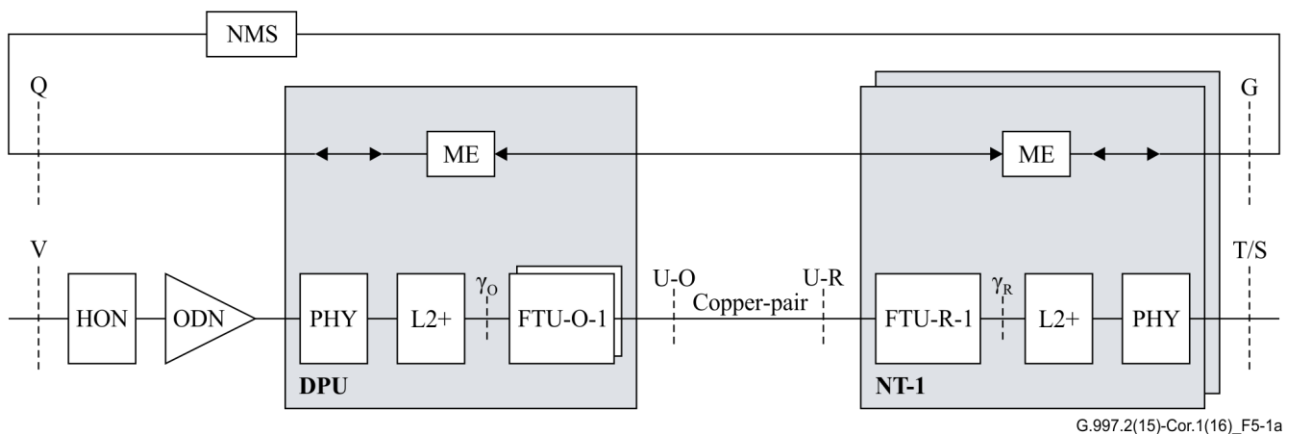


GDR	Gamma Data Rate
G.fast	fast access to subscriber terminals
LOM	Loss of Margin
LOM-FE	Far-End Loss of Margin
LOR	Loss of RMC
LOR-FE	Far-End Loss of RMC
LORS	LOR Second
LOS	Loss of Signal
LOS-FE	Far-End Loss of Signal
LOSS	LOS Second
LPR	Loss of Power
LPR-FE	Far-End Loss of Power
MIB	Management Information Base
MDU	Multi-Dwelling Unit
ME	Management Entity
NDR	Net Data Rate
NDRds	downstream Net Data Rate
NDRus	upstream Net Data Rate
NE	Network Element
NMS	Network Management System
NT	Network Termination
OLR	On-Line Reconfiguration
OSS	Operations Support Systems
PM	Performance Monitoring
PMA	Persistent Management Agent
PMD	Physical Media Dependent
PMS-TC	Physical Media Specific – Transmission Convergence
PSD	Power Spectral Density
REIN	Repetitive Electrical Impulse Noise
RMC	Robust Management Channel
RPA	RMC Parameter Adjustment
SES	Severely Errored Second
SNMP	Simple Network Management Protocol
SNR	Signal-to-Noise Ratio
SRA	Seamless Rate Adaptation
TDD	Time Division Multiplexing
TPS-TC	Transport Protocol Specific – Transmission Convergence

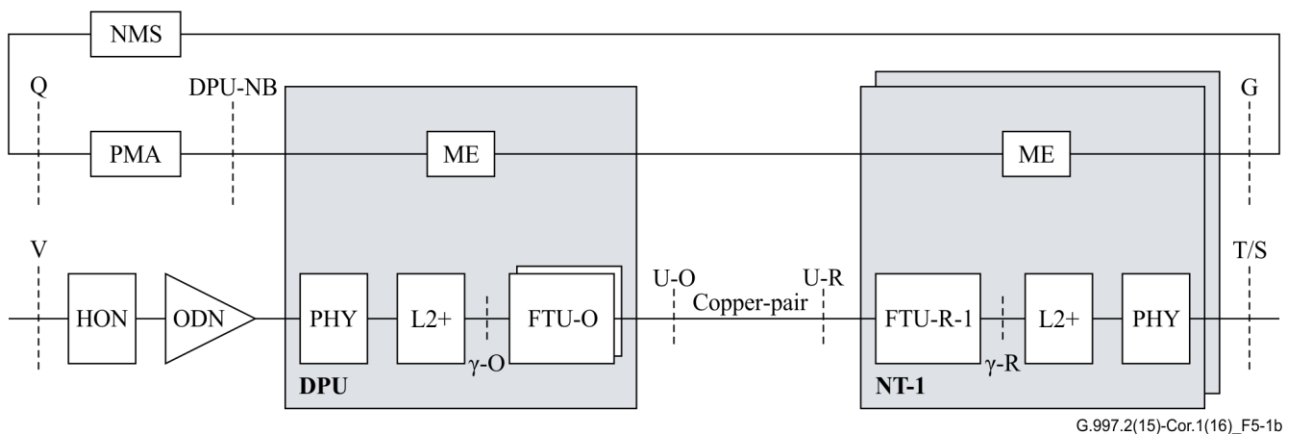
- TR        Threshold Report
- UAS      UnAvailable Second
- U-O      Loop interface – Central office end
- U-R      Loop interface – Remote side (i.e., subscriber end of the loop)

## 5 Management architecture

The management of an access node (AN) or a distribution point unit (DPU) is performed by the network management system (NMS), passing management information over the Q reference point to each AN's management entity (ME) (see Figure 5-1a) or through a persistent management gent (PMA) to the each DPU's ME (see Figure 5-1b). The NMS may also monitor each G.fast transceiver unit – remote side (FTU-R) via the related network termination's (NT's) ME and G reference point. The connection between the ME functions at the AN or DPU and at the NT is established over management channels provided by the G.fast transceiver unit – central office ends (FTU-Os) and FTU-Rs via the copper pairs.



**Figure 5-1a – Reference model of traditional AN deployment  
(shown for line 1 in all N lines ( $N \geq 1$ ) connected to an AN)**



**Figure 5-1b – Reference model of FTTdP deployment with PMA and DPU  
(shown for line 1 in all N lines ( $N \geq 1$ ) connected to a DPU)**

Appendix I contains additional information regarding the Broadband Forum considerations on the fibre to the distribution point (FTTdp) deployment scenario (see also [b-BBF TR-301]).

The fundamental purpose of the PMA (see Appendix I) is to allow the operations support systems (OSS)/NMS to perform all operations on a given DPU whether or not that DPU is actually powered. This includes the following PMA functionality:

- firmware download and management;
- initial provisioning;
- configuration, including rate control;
- test and diagnostics;
- statistics gathering;
- event reporting;
- performance monitoring (PM) history beyond current and previous interval counters;
- management protocol translation between Q interface and the DPU-Northbound interface (DPU-NB interface).

Some of these operations have limited capabilities when the DPU is without power. For example, statistics gathering is limited to the history present in the PMA, since the current information is not available from the DPU.

The OSS/NMS also still needs to be able to ascertain the true power state of the DPU as a whole, and of each given line, for example for diagnostics purposes. It can choose to take into account the power state of a DPU for various processes, e.g., a new firmware download, but does not have to.

While distribution points are at locations where local power is typically not available, DPUs may also be deployed at locations where local powering or forward powering is available (e.g., in multi-dwelling unit (MDU) basements or in fibre to the x (FTTx) cabinets). In this case, a PMA could still exist as a separate entity to the DPU (if the DPU could still be unpowered at times).

[ITU-T G.9701] defines the interfaces between the FTU-O (which is part of the AN or DPU) and the FTU-R (which is part of the NT). This Recommendation specifies the physical layer management for fast access to subscriber terminals (G.fast) transmission systems as seen by the NMS (if the FTU-O is in an AN, see Figure 5-1a) and as seen by the PMA (if the FTU-O is in a DPU, see Figure 5-1b).

Clause 7 and 8 specifies managed objects for configuration, fault, test, diagnostics, status, and inventory management, and for performance monitoring. The list of managed objects applies at the DPU-NB interface shown in Figure 5-1b, relating to the "DPU-MIB" naming as used in [ITU-T G.9701]. The managed objects are defined to provide at least all the information necessary for translation into a YANG data model [b-IETF RFC 6020], although this does not exclude translation to other formats such as an ASN.1 (X.680 series) MIB description used in connection with SNMP [b-IETF RFC 1157].

The definitions of the managed objects defined in clause 7 provide the following information:

- description;
- type;
- unit;
- valid values;
- default value (for configuration objects only);
- reference.

The list of managed objects defined in clauses 7 and 8 also applies at the Q reference point shown in Figure 5-1a.

## 6 Network management protocol

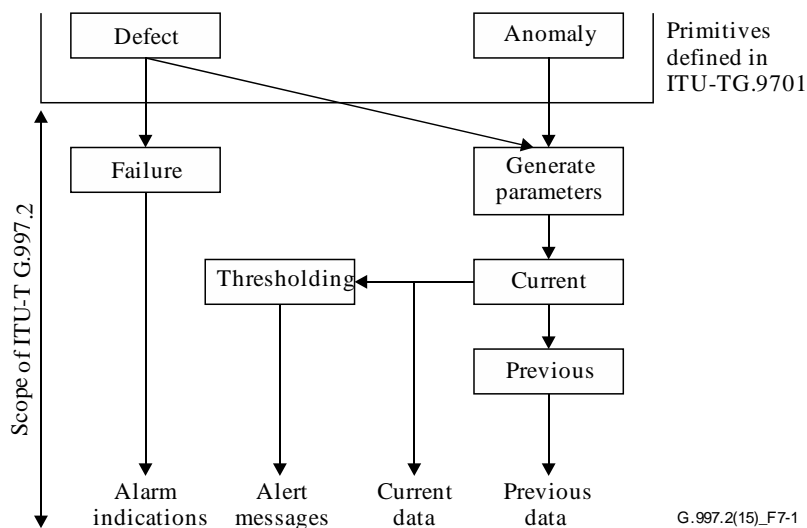
This Recommendation makes no presumption about which management protocol is used between the NMS and the AN (see Figure 5-1a) or between the PMA and the DPU (see Figure 5-1b) for transport of the G.fast-managed objects.

## 7 Managed objects

The list of managed objects contains six types of information:

- 1) configuration objects;
- 2) fault monitoring – failures (alarm indications);
- 3) fault monitoring – threshold crossing (alert messages);
- 4) performance monitoring objects (counters);
- 5) test, diagnostic and status objects;
- 6) inventory objects.

Figure 7-1 shows the in-service performance monitoring process. The primitives are specified in [ITU-T G.9701].



**Figure 7-1 – In-service performance monitoring process**

As [ITU-T G.9701] supports a DPU with up to 128 lines, provisioning every managed object for every G.fast port on the DPU may become burdensome. Therefore, the DPU configuration management (as defined in the Broadband Forum) defines G.fast configuration profiles, as well as a mechanism to associate these profiles to the individual ports. The definition of G.fast configuration profiles is outside the scope of this Recommendation. The allocation of the individual G.fast-managed objects (as defined in this Recommendation) to G.fast configuration profiles is addressed within the scope of the Broadband Forum.

NOTE – The "configuration profiles" are not the "Profiles" discussed in clause 6 of [ITU-T G.9701]. This clause uses the term "profile" for simplifying the configuration of [ITU-T G.9701] ports on a DPU in the field. Clause 6 of [ITU-T G.9701] is a discussion of a technique for defining the native capabilities (e.g., the particular subset of [ITU-T G.9701]) supported by a particular G.fast transceiver.

At the DPU-NB interface, a line is configured through the following information:

- line configuration objects (see Table 7-1) for the line;
- channel configuration objects (see Table 7-2) for the downstream channel;

- channel configuration objects (see Table 7-2) for the upstream channel;
- data path configuration objects (see Table 7-3) for the downstream data path;
- data path configuration objects (see Table 7-3) for the upstream data path.

Line configuration objects relate to the physical media dependent (PMD) sublayer and the robust management channel (RMC). Channel configuration objects relate to the bearer channel-related aspects of the physical media specific – transmission convergence (PMS-TC) sublayer. Data path configuration objects relate to the transport protocol specific – transmission convergence (TPS-TC) sublayer.

At the DPU-NB interface, a line is monitored through the following information:

- line failures (see Table 7-4);
- channel failures (see Table 7-5);
- data path failures (see Table 7-6);
- line performance monitoring objects (see Table 7-7);
- channel performance monitoring objects (see Table 7-8) for the downstream channel;
- channel performance monitoring objects (see Table 7-8) for the upstream channel;
- data path performance monitoring objects (see Table 7-9) for the downstream data path;
- data path performance monitoring objects (see Table 7-9) for the upstream data path;
- line test, diagnostics and status objects (see Table 7-10);
- channel test, diagnostics and status objects (see Table 7-11) for the downstream channel;
- channel test, diagnostics and status objects (see Table 7-11) for the upstream channel;
- data path test, diagnostic and status objects (see Table 7-12) for the downstream channel;
- data path test, diagnostic and status objects (see Table 7-12) for the upstream channel;
- inventory objects (see Table 7-13).

As [ITU-T G.9701] supports a DPU with up to 128 lines, maintaining the performance monitoring and the test, diagnostic and status information for every line may become burdensome. Although access to all mandatory managed objects shall be supported at all times for all ports on the DPU at the DPU-NB interface towards the PMA (see Figure 5-1), the objects may not be maintained within the management entity of the DPU simultaneously for all lines at all times. Although reasonable performance shall be provided at the DPU-NB interface for access to the managed objects of any line, this Recommendation does not define specific performance requirements at this interface.

When the update request flag for a test parameter group (see clause 7.1.9) is set (its value is changed from 0 to 1), the parameters of the associated test parameter groups shall be updated in the DPU-MIB within the update time period specified in Table 7-0. The update request flag for the associated test parameter group is defined in the DPU-MIB and is independent of any autonomous update process in the system. The update request flag shall be reset (its value changed back to 0) by the DPU after the request parameter update is complete. The reset shall be within a period that is shorter than the reset time period specified in Table 7-0 to allow reception of another update request. The reset time period starts since the last time the update request flag was set (externally or by an autonomous process in the system). This applies only to the elements maintained in the DPU.

Test parameters and status parameters shall be updated in L0, L2.1N, L2.1B and L2.2 link states, unless explicitly stated differently in [ITU-T G.9701]. The GDRds/us and ATTGDRds/us shall be updated only in L0 state.

**Table 7-0 – Test parameter groups**

Test parameter group (Note)	Update time period	Reset time period
NE test parameter group 1 (NE-G1)	10 seconds	3 minutes
FE test parameter group 1 (FE-G1)	15 seconds	3 minutes
NE test parameter group 2 (NE-G2)	3 minutes	10 minutes
FE test parameter group 2 (FE-G2)	3 minutes	10 minutes
NOTE – The test parameters contained in each test parameter group are defined in Table 7-10 and Table 7-11.		

Tables 7-1 to 7-11 indicate the status of each managed object over the DPU-NB interface:

- R: Read only
- W: Write only
- R/W: Read and write
- (M): Mandatory
- (O): Optional

Entries in Tables 7-1 to 7-11 labelled with names containing the separator "/" represent multiple objects whose names are obtained by considering all combinations of the elements isolated with the separator. For example, the entry labelled with the name A/B\_C/D\_E/F represents eight objects with names A\_C\_E, A\_C\_F, A\_D\_E, A\_D\_F, B\_C\_E, B\_C\_F, B\_D\_E, B\_D\_F. Also, the entry labelled with the name Ads/us represents two objects with names Ads and Aus. Near-end (-NE) objects apply to the FTU-O, while far-end (-FE) objects apply to the FTU-R.

**Table 7-1 – Line configuration objects**

Category/object	Defined in clause:	DPU-NB interface
<b>Profiles</b>		
[ITU-T G.9701] profiles enabling (PROFILES)	7.1.0.1	R/W (M)
<b>Time division Duplexing (TDD)</b>		
Symbol periods per TDD frame (MF)	7.1.1.1	R/W (M)
Symbol periods per TDD frame dedicated for downstream transmission (Mds)	7.1.1.2	R/W (M)
Cyclic extension (CE)	7.1.1.3	R/W (M)
<b>Power and spectrum usage</b>		
MAXATPds	7.1.2.1	R/W (M)
MAXATPus	7.1.2.2	R/W (M)
CARMASKds	7.1.2.3	R/W (M)
CARMASKus	7.1.2.4	R/W (M)
MIBPSDMASKds	7.1.2.5	R/W (M)
MIBPSDMASKus	7.1.2.6	R/W (M)
RFIBANDS	7.1.2.7	R/W (M)
IARBANDS	7.1.2.8	R/W (M)
UPBOPSDA	7.1.2.9	R/W (M)
UPBOPSDB	7.1.2.10	R/W (M)

**Table 7-1 – Line configuration objects**

Category/object	Defined in clause:	DPU-NB interface
UPBOKL	7.1.2.11	R/W (M)
UPBOKLF	7.1.2.12	R/W (M)
UPBOKLREF	7.1.2.13	R/W (M)
<i>Noise margins</i>		
TARSNRMds	7.1.3.1	R/W (M)
TARSNRMus	7.1.3.2	R/W (M)
MAXSNRMus	7.1.3.3	R/W (M)
MINSNRMds	7.1.3.4	R/W (M)
MINSNRMus	7.1.3.5	R/W (M)
<i>Seamless rate adaptation (SRA)</i>		
SRA-USNRMds	7.1.4.1	R/W (M)
SRA-UTIMEds	7.1.4.2	R/W (M)
SRA-USNRMus	7.1.4.3	R/W (M)
SRA-UTIMEus	7.1.4.4	R/W (M)
SRA-DSNRMds	7.1.4.5	R/W (M)
SRA-DTIMEds	7.1.4.6	R/W (M)
SRA-DSNRMus	7.1.4.7	R/W (M)
SRA-DTIMEus	7.1.4.8	R/W (M)
<i>Fast rate adaptation (FRA)</i>		
FRA-TIMEds	7.1.5.1	R/W (M)
FRA-TIMEus	7.1.5.2	R/W (M)
FRA-NTONESds	7.1.5.3	R/W (M)
FRA-NTONESus	7.1.5.4	R/W (M)
FRA-RTXUCds	7.1.5.5	R/W (M)
FRA-RTXUCus	7.1.5.6	R/W (M)
FRA-VENDISCds	7.1.5.7	R/W (M)
FRA-VENDISCus	7.1.5.8	R/W (M)
<i>Robust management channel (RMC)</i>		
TARSNRM-RMCds	7.1.6.1	R/W (M)
TARSNRM-RMCus	7.1.6.2	R/W (M)
MINSNRM-RMCds	7.1.6.3	R/W (M)
MINSNRM-RMCus	7.1.6.4	R/W (M)
MAXBL-RMCds	7.1.6.5	R/W (M)
MAXBL-RMCus	7.1.6.6	R/W (M)

**Table 7-1 – Line configuration objects**

Category/object	Defined in clause:	DPU-NB interface
<b><i>Vectoring</i></b>		
FEXT cancellation enabling/disabling downstream (FEXT_TO_CANCEL_ENABLEds)	7.1.7.1	R/W (M)
FEXT cancellation enabling/disabling upstream (FEXT_TO_CANCEL_ENABLEus)	7.1.7.2	R/W (M)
<u>XLOG requested subcarrier group size (XLOGREQds)</u>	<u>7.1.7.3</u>	<u>R/W (O)</u>
<u>XLOG requested disturber index (XLOGDREQds)</u>	<u>7.1.3.4</u>	<u>R/W (O)</u>
<b><i>Fast-retrain policy</i></b>		
LOS-PERSISTENCYds	7.1.8.1	R/W (M)
LOS-PERSISTENCYus	7.1.8.2	R/W (M)
LOM-PERSISTENCYds	7.1.8.3	R/W (M)
LOM-PERSISTENCYus	7.1.8.4	R/W (M)
LOR-PERSISTENCYds	7.1.8.5	R/W (M)
LOR-PERSISTENCYus	7.1.8.6	R/W (M)
REINIT_TIME_THRESHOLDds	7.1.8.7	R/W (M)
REINIT_TIME_THRESHOLDus	7.1.8.8	R/W (M)
LOW_ETR_THRESHOLDds	7.1.8.9	R/W (M)
LOW_ETR_THRESHOLDus	7.1.8.10	R/W (M)
<b><i>Update test parameters request</i></b>		
UPDATE-NE-TEST	7.1.9.1	R/W (M)
UPDATE-FE-TEST	7.1.9.2	R/W (M)
<b><i>Low power modes</i></b>		
L2-TARSNRMds/us	7.1.10.1	R/W (M)
L2.1-MAXSNRMds/us	7.1.10.2	R/W (M)
L2-MAXPSDR	7.1.10.3	R/W (M)
L2.1-SRA-USNRMds	7.1.10.4	R/W(M)
L2.1-SRA-USNRMus	7.1.10.5	R/W(M)
L2.1-SRA-DSNRMds	7.1.10.6	R/W(M)
L2.1-SRA-DSNRMus	7.1.10.7	R/W(M)



**Table 7-2 – Channel configuration objects**

Category/object	Defined in clause:	DPU-NB interface
<b>Data rate (downstream/upstream)</b>		
Maximum net data rate (NDR) (MAXNDR ds/us)	7.2.1.1	R/W (M)
Minimum expected throughput (MINETRds/us)	7.2.1.2	R/W (M)
Maximum gamma data rate (GDR) (MAXGDRds/us)	7.2.1.3	R/W (M)
Minimum gamma data rate (MINGDRds/us)	7.2.1.4	R/W (M)
<b>Retransmission (downstream/upstream)</b>		
DELAYMAXds/us	7.2.2.1	R/W (M)
INPMIN_SHINEDs/us	7.2.2.2	R/W (M)
SHINERATIOds/us	7.2.2.3	R/W (M)
INPMIN_REINDs/us	7.2.2.4	R/W (M)
IAT_REINDs/us	7.2.2.5	R/W (M)
RNRATIOds/us	7.2.2.6	R/W (M)
RTX_TESTMODEds/us	7.2.2.7	R/W (M)
<b>Low power modes</b>		
L2.1-MAXNDRds/us	7.2.3.1	R/W (M)
L2.2-MAXNDR	7.2.3.2	R/W (M)
L2.1-MINETRds/us	7.2.3.3	R/W (M)
L2.2-MINETR	7.2.3.4	R/W (M)
L2.1-MINETR-EXITds/us	7.2.3.5	R/W (M)

**Table 7-3 – Data path configuration objects**

Category/object	Defined in clause:	DPU-NB interface
TPS_TESTMODE	7.3.1	R/W (M)
DRA_TESTMODE	7.3.2	R/W (M)

**Table 7-4 – Line failures**

Category/object	Defined in clause:	DPU-NB interface
<b>Near-end (FTU-O) failures</b>		
Loss of signal (LOS)	7.4.1.1	R (M)
Loss of margin (LOM)	7.4.1.2	R (M)
Loss of RMC (LOR)	7.4.1.3	R (M)
Loss of power (LPR)	7.4.1.4	R (M)
<b>Far-end (FTU-R) failures</b>		
Far-end loss of signal (LOS-FE) failure	7.4.2.1	R (M)

**Table 7-4 – Line failures**

Category/object	Defined in clause:	DPU-NB interface
Far-end loss of margin (LOM-FE) failure	7.4.2.2	R (M)
Far-end loss of RMC (LOR-FE) failure	7.4.2.3	R (M)
Far-end loss of power (LPR-FE) failure	7.4.2.4	R (M)
<i>Initialization failures</i>		
Line init (LINIT) failure	7.4.3.1	R (M)

**Table 7-5 – Channel failures**

Category/object	Defined in clause:	DPU-NB interface
<i>Near-end (FTU-O) failures</i>		
<i>Far-end (FTU-R) failures</i>		

**Table 7-6 – Data path failures**

Category/object	Defined in clause:	DPU-NB interface
<i>Near-end (FTU-O) failures</i>		
<i>Far-end (FTU-R) failures</i>		

**Table 7-7 – Line performance monitoring objects**

Category/object	Defined in clause:	DPU-NB interface
<i>Near-end (FTU-O)/Far-end (FTU-R) performance monitoring counters (current/previous 15 min/24 h interval)</i>		
Measured time (CURR/PREV_NE/FE_15/24_L_TIME)	7.7.1	R (M)
Invalid data flag (PREV_NE/FE_15/24_L_INVALID)	7.7.2	R (M)
Time Stamp (PREV_NE/FE_15/24_L_STAMP)	7.7.3	R (M)
LOS failure counter (CURR/PREV_NE/FE_15/24_LOS)	7.7.4	R (M)

**Table 7-7 – Line performance monitoring objects**

<b>Category/object</b>	<b>Defined in clause:</b>	<b>DPU-NB interface</b>
LOM failure counter (CURR/PREV_NE/FE_15/24_LOM)	7.7.5	R (M)
LOR failure counter (CURR/PREV_NE/FE_15/24_LOR)	7.7.6	R (M)
LPR failure counter (CURR/PREV_NE/FE_15/24_LPR)	7.7.7	R (M)
ES counter (CURR/PREV_NE/FE_15/24_ES)	7.7.8	R (M)
Severely errored second (SES) counter (CURR/PREV_NE/FE_15/24_SES)	7.7.9	R (M)
LOSS counter (CURR/PREV_NE/FE_15/24_LOSS)	7.7.10	R (M)
LOR second (LORS) counter (CURR/PREV_NE/FE_15/24_LORS)	7.7.11	R (M)
Unavailable second (UAS) counter (CURR/PREV_NE/FE_15/24_UAS)	7.7.12	R (M)
<b><i>Initialization performance monitoring counters (current/previous 15 min/24 h interval)</i></b>		
Full inits counter (CURR/PREV_15/24_FULL_INITS)	7.7.13	R (M)
Failed full inits counter (CURR/PREV_15/24_FAILEDFULL_INITS)	7.7.14	R (M)
Fast inits counter (CURR/PREV_15/24_FAST_INITS)	7.7.15	R (M)
Failed Fast inits counter (CURR/PREV_15/24_FAILEDFAST_INITS)	7.7.16	R (M)
<b><i>Short interruption performance monitoring counters (current/previous 15 min/24 h interval)</i></b>		
LPR_INTRPT counter (CURR/PREV_15/24_LPR_INTRPT)	7.7.17	R (M)
HRI_INTRPT counter (CURR/PREV_15/24_HRI_INTRPT)	7.7.18	R (M)
SPONT_INTRPT counter (CURR/PREV_15/24_SPONT_INTRPT)	7.7.19	R (M)
<b><i>Near-end (FTU-O)/far-end (FTU-R) initiated OLR/FRA performance monitoring counters (current and previous 15 min/24 h interval)</i></b>		
Successful bitswap counter (CURR/PREV_NE/FE_15/24_BSW)	7.7.20	R (M)
Successful autonomous SRA counter (CURR/PREV_NE/FE_15/24_SRA)	7.7.21	R (M)
Successful FRA counter (CURR/PREV_NE/FE_15/24_FRA)	7.7.22	R (M)
Successful RPA counter (CURR/PREV_NE/FE_15/24_RPA)	7.7.23	R (M)

**Table 7-7 – Line performance monitoring objects**

Category/object	Defined in clause:	DPU-NB interface
<i>Near-end (FTU-O) initiated TIGA performance monitoring counters (current and previous 15 min/24 h interval)</i>		
Successful TIGA counter (CURR/PREV_15/24_TIGA)	7.7.24	R (M)
<u>Link State Usage (current and previous 15min/24h interval)</u>		
<u>L2.1N usage counter (CURR/PREV_15/24_L2.1N)</u>	<u>7.7.25</u>	<u>R (M)</u>
<u>L2.1B usage counter (CURR/PREV_15/24_L2.1B)</u>	<u>7.7.26</u>	<u>R (M)</u>
<u>L2.2 usage counter (CURR/PREV_15/24_L2.2B)</u>	<u>7.7.27</u>	<u>R (M)</u>

**Table 7-8 – Channel performance monitoring objects**

Category/object	Defined in clause:	DPU-NB interface
<i>Near-end (FTU-O)/far-end (FTU-R) performance monitoring counters (current/previous 15 min/24 h interval)</i>		
Measured Time (CURR/PREV_NE/FE_15/24_C_TIME)	7.8.1	R (M)
Invalid Data Flag (PREV_NE/FE_15/24_C_INVALID)	7.8.2	R (M)
Time Stamp (PREV_NE/FE_15/24_C_STAMP)	7.8.3	R (M)
CV counter (CURR/PREV_NE/FE_15/24_CV)	7.8.4	R (M)
RTXUC counter (CURR/PREV_NE/FE_15/24_RTXUC)	7.8.5	R (M)
RTXTX counter (CURR/PREV_NE/FE_15/24_RTXTX)	7.8.6	R (M)
NOTE – The Measured Time, Invalid Data Flag and Time Stamp objects may have the same values as the respective line performance monitoring objects.		

**Table 7-9 – Data path performance monitoring objects**

Category/object	Defined in clause:	DPU-NB interface

**Table 7-10 – Line test, diagnostic and status objects**

Category/Object	Defined in clause:	Test parameter group	DPU–NB Interface
<b>Profile</b>			
G.9701 profile (PROFILE)	7.10.1.1	Not applicable	R (M)
<b>Initialization</b>			
Initialization success/failure cause (INITSFCAUSE)	7.10.2.1	Not applicable	R (M)
Initialization last transmitted downstream signal (INTLASTSSIGNALds)	7.10.2.2	Not applicable	R (M)
Initialization last received upstream signal (INTLASTSIGNALus)	7.10.2.3	Not applicable	R (M)
<b>Signal-to-noise ratio margin</b>			
SNRMds	7.10.3.1	Not applicable	R (M)
SNRMus	7.10.3.2	Not applicable	R (M)
<b>Upstream power back-off</b>			
UPBOKLE	7.10.4.1	Not applicable	R (M)
UPBOKLE–R	7.10.4.2	Not applicable	R (M)
<b>Actual aggregate transmit power</b>			
ACTATPds	7.10.5.1	FE-G1	R (M)
ACTATPus	7.10.5.2	NE-G1	R (M)
<b>Actual transmit power spectrum density per sub-carrier</b>			
ACTPSDpsds	7.10.6.1	FE-G1	R (M)
ACTPSDpsus	7.10.6.2	NE-G1	R (M)
<b>Channel characteristics per sub-carrier</b>			
HLOGMTds	7.10.1.1	NE-G2	R(M)
HLOGGds	7.10.7.2	NE-G2	R(M)
HLOGpsds	7.10.7.3	NE-G2	R(M)
<u>HLOGMTus</u>	<u>7.10.1.4</u>	<u>NE-G2</u>	<u>R (M)</u>
<u>HLOGGus</u>	<u>7.10.7.5</u>	<u>NE-G2</u>	<u>R (M)</u>
<u>HLOGpsus</u>	<u>7.10.7.6</u>	<u>NE-G2</u>	<u>R (M)</u>
<b>Signal-to-noise ratio per sub-carrier</b>			
SNRMTds	7.10.8.1	FE-G1	R (M)
SNRGds	7.10.8.2	FE-G1	R (M)
SNRpsds	7.10.8.3	FE-G1	R (M)
SNRMTus	7.10.8.4	NE-G1	R (M)
SNRGus	7.10.8.5	NE-G1	R (M)
SNRpsus	7.10.8.6	NE-G1	R (M)
<b>Quiet line noise per sub-carrier</b>			
QLNMTds	7.10.9.1	FE-G2	R (M)
QLNGds	7.10.9.2	FE-G2	R (M)
QLNpsds	7.10.9.3	FE-G2	R (M)
QLNMTus	7.10.9.4	NE-G2	R (M)
QLNGus	7.10.9.5	NE-G2	R (M)
QLNpsus	7.10.9.6	NE-G2	R (M)

**Table 7-10 – Line test, diagnostic and status objects**

Category/Object	Defined in clause:	Test parameter group	DPU–NB Interface
<i>Active line noise per sub-carrier</i>			
ALNMT	7.10.10.1	FE-G2	R (M)
ALNG	7.10.10.2	FE-G2	R (M)
ALNps	7.10.10.3	FE-G2	R (M)
<i>Low power modes</i>			
L2.1-SNRMds	7.10.16.1	Not applicable	R(M)
L2.1-SNRMus	7.10.16.2	Not applicable	R(M)
L2.2-SNRMds	7.10.16.3	Not applicable	R(M)
L2.2-SNRMus	7.10.16.4	Not applicable	R(M)
L2-SNRM-RMCds	7.10.16.5	Not applicable	R(M)
L2-SNRM-RMCus	7.10.16.6	Not applicable	R(M)
<i>Bit allocation per sub-carrier on data symbols</i>			
BITSpsds	7.10.11.1	Not applicable	R (M)
BITSpsus	7.10.11.2	Not applicable	R (M)
<i>RMC</i>			
SNRM-RMCds	7.10.12.1	Not applicable	R (M)
SNRM-RMCus	7.10.12.2	Not applicable	R (M)
BITS-RMCpsds	7.10.12.3	Not applicable	R (M)
BITS-RMCpsus	7.10.12.4	Not applicable	R (M)
<i>Test parameter time stamps</i>			
STAMP-TEST-NE-G1	7.10.13.1	Not applicable	R (M)
STAMP-TEST-FE-G1	7.10.13.2	Not applicable	R (M)
STAMP-TEST-NE-G2	7.10.13.3	Not applicable	R (M)
STAMP-TEST-FE-G2	7.10.13.4	Not applicable	R (M)
<i>OLR time stamps</i>			
STAMP-BSWds	7.10.14.1	Not applicable	R (M)
STAMP-BSWus	7.10.14.2	Not applicable	R (M)
STAMP-SRAds	7.10.14.3	Not applicable	R (M)
STAMP-SRAus	7.10.14.4	Not applicable	R (M)
STAMP-FRAds	7.10.14.5	Not applicable	R (M)
STAMP-FRAus	7.10.14.6	Not applicable	R (M)
STAMP-RPAds	7.10.14.7	Not applicable	R (M)
STAMP-RPAus	7.10.14.8	Not applicable	R (M)
STAMP-TIGA	7.10.14.9	Not applicable	R (M)
<i>Signal attenuation</i>			
SATNds	7.10.15.1	FE-G1	R (M)
SATNus	7.10.15.2	NE-G1	R (M)
<i>Vectoring</i>			
<u>XLOGDISTds</u>	<u>7.10.17.1</u>	<u>NE-G2</u>	<u>R (O)</u>
<u>XLOGBANDSds</u>	<u>7.10.17.2</u>	<u>NE-G2</u>	<u>R (O)</u>
<u>XLOGpsds</u>	<u>7.10.17.3</u>	<u>NE-G2</u>	<u>R (O)</u>

**Table 7-11 – Channel test, diagnostic and status objects**

Category/Object	Defined in clause:	Test parameter group	DPU–NB Interface
<b><i>Actual data rates(downstream/upstream)</i></b>			
Net Data Rate (NDRds/us)	7.11.1.1	Not applicable	R (M)
Expected Throughput (ETRds/us)	7.11.1.2	Not applicable	R (M)
Gamma Data Rate (GDRds/us)	7.11.1.3	Not applicable	R (M)
<b><i>Attainable data rates (downstream/upstream)</i></b>			
Attainable net Data rate (ATTNDRds/us)	7.11.2.1	Not applicable	R (M)
Attainable Expected Throughput (ATTETRds/us)	7.11.2.2	Not applicable	R (M)
Attainable Gamma Data Rate (ATTGDRds/us)	7.11.2.3	Not applicable	R (M)
<b><i>Actual impulse noise protection (downstream/upstream)</i></b>			
ACTINPds/us	7.11.3.1	Not applicable	R (M)
ACTINP_REINds/us	7.11.3.2	Not applicable	R (M)
<b><i>Actual framer setting (downstream/upstream)</i></b>			
DTU–NFECds/us	7.11.4.1	Not applicable	R (M)
DTU–RFECds/us	7.11.4.2	Not applicable	R (M)
DTU–Qds/us	7.11.4.3	Not applicable	R (M)
<b><i>Test parameters per time interval (downstream/upstream)</i></b>			
Error–free bits current 15 minutes (EFB–C15Mds/us)	7.11.5.1	Not applicable	R (M)
Error–free bits previous 15 minutes (EFB–P15Mds/us)	7.11.5.2	Not applicable	R (M)
Error–free bits current 24 hours (EFB–C24Hds/us)	7.11.5.3	Not applicable	R (M)
Error–free bits previous 24 hours (EFB–P24Hds/us)	7.11.5.4	Not applicable	R (M)
MINEFTR current15 minutes (MINEFTR_C15Mds/us)	7.11.5.5	Not applicable	R (M)
MINEFTR previous15 minutes (MINEFTR_P15Mds/us)	7.11.5.6	Not applicable	R (M)
MINEFTR current 24 hours(MINEFTR_C24Hds/us)	7.11.5.7	Not applicable	R (M)
MINEFTR previous 24 hours (MINEFTR_P24Hds/us)	7.11.5.8	Not applicable	R (M)
<b><i>Low power modes (downstream/upstream)</i></b>			
L2.1-NDRds/us	7.11.6.1	Not applicable	R(M)
L2.2-NDRds/us	7.11.6.2	Not applicable	R(M)
L2.1-ETRds/us	7.11.6.3	Not applicable	R(M)
L.2.2-ETRds/us	7.11.6.4	Not applicable	R(M)

**Table 7-12 – Data path test, diagnostic and status objects**

Category/object	Defined in clause:	DPU-NB interface

**Table 7-13 – Inventory objects**

Category/object	Defined in clause:	DPU-NB interface
<i>FTU related inventory</i>		
FTU-O ITU-T G.994.1 vendor ID (FTUO_GHS_VENDOR)	7.13.1.1	R (M)
FTU-R ITU-T G.994.1 vendor ID (FTUR_GHS_VENDOR)	7.13.1.2	R (M)
FTU-O version number (FTUO_VERSION)	7.13.1.3	R (M)
FTU-R version number (FTU-R VERSION)	7.13.1.4	R (M)
FTU-O self-test result (FTUO-SELFTEST)	7.13.1.5	R (M)
FTU-R self-test result (FTUR-SELFTEST)	7.13.1.6	R (M)
ITU-T G.9701 profile support (FTUO_PROFILES)	7.13.1.7	R (M)
ITU-T G.9701 profile support (FTUR_PROFILES)	7.13.1.8	R (M)
<i>System related inventory</i>		
DPU system vendor ID (DPU_SYSTEM_VENDOR)	7.13.2.1	R (M)
NT system vendor ID (NT_SYSTEM_VENDOR)	7.13.2.2	R (M)
DPU serial number (DPU_SYSTEM_SERIALNR)	7.13.2.3	R (M)
NT serial number (NT_SYSTEM_SERIALNR)	7.13.2.4	R (M)
<u>VCE identifier (VCE_ID)</u>	<u>7.13.2.5</u>	<u>R (M)</u>
<u>VCE port index (VCE_PORT_INDEX)</u>	<u>7.13.2.6</u>	<u>R (M)</u>

**Table 7-14 – Link state objects**

Category/Object	Defined in clause:	DPU-NB
Link State Test Configuration		
Link State Force (LS-FORCED)	7.14.1.1	R/W (M)
Link State Enabling (LS-ENABLE)	7.14.1.2	R/W (M)
<i>Link state reporting</i>		
Link State (LINK-STATE)	7.14.2.1	R (M)
Link State at update of near-end test parameter group 1 (LINK-STATE-TEST-NE-G1)	7.14.2.2	R (M)
Link State at update of far-end test parameter group 1 (LINK-STATE-TEST-FE-G1)	7.14.2.3	R (M)



## 7.1 Line configuration objects

### 7.1.0 Profiles

#### 7.1.0.1 ITU-T G.9701 profiles enabling (PROFILES)

**Description:** Defines for each profile whether operation according to that profile is allowed or disallowed.

**Type:** Array of PROFILEdescriptor[0...N-1] with  $N \leq 1$ .

##### PROFILEdescriptor

**Type:** boolean.

**Valid values:** false (disallowed) and true (allowed).

##### Bit representation

0 [ITU-T G.9701] profile 106a

1 [ITU-T G.9701] profile 106b

2 [ITU-T G.9701] profile 212a

**Default value:** All elements of the array set to true (All profiles allowed).

**Reference:** Clause 6 of [ITU-T G.9701].

#### 7.1.1 Time division duplexing (TDD)

##### 7.1.1.1 Number of symbol periods in a TDD frame (MF)

**Description:** Defines the total number of symbol periods in a TDD frame.

**Type:** 8-bit unsigned integer.

**Valid values:** 23 and 36.

**Default value:** 36.

**Reference:** Clause 10.5 of [ITU-T G.9701].

##### 7.1.1.2 Number of downstream symbol periods in a TDD frame (Mds)

**Description:** Defines the total number of symbol positions in a TDD frame allocated for downstream transmission. The total number of symbol positions in a TDD frame allocated for upstream transmission is calculated as  $M_{us} = MF - 1 - M_{ds}$ .

**Type:** 8-bit unsigned integer.

**Valid values:** 10...32 (if MF=36) and 6...19 (if MF=23).

**Default value:** 28 (if MF=36) and 18 (if MF=23).

**Reference:** Clause 10.5 of [ITU-T G.9701].

##### 7.1.1.3 Cyclic extension (CE)

**Description:** Defines the cyclic extension ( $L_{CP}$ ) to be used.

**Type:** 8-bit unsigned integer.

**Unit:** N/64 samples, with N = index of highest supported downstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]) plus one.

**Valid values:** 4, 8, 10, 12, 14, 16, 20, 24, 30 and 33.

**Default value:** 10.

**Reference:** Clause 10.4.4 of [ITU-T G.9701].

## 7.1.2 Power and spectrum usage

### 7.1.2.1 Downstream maximum aggregate transmit power (MAXATPDs)

**Description:** Defines the maximum aggregate transmit power at the U-O2 reference point in the downstream direction during initialization and showtime (in dBm).

**Type:** 16-bit signed integer.

**Unit:** 0.1 dBm.

**Valid values:** -310...+310 (-31 to +31 dBm).

**Default value:** 40 (4 dBm).

**Reference:** Clause 7.3.2 of [ITU-T G.9701].

### 7.1.2.2 Upstream maximum aggregate transmit power (MAXATPus)

**Description:** Defines the maximum aggregate transmit power at the U-R2 reference point in the upstream direction during initialization and showtime (in dBm).

**Type:** 16-bit signed integer.

**Unit:** 0.1 dBm.

**Valid values:** -310...+310 (-31 to +31 dBm).

**Default value:** 40 (4 dBm).

**Reference:** Clause 7.3.2 of [ITU-T G.9701].

### 7.1.2.3 Downstream sub-carrier masking (CARMASKds)

**Description:** Defines the masked sub-carrier bands in the downstream direction. All sub-carriers within the band, i.e., with indices greater than or equal to the start sub-carrier index and less than or equal to the stop sub-carrier index, are masked, i.e., have a transmit power set to zero (linear scale).

**Type:** Array of CARMASKdescriptor[0...N-1], with  $N \leq 32$ .

#### **CARMASKdescriptor:**

**Type:** Record of a start sub-carrier index and a stop sub-carrier index.

#### **Sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**Default value:** Empty array (No masked sub-carriers).

**Reference:** Clause 6.3 of [ITU-T G.9700], and clause 7.3.1.3 of [ITU-T G.9701].

### 7.1.2.4 Upstream sub-carrier masking (CARMASKus)

**Description:** Defines the masked sub-carrier bands in the upstream direction. All sub-carriers within the band, i.e., with indices greater than or equal to the start sub-carrier index and less than or equal to the stop sub-carrier index, have a transmit power set to zero (linear scale).

**Type:** Array of CARMASKdescriptor[0...N-1], with  $N \leq 32$ .

**CARMASKdescriptor:** See CARMASKds in clause 7.1.2.3.

**Default value:** Empty array (No masked sub-carriers).

**Reference:** Clause 6.3 of [ITU-T G.9700] and clause 7.3.1.3 of [ITU-T G.9701].

### 7.1.2.5 Downstream PSD mask (MIBPSDMASKds)

**Description:** Defines the downstream power spectral density (PSD) mask applicable at the U-O2 reference point. Requirements for a valid MIBPSDMASKds are defined in clauses 7.3.1.1.2.1 and 7.3.1.1.2.2 of [ITU-T G.9701].

**Type:** Array of MIBPSDMASKdescriptor[0...N-1], with N=0 or  $2 \leq N \leq 32$ .

**PSDMASKdescriptor:**

**Type:** Record of a sub-carrier index and a PSD level.

**Sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**PSD level:**

**Type:** 8-bit unsigned integer.

**Unit:** -0.5 dBm/Hz.

**Valid values:** 0...255 (0 to -127.5 dBm/Hz).

**Default value:** Empty array (Limit PSD mask defined in [ITU-T G.9700]).

**Reference:** Clause 7.3.1.1 of [ITU-T G.9701].

### 7.1.2.6 Upstream PSD mask (MIBPSDMASKus)

**Description:** Defines the upstream PSD mask applicable at the U-R2 reference point. Requirements for a valid MIBPSDMASKus are defined in clauses 7.3.1.1.2.1 and 7.3.1.1.2.2 of [ITU-T G.9701].

**Type:** Array of MIBPSDMASKdescriptor[0...N-1], with N=0 or  $2 \leq N \leq 32$ .

**PSDMASKdescriptor:** See MIBPSDMASKds in clause 7.1.2.5.

**Default value:** Empty array (Limit PSD mask defined in [ITU-T G.9700]).

**Reference:** Clause 7.3.1.1 of [ITU-T G.9701].

### 7.1.2.7 RFI bands (RFIBANDS)

**Description:** Defines the bands where the PSD shall be reduced as specified in clause 7.3.1.2 of [ITU-T G.9701].

**Type:** Array of RFIBANDdescriptor[0...N-1], with  $N \leq 32$ .

**RFIBANDdescriptor:**

**Type:** Record of a start sub-carrier index and a stop sub-carrier index.

**Sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**Default value:** Empty array (No RFI bands, no PSD reduction).

**Reference:** Clauses 7.3.1.2 and 12.3.2.1.1 of [ITU-T G.9701].

### 7.1.2.8 International amateur radio bands (IARBANDS)

**Description:** Defines for each international amateur radio (IAR) band whether transmit PSD reduction is enabled or disabled in that band.

**Type:** Array of IARBANDdescriptor[0...11].

**IARBANDdescriptor:**

**Type:** boolean.

**Valid values:** false (disabled) and true (enabled).

**Bit representation:**

0	International amateur radio band 1800-2000 kHz
1	International amateur radio band 3500-4000 kHz
2	International amateur radio band 7000-7300 kHz
3	International amateur radio band 10100-10150 kHz
4	International amateur radio band 14000-14350 kHz
5	International amateur radio band 18068-18168 kHz
6	International amateur radio band 21000-21450 kHz
7	International amateur radio band 24890-24990 kHz
8	International amateur radio band 28000-29700 kHz
9	International amateur radio band 50000-54000 kHz
10	International amateur radio band 70000-70500 kHz
11	International amateur radio band 144000-148000 kHz

**Default value:** All elements of the array set to false (All IAR bands disabled, no PSD reduction).

**Reference:** Clauses 7.3.1.2 and 12.3.2.1.1 of [ITU-T G.9701], Tables 11.70.8 and 11.70.8.1 of [ITU-T G.994.1].

**7.1.2.9 Upstream power back-off reference PSD (UPBOPSDA)**

**Description:** Defines the parameter  $a$  for the UPBO reference PSD used to compute the upstream power back-off for the upstream frequency band.

**Type:** 16-bit unsigned integer.

**Unit:** 0.01 dBm/Hz.

**Offset:** 40 dBm/Hz.

**Valid values:** 0...4095 (40 to 80.95 dBm/Hz).

**Default value:** 0 (40 dBm/Hz).

**Reference:** Clause 7.3.1.4 of [ITU-T G.9701].

**7.1.2.10 Upstream power back-off reference PSD (UPBOPSDB)**

**Description:** Defines the parameter  $b$  for the UPBO reference PSD used to compute the upstream power back-off for the upstream frequency band.

**Type:** 16-bit unsigned integer.

**Unit:** 0.01 dBm/Hz.

**Valid values:** 0...4095 (0 to 40.95 dBm/Hz).

**Default value:** 0 (0 dBm/Hz).

**Reference:** Clause 7.3.1.4 of [ITU-T G.9701].

**7.1.2.11 Upstream electrical length (UPBOKL)**

**Description:** Defines the electrical length  $kl_0$  (expressed in dB at 1 MHz).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...1280 (0 to 128 dB).

**Default value:** 0 (0 dB)

**Reference:** Clause 7.3.1.4.2.1 of [ITU-T G.9701].

#### **7.1.2.12 Force electrical length (UPBOKLF)**

**Description:** Defines whether or not the FTU-R is forced to use the electrical length  $kl_0 = \text{UPBOKL}$  to compute the UPBOMASK. If not forced, the FTUs determine the electrical length  $kl_0$ .

**Type:** boolean.

**Valid values:** false (not forced) and true (forced).

**Default value:** false (not forced).

**Reference:** Clause 7.3.1.4.2.1 of [ITU-T G.9701].

#### **7.1.2.13 UPBO reference electrical length per band (UPBOKLREF)**

**Description:** Defines the UPBO reference electrical length  $kl_{0\_REF}$  used to compute the upstream power back-off for the Equalized FEXT UPBO method. If  $kl_{0\_REF} = 0$  (special value) then the Equal PSD UPBO method is used.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0 (special value) and 18...255 (1.8 to 25.5 dB).

**Default value:** 0 (special value).

**Reference:** Clause 7.3.1.4.2.2 of [ITU-T G.9701].

### **7.1.3 Noise margin**

#### **7.1.3.1 Downstream target noise margin (TARSNRMds)**

**Description:** Defines the downstream target noise margin for the channel initialization policy.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clause 12.3.7 of [ITU-T G.9701].

#### **7.1.3.2 Upstream target noise margin (TARSNRMus)**

**Description:** Defines the upstream target noise margin used in the channel initialization policy.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clause 12.3.7 of [ITU-T G.9701].

### 7.1.3.3 Upstream maximum noise margin (MAXSNRMus)

**Description:** Defines the upstream maximum noise margin used in the channel initialization policy. The special value indicates there is no maximum bound for the upstream noise margin (i.e., the upstream maximum noise margin is infinite).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB) and 511 (special value).

**Default value:** 511 (special value).

**Reference:** Clause 12.3.7 of [ITU-T G.9701].

### 7.1.3.4 Downstream minimum noise margin (MINSNRMds)

**Description:** Defines the downstream minimum noise margin the FTU-R receiver shall tolerate. If the downstream noise margin (SNRMds) falls below this level, a loss-of-margin (*lom*) defect occurs. Upon persistency of the *lom* defect, the FTU-R triggers a re-initialization (see clause 12.1.4.2 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

### 7.1.3.5 Upstream minimum noise margin (MINSNRMus)

**Description:** Defines the upstream minimum noise margin the FTU-O receiver shall tolerate. If the upstream noise margin (SNRMus) falls below this level, the FTU-O requests the FTU-R to increase the FTU-R transmit power. If an increase to FTU-R transmit power is not possible, a *lom* defect occurs. Upon persistency of the *lom* defect, the FTU-O triggers a re-initialization (see clause 12.1.4.2 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

## 7.1.4 Seamless rate adaptation

### 7.1.4.1 Downstream upshift noise margin (SRA-USNRMds)

**Description:** If the downstream noise margin (SNRMds) is above the downstream upshift noise margin and stays above that for more than the time specified by the downstream minimum upshift rate adaptation interval (SRA-UTIMEds), the FTU-R autonomously attempts to increase the downstream net data rate (NDRds).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 70 (7 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### **7.1.4.2 Upstream upshift noise margin (SRA-USNRMus)**

**Description:** If the upstream noise margin (SNRMus) is above the upstream upshift noise margin and stays above that for more than the time specified by the upstream minimum upshift rate adaptation interval (SRA-UTIMEus), the FTU-O autonomously attempts to increase the upstream net data rate (NDRus).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 70 (7 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### **7.1.4.3 Downstream minimum time interval for upshift SRA (SRA-UTIMEds)**

**Description:** Defines the interval of time the downstream noise margin (SNRMds) should stay above the downstream upshift noise margin (SRA-USNRMds) before the FTU-R autonomously attempts to increase the NDRds.

**Type:** 16-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0...16383 (0 to  $2^{14}-1$  s).

**Default value:** 8 (8 s).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### **7.1.4.4 Upstream minimum time interval for upshift SRA (SRA-UTIMEus)**

**Description:** Defines the interval of time the upstream noise margin (SNRMus) should stay above the upstream upshift noise margin (SRA-USNRMus) before the FTU-O autonomously attempts to increase the NDRus.

**Type:** 16-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0...16383 (0 to  $2^{14}-1$  s).

**Default value:** 8 (8 s).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### **7.1.4.5 Downstream downshift noise margin (SRA-DSNRMds)**

**Description:** If the downstream noise margin (SNRMds) is below the downstream downshift noise margin and stays below that for more than the time specified by the downstream minimum downshift rate adaptation interval (SRA-DTIMEds), the FTU-R autonomously attempts to decrease the NDRds.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 50 (5 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### 7.1.4.6 Upstream downshift noise margin (SRA-DSNRMus)

**Description:** If the upstream noise margin (SNRMus) is below the upstream downshift noise margin and stays below that for more than the time specified by the upstream minimum downshift rate adaptation interval (SRA-DTIMEus), the FTU-O autonomously attempts to decrease the NDRus.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0..310 (0 to 31 dB).

**Default value:** 50 (5 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### 7.1.4.7 Downstream minimum time interval for downshift SRA (SRA-DTIMEds)

**Description:** Defines the interval of time the downstream noise margin (SNRMds) should stay below the downstream downshift noise margin (SRA-DSNRMds) before the FTU-R autonomously attempts to decrease the NDRds.

**Type:** 16-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0...16383 (0 to  $2^{14}-1$  s).

**Default value:** 2 (2 s).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### 7.1.4.8 Upstream minimum time interval for downshift SRA (SRA-DTIMEus)

**Description:** Defines the interval of time the upstream noise margin (SNRMus) should stay below the upstream downshift noise margin (SRA-DSNRMus) before the FTU-O autonomously attempts to decrease the NDRus.

**Type:** 16-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0...16383 (0 to  $2^{14}-1$  s).

**Default value:** 2 (2 s).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

### 7.1.5 Fast rate adaptation

#### 7.1.5.1 Downstream FRA time window (FRA-TIMEds)

**Description:** Defines the duration of the time window used in the standard FRA triggering criteria (see clause 13.4.3.2 of [ITU-T G.9701]) for the downstream direction. The special value 0 indicates that vendor discretionary values for *fra-ntones*, *fra-rtx-uc*, and *fra-time* may be used in the downstream direction.

**Type:** 8-bit unsigned integer.

**Unit:** 1 logical frame length.

**Valid values:** 0 (special value) and (1...8 (if MF=36) or 1...12 (if MF=23)).

**Default value:** 8 (if MF=36) or 12 (if MF=23).

**Reference:** Clause 13.3.1.1.1.1 of [ITU-T G.9701].



### 7.1.5.2 Upstream FRA time window (FRA-TIMEus)

**Description:** Defines the duration of the time window used in the standard FRA triggering criteria (see clause 13.4.3.2 of [ITU-T G.9701]) for the upstream direction. The special value 0 indicates that vendor discretionary values for *fra-ntones*, *fra-rtx-uc*, and *fra-time* may be used in the upstream direction.

**Type:** 8-bit unsigned integer.

**Unit:** 1 logical frame length.

**Valid values:** 0 (special value) and (1...8 (if MF=36) or 1...12 (if MF=23)).

**Default value:** 8 (if MF=36) or 12 (if MF=23).

**Reference:** Clause 13.3.1.1.1.1 of [ITU-T G.9701].

### 7.1.5.3 Downstream FRA minimum percentage of degraded tones (FRA-NTONESds)

**Description:** Defines the minimum percentage of loaded sub-carriers that are detected as degraded throughout a time window equal to FRA-TIMEds in order to arm the first FRA triggering criteria (see clause 13.3.1.1.1.5 of [ITU-T G.9701]) in the downstream direction. The special value 0 indicates that monitoring of the percentage of degraded sub-carriers is disabled.

**Type:** 8-bit unsigned integer.

**Valid values:** 0 and 1...100.

**Default value:** 50.

**Reference:** Clause 13.3.1.1.1.2 of [ITU-T G.9701].

### 7.1.5.4 Upstream FRA minimum percentage of degraded tones (FRA-NTONESus)

**Description:** Defines the minimum percentage of loaded sub-carriers (i.e., sub-carriers with  $b_i > 0$ ) that are detected as degraded throughout a time window equal to FRA-TIMEus in order to arm the first FRA triggering criteria (see clause 13.3.1.1.1.5 of [ITU-T G.9701]) in the upstream direction. The special value 0 indicates that monitoring of the percentage of degraded sub-carriers is disabled.

**Type:** 8-bit unsigned integer.

**Valid values:** 0 and 1...100.

**Default value:** 50.

**Reference:** Clause 13.3.1.1.1.2 of [ITU-T G.9701].

### 7.1.5.5 Downstream FRA number of uncorrectable DTU (FRA-RTXUCds)

**Description:** Defines the minimum number of *rtx-uc* anomalies received throughout a time window equal to FRA-TIMEds in order to arm the second FRA triggering criteria (see clause 13.3.1.1.1.5 of [ITU-T G.9701]) in the downstream direction. The special value 0 indicates that monitoring of the number of *rtx-uc* anomalies is disabled.

**Type:** 16-bit unsigned integer.

**Valid values:** 0 and 1...1023.

**Default value:** 150.

**Reference:** Clause 13.3.1.1.1.3 of [ITU-T G.9701].

### 7.1.5.6 Upstream FRA number of uncorrectable DTU (FRA-RTXUCus)

**Description:** Defines the minimum number of *rtx-uc* anomalies received throughout a time window equal to FRA-TIMEus in order to arm the second FRA triggering criteria (see clause 13.3.1.1.1.5 of

[ITU-T G.9701]) in the upstream direction. The special value 0 indicates that monitoring of the number of *rtx-uc* anomalies is disabled.

**Type:** 16-bit unsigned integer.

**Valid values:** 0 and 1...1023.

**Default value:** 150.

**Reference:** Clause 13.3.1.1.1.3 of [ITU-T G.9701].

#### **7.1.5.7 Downstream vendor discretionary FRA triggering criteria (FRA-VENDISCds)**

**Description:** Defines whether vendor discretionary FRA triggering criteria may be used (enabled) or not (disabled) in the downstream direction.

**Type:** boolean.

**Valid values:** false (disabled) and true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 13.3.1.1.1.4 of [ITU-T G.9701].

#### **7.1.5.8 Upstream vendor discretionary FRA triggering criteria (FRA-VENDISCus)**

**Description:** Defines whether vendor discretionary FRA triggering criteria may be used (enabled) or not (disabled) in the upstream direction.

**Type:** boolean.

**Valid values:** false (disabled) and true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 13.3.1.1.1.4 of [ITU-T G.9701].

### **7.1.6 Robust management channel**

#### **7.1.6.1 Downstream target noise margin for RMC (TARSNRM-RMCds)**

**Description:** Defines the downstream RMC noise margin (SNRM-RMCds) that the FTU-R receiver shall achieve, relative to the BER requirement, or better, to successfully complete initialization.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clause 12.3.3.2.1 of [ITU-T G.9701].

#### **7.1.6.2 Upstream target noise margin (TARSNRM-RMCus)**

**Description:** Defines the upstream RMC noise margin (SNRM-RMCus) that the FTU-O receiver shall achieve, relative to the BER requirement, or better, to successfully complete initialization.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clause 12.3.3.2.1 of [ITU-T G.9701].

### 7.1.6.3 Downstream minimum noise margin for RMC (MINSNRM-RMCds)

**Description:** Defines the downstream minimum noise margin the FTU-R receiver tolerates for the RMC. If the downstream RMC noise margin (SNRM-RMCds) falls below this level, the FTU-R initiates the RMC parameter adjustment (RPA) procedure.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 13.2.1.3 of [ITU-T G.9701].

### 7.1.6.4 Upstream minimum noise margin for RMC (MINSNRM-RMCus)

**Description:** Defines the upstream minimum noise margin the FTU-O receiver tolerates for the RMC. If the downstream RMC noise margin (SNRM-RMCus) falls below this level, the FTU-O initiates the RPA procedure.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 13.2.1.3 of [ITU-T G.9701].

### 7.1.6.5 Downstream maximum bitloading for RMC (MAXBL-RMCds)

**Description:** Defines the maximum allowed bit-loading for the downstream RMC sub-carriers.

**Type:** 8-bit unsigned integer.

**Valid values:** 2...6.

**Default value:** 6.

**Reference:** Clause 12.3.3.2.1 of [ITU-T G.9701].

### 7.1.6.6 Upstream maximum bitloading for RMC (MAXBL-RMCus)

**Description:** Defines the maximum allowed bit-loading for the upstream RMC sub-carriers.

**Type:** 8-bit unsigned integer.

**Valid values:** 2...6.

**Default value:** 6.

**Reference:** Clause 12.3.3.2.1 of [ITU-T G.9701].

## 7.1.7 Vectoring

### 7.1.7.1 FEXT cancellation enabling/disabling downstream (FEXT\_TO\_CANCEL\_ENABLEds)

**Description:** Defines whether FEXT cancellation in the downstream direction from all the other vectored lines into the line in the vectored group is enabled or disabled.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** true (enabled).

**Reference:** Clause 11.4.3.1 of [ITU-T G.9701].

#### **7.1.7.2 FEXT cancellation enabling/disabling upstream (FEXT\_TO\_CANCEL\_ENABLEus)**

**Description:** Defines whether FEXT cancellation in the upstream direction from all the other vectored lines into the line in the vectored group is enabled or disabled.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** true (enabled).

**Reference:** Clause 11.4.3.1 of [ITU-T G.9701].

#### **7.1.7.3 XLOG requested subcarrier group size (XLOGGREQds)**

**Description:** This parameter is the requested lower bound on the value of XLOGGds in the reporting of Xlogpsds

**Type:** 8-bit signed integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, 8, 16, 32, and 64.

**Default value:** 1.

**Reference:** Clause 11.4.3.2 of [ITU-T G.9701].

*Add clause 7.1.7.4*

#### **7.1.7.4 XLOG requested disturber index (XLOGDREQds)**

**Description:** This parameter is the requested value of the VCE\_port\_index (XLOGDISTds) for the disturber line in the reporting of XLOGpsds.

**Type:** 16-bit unsigned integer.

**Valid values:** 1..65535.

**Default value:** 1.

**Reference:** Clause 11.4.3.2 of [ITU-T G.9701].

### **7.1.8 Fast-retrain policy**

#### **7.1.8.1 Downstream los defect persistency (LOS\_PERSISTENCYds)**

**Description:** Defines the downstream *los* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-R receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 0.1 s.

**Valid values:** 1...20 (0.1 to 2 s).

**Default value:** 2 (0.2 s).

**Reference:** Clause 12.1.4.3.1 of [ITU-T G.9701].

#### **7.1.8.2 Upstream los defect persistency (LOS\_PERSISTENCYus)**

**Description:** Defines the upstream *los* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-O receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 0.1 s.

**Valid values:** 1...20 (0.1 to 2 s).

**Default value:** 2 (0.2 s).

**Reference:** Clause 12.1.4.3.1 of [ITU-T G.9701].

#### **7.1.8.3 Downstream *lom* defect persistency (LOM\_PERSISTENCYds)**

**Description:** Defines the downstream *lom* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-R receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 2...20 (2 to 20 s).

**Default value:** 2 (2 s).

**Reference:** Clause 12.1.4.3.2 of [ITU-T G.9701].

#### **7.1.8.4 Upstream *lom* defect persistency (LOM\_PERSISTENCYus)**

**Description:** Defines the upstream *lom* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-O receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 2...20 (2 to 20 s).

**Default value:** 2 (2 s).

**Reference:** Clause 12.1.4.3.2 of [ITU-T G.9701].

#### **7.1.8.5 Downstream *lor* defect persistency (LOR\_PERSISTENCYds)**

**Description:** Defines the downstream *lor* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-R receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 0.1 s.

**Valid values:** 1...20 (0.1 to 2 s).

**Default value:** 2 (0.2 s).

**Reference:** Clause 12.1.4.3.3 of [ITU-T G.9701].

#### **7.1.8.6 Upstream *lor* defect persistency (LOR\_PERSISTENCYus)**

**Description:** Defines the upstream *lor* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-O receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 0.1 s.

**Valid values:** 1...20 (0.1 to 2 s).

**Default value:** 2 (0.2 s).

**Reference:** Clause 12.1.4.3.3 of [ITU-T G.9701].

#### **7.1.8.7 Downstream re-initialization time threshold (REINIT\_TIME\_THRESHOLD<sub>Dds</sub>)**

**Description:** Defines the downstream threshold for the SES and eoc timeout conditions for declaring a High\_BER event (see clause 12.1.4.3.4) at the FTU-R receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 5...31 (5 to 31 s).

**Default value:** 10 (10 s).

**Reference:** Clause 12.1.4.3.4 of [ITU-T G.9701].

#### **7.1.8.8 Upstream re-initialization time threshold (REINIT\_TIME\_THRESHOLD<sub>Dus</sub>)**

**Description:** Defines the upstream threshold for the SES and eoc timeout conditions for declaring a High\_BER event (see clause 12.1.4.3.4) at the FTU-O receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 5...31 (5 to 31 s).

**Default value:** 10 (10 s).

**Reference:** Clause 12.1.4.3.4 of [ITU-T G.9701].

#### **7.1.8.9 Downstream low ETR threshold (LOW\_ETR\_THRESHOLD<sub>Dds</sub>)**

**Description:** Defines the downstream threshold for the low ETR condition for declaring a High\_BER event (see clause 12.1.4.3.4) at the FTU-R receiver, as part of the fast-retrain policy. The special value 0 indicates that no High\_BER event is declared based on *ETR* being below the *ETR<sub>min</sub>*.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0 and 1...30 (1 to 30 s).

**Default value:** 20 (20 s).

**Reference:** Clause 12.1.4.3.4 of [ITU-T G.9701].

#### **7.1.8.10 Upstream low ETR threshold (LOW\_ETR\_THRESHOLD<sub>Dus</sub>)**

**Description:** Defines the upstream threshold for the low ETR condition for declaring a High\_BER event (see clause 12.1.4.3.4) at the FTU-O receiver, as part of the fast-retrain policy. The special value 0 indicates that no High\_BER event is declared based on *ETR* being below the *ETR<sub>min</sub>*.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0 and 1...30 (1 to 30 s).

**Default value:** 20 (20 s).

**Reference:** Clause 12.1.4.3.4 of [ITU-T G.9701].

### **7.1.9 Update test parameters**

#### **7.1.9.1 Update request flag for near-end test parameters (UPDATE-NE-TEST)**

**Description:** Forces an update of one or more of the near-end test parameter groups that can be updated during showtime. See introductory text to clause 7.

**Type:** Array of UPDATEREQUESTFLAGdescriptor[0..1].

**UPDATEREQUESTFLAGdescriptor:**

**Type:** boolean.

**Valid values:** false (no update forced) or true (update forced).

**Bit representation:**

0 Near-end test parameter group 1 (NE-G1)

1 Near-end test parameter group 2 (NE-G2)

**Default value:** All elements of the array set to false (no update forced).

**Reference:** Clause 11.1 of ITU-T G.9701.

### 7.1.9.2 Update request flag for far-end test parameters (UPDATE-FE-TEST)

**Description:** Forces an update of one or more of the far-end test parameter group that can be updated during showtime. See introductory text to clause 7.

**Type:** Array of UPDATEREQUESTFLAGdescriptor[0..1].

**UPDATEREQUESTFLAGdescriptor:** see clause 7.1.9.1.

**Bit representation:**

0 Far-end test parameter group 1 (FE-G1)

1 Far-end test parameter group 2 (FE-G2)

**Default value:** All elements of the array set to false (no update forced).

**Reference:** Clause 11.1 of [ITU-T G.9701].

### 7.1.10 Low power modes

#### 7.1.10.1 Target noise margin in L2 (L2-TARSNRMds/us)

**Description:** Defines the target noise margin used during the L2.1N, L2.1B and L2.2 link states.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0..310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clauses 13.4.1.5 and 13.4.2.5 of [ITU-T G.9701].

#### 7.1.10.2 Maximum noise margin in L2.1 (L2.1-MAXSNRMds/us)

**Description:** Defines the maximum noise margin allowed during the L2.1N and L2.1B link states.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0..310 (0 to 31 dB) and 511 (special value).

**Default value:** 511 (special value).

**Reference:** Clauses 13.4.1.5 and 13.4.2.5 of [ITU-T G.9701].

### 7.1.10.3 Maximum PSD reduction in L2 (L2-MAXPSDR)

**Description:** Defines the maximum PSD reduction allowed during the L2.1N, L2.2B and L2.2 link states for both the upstream and downstream direction. The special value indicates there is no maximum bound for the PSD reduction (i.e., the maximum PSD reduction is infinite).

**Type:** 8-bit unsigned integer.

**Unit:** 1 dB.

**Valid values:** 0..10 (0 to 10 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

### 7.1.10.4 Downstream upshift noise margin in L2.1 (L2.1-SRA-USNRMds)

**Description:** If the downstream noise margin in the L2.1N and L2.1B link states (L2.1-SNRMds) is above the downstream upshift noise margin and stays above that for more than the time specified by the downstream minimum upshift rate adaptation interval (SRA-UTIMEds), the FTU-R autonomously attempts to increase the downstream net data rate in the L2.1 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 70 (7 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

### 7.1.10.5 Upstream upshift noise margin in L2.1 (L2.1-SRA-USNRMus)

**Description:** If the upstream noise margin in the L2.1N and L2.1B link states (L2.1-SNRMus) is above the upstream upshift noise margin and stays above that for more than the time specified by the upstream minimum upshift rate adaptation interval (SRA-UTIMEus), the FTU-O autonomously attempts to increase the upstream net data rate in the L2.1 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 70 (7 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

### 7.1.10.6 Downstream downshift noise margin in L2.1 (L2.1-SRA-DSNRMds)

**Description:** If the downstream noise margin in the L2.1N and L2.1B link states (L2.1-SNRMds) is below the downstream downshift noise margin and stays below that for more than the time specified by the downstream minimum downshift rate adaptation interval (SRA-DTIMEds), the FTU-R autonomously attempts to decrease the downstream net data rate in the L2.1 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 50 (5 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].



### 7.1.10.7 Upstream downshift noise margin in L2.1 (L2.1-SRA-DSNRMus)

**Description:** If the upstream noise margin in the L2.1N and L2.1B link states (L2.1-SNRMus) is below the upstream downshift noise margin and stays below that for more than the time specified by the upstream minimum downshift rate adaptation interval (SRA-DTIMEus), the FTU-O autonomously attempts to decrease the upstream net data rate in the L2.1 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0..310 (0 to 31 dB).

**Default value:** 50 (5 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

## 7.2 Channel configuration objects

### 7.2.1 Data rates

#### 7.2.1.1 Maximum net data rate (MAXNDRds/us)

**Description:** Defines the value of the maximum NDR (see clause 11.4.2.2 of [ITU-T G.9701]).

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 4294967295 (4294967295 kbit/s).

**Reference:** Clause 11.4.2.2 of [ITU-T G.9701].

#### 7.2.1.2 Minimum expected throughput (MINETRds/us)

**Description:** Defines the value of the minimum expected throughput (see clause 11.4.2.1 of [ITU-T G.9701]).

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 0 (0 bit/s).

**Reference:** Clause 11.4.2.1 of [ITU-T G.9701].

#### 7.2.1.3 Maximum gamma data rate (MAXGDRds/us)

**Description:** Defines the maximum value of the gamma data rate (GDR) (see clause 7.11.1.3). The GDR shall not exceed MAXGDR at the start of showtime and during showtime.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 4294967295 (4294967295 kbit/s).

**Reference:** None.

#### 7.2.1.4 Minimum gamma data rate (MINGDRds/us)

**Description:** Defines the minimum value of the GDR (see clause 7.11.1.3). The GDR may be less than MINGDR. If the GDR is less than MINGDR at initialization or when GDR becomes less than MINGDR during showtime, a threshold crossing alert occurs.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 0 (0 bit/second).

**Reference:** None.

### 7.2.2 Retransmission

#### 7.2.2.1 Maximum delay (DELAYMAXds/us)

**Description:** Defines the maximum allowed delay for retransmission (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *delay\_max* is set to the same value as the maximum delay (see clause 11.4.2.3 of [ITU-T G.9701]).

**Type:** 32-bit unsigned integer.

**Unit:** 0.25 ms.

**Valid values:** 4..64 (1 to 16 milliseconds).

**Default value:** 40 (10 ms).

**Reference:** Clause 11.4.2.3 of [ITU-T G.9701].

#### 7.2.2.2 Minimum impulse noise protection against SHINE (INPMIN\_SHINEds/us)

**Description:** Defines the minimum impulse noise protection against SHINE (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *INP\_min\_shine* is set to the same value as the minimum impulse noise protection against SHINE (see clause 11.4.2.4 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol period.

**Valid values:** 0...520 (0 to 520 symbol periods).

**Default value:** 0 (0 symbol periods).

**Reference:** Clause 11.4.2.4 of [ITU-T G.9701].

#### 7.2.2.3 SHINE ratio (SHINERATIOds/us)

**Description:** Defines the *SHINEratio* that is used in the definition of the expected throughput rate (*ETR*) (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *SHINEratio* is set to the same value as the SHINE ratio (see clause 11.4.2.5 of [ITU-T G.9701]).

**Type:** 8-bit unsigned integer.

**Unit:** 0.001.

**Valid values:** 0...100 (0 to 0.1).

**Default value:** 0 (0).

**Reference:** Clause 11.4.2.5 of [ITU-T G.9701].

#### 7.2.2.4 Minimum impulse noise protection against REIN (INPMIN\_REINds/us)

**Description:** Defines the minimum impulse noise protection against repetitive electrical impulse noise (REIN) (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *INP\_min\_rein* is set to the same value as the minimum impulse noise protection against REIN (see clause 11.4.2.6 of [ITU-T G.9701]).

**Type:** 8-bit unsigned integer.

**Unit:** 1 symbol period.

**Valid values:** 0...63 (0 to 63 symbol periods).

**Default value:** 0 (0 symbol periods).

**Reference:** Clause 11.4.2.6 of [ITU-T G.9701].

#### 7.2.2.5 REIN inter-arrival time (IAT\_REINds/us)

**Description:** Defines the REIN inter-arrival time (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *iat\_rein\_flag* is set to the same value as the REIN inter-arrival time (see clause 11.4.2.7 of [ITU-T G.9701]).

**Type:** enumeration.

**Valid values:** 0 (100 Hz), 1 (120 Hz), 2 (300 Hz), and 3 (360 Hz).

**Default value:** 0 (100 Hz).

**Reference:** Clause 11.4.2.7 of [ITU-T G.9701].

#### 7.2.2.6 Minimum Reed-Solomon RFEC/NFEC ratio (RNRATIOds/us)

**Description:** Defines the minimal required ratio, RFEC/NFEC, of Reed-Solomon code parameters. The ITU-T G.9701 control parameter *rnratio* is set to the same value as the minimum Reed-Solomon RFEC/NFEC ratio (see clause 11.4.2.8 of [ITU-T G.9701]).

**Type:** 8-bit unsigned integer.

**Unit:** 1/32.

**Valid values:** 0...8 (0 to 1/4).

**Default value:** 0 (0).

**Reference:** Clause 11.4.2.8 of [ITU-T G.9701].

#### 7.2.2.7 RTX-TC testmode (RTX\_TESTMODEds/us)

**Description:** Defines whether the retransmission testmode defined in clause 9.8.3.1.2 of [ITU-T G.9701] is enabled or disabled. The RTX\_TESTMODE setting may be changed during showtime. When changed, it shall take effect on the line within 2 s without re-initialization.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 9.8.3.1.2 of [ITU-T G.9701].

### 7.2.3 Low power modes

#### 7.2.3.1 Maximum net data rate in L2.1 (L2.1-MAXNDRds/us)

**Description:** Defines the value of the maximum net data rate allowed during the L2.1N and L2.1B link states.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}$ -1 kbit/s).

**Default value:** 4294967295 (4294967295 kbit/second).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

### **7.2.3.2 Maximum net data rate in L2.2 (L2.2-MAXNDR)**

**Description:** Defines the value of the maximum net data rate allowed during the L2.2 link state for both the upstream and downstream direction.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}$ -1 kbit/s).

**Default value:** 4294967295 (4294967295 kbit/second).

**Reference:** Clause 13.4.2.5 of [ITU-T G.9701].

### **7.2.3.3 Minimum expected throughput in L2.1 (L2.1-MINETRds/us)**

**Description:** Defines the value of the minimum expected throughput allowed during the L2.1N and L2.1B link states.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}$ -1 kbit/s).

**Default value:** 0 (0 bits/second).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

### **7.2.3.4 Minimum expected throughput in L2.2 (L2.2-MINETR)**

**Description:** Defines the value of the minimum expected throughput allowed during the L2.2 link state for both the upstream and downstream direction.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}$ -1 kbit/s).

**Default value:** 0 (0 bits/second).

**Reference:** Clause 13.4.2.5 of [ITU-T G.9701].

### **7.2.3.5 Minimum expected throughput after exit from L2.1 (L2.1-MINETR-EXITds/us)**

**Description:** Defines the value of the minimum expected throughput allowed after exit from the L2.1N to the L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}$ -1 kbit/s).

**Default value:** 0 (0 bits/second).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

## 7.3 Data path configuration objects

### 7.3.1 TPS-TC testmode (TPS\_TESTMODE)

**Description:** Defines whether the TPS-TC testmode defined in clause 8.3.1 of [ITU-T G.9701] is enabled or disabled. The TPS\_TESTMODE setting may be changed during showtime. When changed, it shall take effect on the line within 2 s without re-initialization.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 8.3.1 of [ITU-T G.9701].

### 7.3.2 DRA testmode (DRA\_TESTMODE)

**Description:** Defines whether the dynamic resource allocation (DRA) testmode defined in clause 9.8.3.1.2 of [ITU-T G.9701] is enabled or disabled. The DRA\_TESTMODE setting may be changed during showtime. When changed, it shall take effect on the line within 2 s without re-initialization.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 9.8.3.1.2 of [ITU-T G.9701].

## 7.4 Line failures

Any failure defined in this clause shall be conveyed by the DPU over the DPU-NB interface and may be conveyed by the NT over the T-/S-interface after it is detected.

The near-end failure detections shall be provided at the DPU and may be provided at the NT.

The far-end failure detections shall be provided at the DPU (NT is at the far-end), and may be provided at the NT (DPU is at the far-end).

### 7.4.1 Near end failures

The LOS, LOR, and LOM failures are mutually exclusive and reflect the reason cause of the triggered re-initialization. If no LOS, LOR, or LOM failure is declared, then the re-initialization is triggered by a High\_BER event (see clause 12.1.4 of [ITU-T G.9701]).

#### 7.4.1.1 Loss-of-signal (LOS) failure

A LOS failure is declared when a re-initialization is triggered by a persistent near-end *los* defect. A LOS failure is cleared immediately at the start of showtime in the receiving direction.

#### 7.4.1.2 Loss-of-RMC (LOR) failure

A LOR failure is declared when a re-initialization is triggered by a persistent near-end *lor* defect. A LOR failure is cleared immediately at the start of showtime in the receiving direction.

#### 7.4.1.3 Loss-of-margin (LOM) failure

A LOM failure is declared when a re-initialization is triggered by a persistent near-end *lom* defect. A LOM failure is cleared immediately at the start of showtime in the receiving direction.

#### 7.4.1.4 Loss of power failure

A LPR failure is declared after  $2.5 \pm 0.5$  s of contiguous near-end *lpr* primitive presence. An LPR failure is cleared after  $10 \pm 0.5$  s of no near-end *lpr* primitive presence.

### 7.4.2 Far-end failures

#### 7.4.2.1 Far-end loss of signal failure

A LOS-FE failure is declared when a re-initialization is triggered with a far-end *los* defect present. A LOS-FE failure is cleared immediately at the start of showtime in the transmitting direction.

#### 7.4.2.2 Far-end loss of RMC failure

A LOR-FE failure is declared when a re-initialization is triggered with a far-end *lor* defect present and no LOS-FE failure is present. A LOR-FE failure is cleared immediately at the start of showtime in the transmitting direction.

#### 7.4.2.3 Far-end loss of margin failure

A LOM-FE failure is declared when a re-initialization is triggered with a far-end *lom* defect present and no LOS-FE failure is present and no LOR-FE failure is present. A LOM-FE failure is cleared immediately at the start of showtime in the transmitting direction.

#### 7.4.2.4 Far-end loss of power failure

A LPR-FE failure is declared after the occurrence of a far-end *lpr* primitive followed by  $2.5 \pm 0.5$  s of contiguous near-end *los* defect. A LPR-FE failure is cleared after  $10 \pm 0.5$  s of no near-end *los* defect.

### 7.4.3 Initialization failures

#### 7.4.3.1 Line initialization (LINIT) failure

When the near-end transmitter enters the SILENT state and fails to reach the SHOWTIME state (after a vendor discretionary number of retries and/or within a vendor discretionary timeout), then an initialization failure occurs. An initialization failure cause and last successful transmitted state are reported (see clause 7.10.2).

## 7.5 Channel failures

No channel failures are defined.

## 7.6 Data path failures

No data path failures are defined.

## 7.7 Line performance monitoring objects

The line performance monitoring objects defined in Table 7-7 are subject to the rules defined in clause 8.

CURR/PREV means that the object may apply separately for the current interval and the previous interval, NE/FE means that the object may apply separately for network element (NE) and FE, and 15/24 means that the object may apply separately for 15 min and 24 h intervals.

### 7.7.1 Measured Time (CURR/PREV\_NE/FE\_15/24\_L\_TIME)

**Description:** Reports the amount of time, measured in seconds, that statistics for this interval have been counted.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (for 15 min interval) and 0...86400 (for 24 h interval).

**Reference:** Clause 8.9.

#### **7.7.2 Invalid Data flag (PREV\_NE/FE\_15/24\_L\_INVALID)**

**Description:** Reports the validity of the corresponding PM data. Reported only with the previous interval PM counters.

**Type:** boolean.

**Valid values:** TRUE (PM data is incomplete or invalid) and FALSE (PM data is complete and valid).

**Reference:** Clause 8.9.

#### **7.7.3 Time Stamp (PREV\_NE/FE\_15/24\_L\_STAMP)**

**Description:** Reports the start date/time for this interval. Reported only with the previous interval PM counters.

**Type:** String (as defined in clause 8.12).

**Reference:** None.

#### **7.7.4 LOS failure counter (CURR/PREV\_NE/FE\_15/24\_LOS)**

**Description:** For NE, reports a count of the LOS failures defined in clause 7.4.1.1. For FE, reports a count of the LOS-FE failures defined in clause 7.4.2.1.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clauses 7.4.1.1 and 7.4.2.1.

#### **7.7.5 LOR failure counter (CURR/PREV\_NE/FE\_15/24\_LOR)**

**Description:** For NE, reports a count of the LOR failures defined in clause 7.4.1.2. For FE, reports a count of the LOR-FE failures defined in clause 7.4.2.2.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clauses 7.4.1.2 and 7.4.2.2.

#### **7.7.6 LOM failure counter (CURR/PREV\_NE/FE\_15/24\_LOM)**

**Description:** For NE, reports a count of the LOM failures defined in clause 7.4.1.3. For FE, reports a count of the LOM-FE failures defined in clause 7.4.2.3.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clauses 7.4.1.3 and 7.4.2.3.

#### **7.7.7 LPR failure counter (CURR/PREV\_NE/FE\_15/24\_LPR)**

**Description:** For NE, reports a count of the LPR failures defined in clause 7.4.1.4. For FE, reports a count of the LPR-FE failures defined in clause 7.4.2.4.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clauses 7.4.1.4 and 7.4.2.4.

### 7.7.8 ES counter (CURR/PREV\_NE/FE\_15/24\_ES)

**Description:** Reports the count of errored seconds (ESs). An ES is defined in clause 11.4.4.2 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.2 of [ITU-T G.9701].

### 7.7.9 SES counter (CURR/PREV\_NE/FE\_15/24\_SES)

**Description:** Reports the count of SESs. An SES is defined in clause 11.4.4.3 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.3 of [ITU-T G.9701].

### 7.7.10 LOSS counter (CURR/PREV\_NE/FE\_15/24\_LOSS)

**Description:** Reports the count of LOS seconds (LOSS). A LOSS is defined in clause 11.4.4.4 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.4 of [ITU-T G.9701].

### 7.7.11 LORS counter (CURR/PREV\_NE/FE\_15/24\_LORS)

**Description:** Reports the count of LORS. A LORS is defined in clause 11.4.4.5 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.5 of [ITU-T G.9701].

### 7.7.12 UAS counter (CURR/PREV\_NE/FE\_15/24\_UAS)

**Description:** Reports the count of unavailable seconds (UAS). An unavailable second (UAS) is defined in clause 11.4.4.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.6 of [ITU-T G.9701].

### 7.7.13 Full inits counter (CURR/PREV\_15/24\_FULL\_INITS)

**Description:** Reports a count of the full initialization primitives (full\_init). The full initialization primitive (full\_init) is defined in clause 11.3.1.5 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.5 of [ITU-T G.9701].



#### **7.7.14 Failed full inits counter (CURR/PREV\_15/24\_FAILEDFULL\_INITS)**

**Description:** Reports a count of the failed full initialization primitives (*failedfull\_init*). The failed full initialization primitive (*failedfull\_init*) is defined in clause 11.3.1.5 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.5 of [ITU-T G.9701].

#### **7.7.15 Fast inits counter (CURR/PREV\_15/24\_FAST\_INITS)**

**Description:** Reports a count of the fast initialization primitives (*fast\_init*). The fast initialization primitive (*fast\_init*) is defined in clause 11.3.1.5 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.5 of [ITU-T G.9701].

#### **7.7.16 Failed fast inits counter (CURR/PREV\_15/24\_FAILEDFAST\_INITS)**

**Description:** Reports a count of the failed fast initialization primitives (*failedfast\_init*). The failed fast initialization primitive (*failedfast\_init*) is defined in clause 11.3.1.5 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.5 of [ITU-T G.9701].

#### **7.7.17 LPR\_INTRPT counter (CURR/PREV\_15/24\_LPR\_INTRPT)**

**Description:** Reports a count of the loss-of-power interruption anomalies (*lpr\_intrpt*). The loss-of-power interruption anomaly (*lpr\_intrpt*) is defined in clause 11.3.1.1 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

#### **7.7.18 HRI\_INTRPT counter (CURR/PREV\_15/24\_HRI\_INTRPT)**

**Description:** Reports a count of the host-reinit interruption anomalies (*hri\_intrpt*). The host-reinit interruption anomaly (*hri\_intrpt*) is defined in clause 11.3.1.1 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

#### **7.7.19 SPONT\_INTRPT counter (CURR/PREV\_15/24\_SPONT\_INTRPT)**

**Description:** Reports a count of the spontaneous interruption anomalies (*spont\_intrpt*). The spontaneous interruption anomaly (*spont\_intrpt*) is defined in clause 11.3.1.1 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

#### **7.7.20 Successful bit swap counter (CURR/PREV\_NE/FE\_15/24\_BSW)**

**Description:** Reports a count of the successful bit swap primitives (*success\_BSW*). The successful bit swap primitive (*success\_BSW*) is defined in clause 11.3.1.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.21 Successful autonomous SRA (CURR/PREV\_NE/FE\_15/24\_SRA)**

**Description:** Reports a count of the successful autonomous SRA primitives (*success\_SRA*). The successful autonomous SRA primitive (*success\_SRA*) is defined in clause 11.3.1.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.22 Successful FRA counter (CURR/PREV\_NE/FE\_15/24\_FRA)**

**Description:** Reports a count of the successful FRA primitives (*success\_FRA*). The successful FRA primitive (*success\_FRA*) is defined in clause 11.3.1.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.23 Successful RPA counter (CURR/PREV\_NE/FE\_15/24\_RPA)**

**Description:** Reports a count of the successful RPA primitives (*success\_RPA*). The successful RPA primitive (*success\_RPA*) is defined in clause 11.3.1.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.24 Successful TIGA counter (CURR/PREV\_15/24\_TIGA)**

**Description:** Reports a count of the successful TIGA primitives (*success\_TIGA*). The successful TIGA primitive (*success\_TIGA*) is defined in clause 11.3.1.6 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.25 L2.1N usage counter (CURR/PREV\_15/24\_L2.1N)**

**Description:** Reports the count of L2.1N link state seconds (L2.1NSs). An L2.1NS is defined in clause 12.1.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer

Unit: 1 second

Valid values: 0 .. 86400 (0 to 86400 s)

Reference: Clause 12.1.1.1 of [ITU-T G.9701]

#### **7.7.26 L2.1B usage counter (CURR/PREV\_15/24\_L2.1B)**

Description: Reports the count of L2.1B link state seconds (L2.1BSs). An L2.1BS is defined in clause 12.1.1.1 of [ITU-T G.9701].

Type: 32-bit unsigned integer

Unit: 1 second

Valid values: 0 .. 86400 (0 to 86400 s)

Reference: Clause 12.1.1.1 of [ITU-T G.9701]

#### **7.7.27 L2.2 usage counter (CURR/PREV\_15/24\_L2.2)**

Description: Reports the count of L2.2 link state seconds (L2.2Ss). An L2.2S is defined in clause 12.1.1.1 of [ITU-T G.9701].

Type: 32-bit unsigned integer

Unit: 1 second

Valid values: 0 .. 86400 (0 to 86400 s)

Reference: Clause 12.1.1.1 of [ITU-T G.9701]

### **7.8 Channel performance monitoring objects**

The channel performance monitoring objects defined in Table 7-8 are subject to the rules defined in clause 8.

#### **7.8.1 Measured Time (CURR/PREV\_NE/FE\_15/24\_C\_TIME)**

**Description:** Reports the amount of time, measured in seconds, that statistics for this interval have been counted.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (for 15 min interval) and 0...86400 (for 24 h interval).

**Reference:** Clause 8.9.

#### **7.8.2 Invalid Data Flag (PREV\_NE/FE\_15/24\_C\_INVALID)**

**Description:** Reports the validity of the corresponding PM data. Reported only with the previous interval PM counters.

**Type:** boolean.

**Valid values:** TRUE (PM data is incomplete or invalid) and FALSE (PM data is complete and valid).

**Reference:** Clause 8.9.

#### **7.8.3 Time Stamp (PREV\_NE/FE\_15/24\_C\_STAMP)**

**Description:** Reports the start date/time for this interval. Reported only with the previous interval PM counters.

**Type:** String (as defined in clause 8.12).

**Reference:** None.

#### 7.8.4 CV counter (CURR/PREV\_NE/FE\_15/24\_CV)

**Description:** Reports a count of the cyclic redundancy check anomalies (*crc*). The cyclic redundancy check anomaly (*crc*) is defined in clause 11.3.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

#### 7.8.5 Uncorrected DTU counter (CURR/PREV\_NE/FE\_15/24\_RTXUC)

**Description:** Reports a count of the uncorrected DTU anomalies (*rtx-uc*). The uncorrected DTU anomaly (*rtx-uc*) is defined in clause 11.3.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

#### 7.8.6 Retransmitted DTU counter (CURR/PREV\_NE/FE\_15/24\_RTXTX)

**Description:** Reports a count of the retransmitted DTU anomalies (*rtx-tx*). The retransmitted DTU anomaly (*rtx-tx*) is defined in clause 11.3.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

### 7.9 Data path performance monitoring objects

No data path performance monitoring objects are defined.

### 7.10 Line test, diagnostics and status objects

#### 7.10.1 Profile

##### 7.10.1.1 ITU-T G.9701 profile (PROFILE)

**Description:** Reports for each profile whether operation according to that profile is enabled or disabled. Only one profile can be enabled.

**Type:** Array of PROFILEdescriptor[0...N-1] with N=1.

##### PROFILEdescriptor:

**Type:** boolean.

**Valid values:** 0 (disabled) and 1 (enabled).

##### Bit representation

0 [ITU-T G.9701] profile 106a.

**Reference:** Clause 6 of [ITU-T G.9701].

#### 7.10.2 Initialization

##### 7.10.2.1 Initialization success/failure cause (INITSFCAUSE)

**Description:** Reports whether the last full or fast initialization procedure was successful. If the last initialization procedure was not successful, this parameter provides the reason.

**Type:** enumeration.

**Valid values:** 0...6.

- 0 Successful.
- 1 Configuration error.  
This error occurs if the line cannot reach the L0 state due to a mismatch of configuration and FTU capabilities.
- 2 Configuration not feasible on the line.  
This error occurs if the line cannot reach the L0 state due to a mismatch of configuration and line and noise characteristics.
- 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 far-end FTU detected.  
This error occurs if the far-end FTU is not powered or not connected or if the line is too long to allow detection of a far-end FTU.
- 5 Any other or unknown initialization failure cause.

**Reference:** Clause 12.3.1 of [ITU-T G.9701].

#### **7.10.2.2 Initialization last transmitted downstream signal (INITLASTSIGNALds)**

**Description:** Reports the downstream signal count of the last transmitted initialization signal in the last full or fast initialization performed on the line. The downstream signal count is defined in clause 12.3.1 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Valid values:** 0...21.

**Reference:** Clause 12.3.1 of [ITU-T G.9701].

#### **7.10.2.3 Initialization last received upstream signal (INITLASTSIGNALus)**

**Description:** Reports the upstream signal count of the last received initialization signal in the last full or fast initialization performed on the line. The upstream signal count is defined in clause 12.3.1 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Valid values:** 0...10.

**Reference:** Clause 12.3.1 of [ITU-T G.9701].

### **7.10.3 Signal-to-noise ratio margin**

#### **7.10.3.1 Downstream signal-to-noise ratio margin (SNRMds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the downstream direction during the L0 link state. A first special value (−512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (−511) indicates that the signal-to-noise ratio margin is less than or equal to −51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:**  $-512, -511, 511$  (special values) and  $-510\dots+510$  ( $-51.0$  dB to  $+51.0$  dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

### 7.10.3.2 Downstream signal-to-noise ratio margin (SNRMus)

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the upstream direction during the L0 link state. The same special values as for SNRMds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:**  $-512, -511, +511$  (special value) and  $-510\dots+510$  ( $-51.0$  dB to  $+51.0$  dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

### 7.10.4 Upstream power back-off

#### 7.10.4.1 FTU-O estimated upstream power back-off electrical length (UPBOKLE)

**Description:** Reports the electrical length that would have been sent from the FTU-O to the FTU-R if the electrical length was not forced by the DPU-MIB. If the electrical length is not forced by the DPU-MIB, then this object reports the final electrical length, as determined by the FTU-O (see clause 7.3.1.4.2.1 of [ITU-T G.9701]) and conveyed in the O-UPDATE initialization message (see clause 12.3.3.2.4 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:**  $0\dots1280$  (0 dB to 128 dB).

**Reference:** Clauses 7.3.1.4.2.1 and 12.3.3.2.3 of [ITU-T G.9701].

#### 7.10.4.2 FTU-R estimated upstream power back-off electrical length (UPBOKLE-R)

**Description:** Reports the estimate of the electrical length, as determined by the FTU-R (see clause 7.3.1.4.2.1 of [ITU-T G.9701]) and conveyed in the R-MSG1 initialization message (see clause 12.3.3.2.3 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:**  $0\dots1280$  (0 dB to 128 dB).

**Reference:** See clauses 7.3.1.4.2.1 and 12.3.3.2.3 of [ITU-T G.9701].

### 7.10.5 Actual aggregate transmit power

#### 7.10.5.1 Downstream actual aggregate transmit power (ACTATPDs)

**Description:** Reports the total amount of transmit power delivered by the FTU-O at the U-O2 reference point, at the instant of measurement. A first special value ( $-512$ ) indicates that the transmit power is undetermined. A second special value ( $-311$ ) indicates that the transmit power is less than or equal to  $-31.1$  dBm. A third special value ( $+311$ ) indicates that the transmit power is greater than or equal to  $+31.1$  dBm.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:**  $-512, -311, 311$  (special values) and  $-310\dots310$  ( $-31$  dBm to  $+31$  dBm).

**Reference:** Clause 11.4.1.2.6 of [ITU-T G.9701].

### 7.10.5.2 Upstream actual aggregate transmit power (ACTATPus)

**Description:** Reports the total amount of transmit power delivered by the FTU-R at the U-R2 reference point, at the instant of measurement. The same special values as for ACTATPds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -311, 311 (special values) and -310...310 (-31 dBm to +31 dBm).

**Reference:** Clause 11.4.1.2.6 of [ITU-T G.9701].

### 7.10.6 Actual transmit PSD per sub-carrier

#### 7.10.6.1 Downstream actual transmit PSD per sub-carrier (ACTPSDpsds)

**Description:** Reports the transmit PSD per sub-carrier delivered by the FTU-O at the U-O2 reference point as calculated by the VCE from the downstream ACTPSDREF-ps. A special value indicates that no transmit PSD value is available for the sub-carrier, or its transmit power is zero, or is out of the range to be represented.

**Type:** Array of PSDdescriptor[0...N-1], with N = index of highest supported downstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]).

**PSDdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** -0.5 dBm/Hz.

**Valid values:** 0...254 (0 to -127 dBm/Hz) and 255 (special value).

**Reference:** Clause 11.4.1.2.5 of [ITU-T G.9701].

#### 7.10.6.2 Upstream actual transmit PSD per sub-carrier (ACTPSDpsus)

**Description:** Reports the transmit PSD per sub-carrier delivered by the FTU-R at the U-R2 reference point, as calculated by the VCE from the upstream ACTPSDREF-ps. A special value indicates that no transmit PSD value is available for the sub-carrier, or its transmit power is zero, or is out of the range to be represented.

**Type:** Array of PSDdescriptor[0...N-1], with N = index of highest supported upstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]).

**PSDdescriptor:** See ACTPSDpsds in clause 7.10.6.1.

**Reference:** Clause 11.4.1.2.5 of [ITU-T G.9701].

### 7.10.7 Channel characteristics function per sub-carrier (HLOG)

#### 7.10.7.1 Downstream HLOG measurement time (HLOGMTds)

**Description:** Reports the number of symbols used to measure the downstream Hlog(f) values. The object is updated only in L0 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

#### 7.10.7.2 Downstream HLOG sub-carrier group size (HLOGGds)

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the downstream Hlog(f) values. The object is updated only in L0 link state.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, and 4.

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

### **7.10.7.3 Downstream HLOG(f) (HLOGpsds)**

**Description:** Reports the downstream Hlog(f) as one value per sub-carrier group. A first special value (1023) indicates that the Hlog(f) for this sub-carrier group is undetermined. A second special value (1022) indicates that no measurement could be done for this sub-carrier group because it is out of the MEDLEY set. A third special value (0) indicates that the Hlog(f) for this sub-carrier group is greater than or equal to +6.0 dB. A fourth special value (1020) indicates that the Hlog(f) for this sub-carrier group is less than or equal to -96.0 dB. The object is updated only in L0 link state.

**Type:** Array of HLOGdescriptor[0..N-1], where N = index of highest sub-carrier index in the MEDLEY set, divided by HLOGG, rounded to the higher integer.

**HLOGdescriptor:**

**Type:** 16-bit unsigned integer.

**Unit:** -0.1 dB.

**Offset:** 6 dB.

**Valid values:** 1..1019 (+5.9 to -95.9 dB) and 0,1020,1022,1023 (special values).

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

### **7.10.7.4 Upstream HLOG measurement time (HLOGMTus)**

**Description:** Reports the number of symbols used to measure the upstream Hlog(f) values.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

### **7.10.7.5 Upstream HLOG sub-carrier group size (HLOGGus)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the upstream Hlog(f) values.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2 and 4.

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

### **7.10.7.6 Upstream HLOG(f) (HLOGpsus)**

**Description:** Reports the upstream Hlog(f) as one value per sub-carrier group. The same special values as for the HLOGpsds are defined. The object is updated only in L0 link state.

**Type:** Array of HLOGdescriptor[0..N-1], where N = index of highest sub-carrier index in the MEDLEY set, divided by HLOGG, rounded to the higher integer.



**HLOGdescriptor:**

**Type:** 16-bit unsigned integer.

**Unit:** -0.1 dB.

**Offset:** 6 dB.

**Valid values:** 1..1019 (+5.9 to -95.9 dB) and 0,1020,1022,1023 (special values).

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

**7.10.8 Signal-to-noise ratio per sub-carrier (SNR)**

**7.10.8.1 Downstream signal-to-noise ratio PSD measurement time (SNRMTds)**

**Description:** Reports the number of symbols used to measure the downstream SNR(f) values.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0...65535.

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

**7.10.8.2 Downstream SNR(f) sub-carrier group size (SNRGds)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the downstream SNR(f) values.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, and 8.

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

**7.10.8.3 Downstream SNR(f) (SNRpsds)**

**Description:** Reports the downstream SNR(f) values. A special value indicates that no measurement could be done for this sub-carrier group because it is out of the downstream MEDLEY set or its transmit power is zero.

**Type:** Array of SNRdescriptor[0...N-1], where N = index of highest supported downstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]), divided by SNRGds, rounded to the higher integer.

**SNRdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** 0.5 dB.

**Offset:** -32 dB.

**Valid values:** 0...254 (-32 to 95 dB) and 255 (special value).

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

**7.10.8.4 Upstream signal-to-noise ratio PSD measurement time (SNRMTus)**

**Description:** Reports the number of symbols used to measure the upstream SNR(f) values.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0...65535 (0 to  $2^{16}-1$  symbols).

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

#### **7.10.8.5 Upstream SNR(f) sub-carrier group size (SNRGus)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the upstream SNR(f) values.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, and 8.

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

#### **7.10.8.6 Upstream SNR(f) (SNRpsus)**

**Description:** Reports the upstream SNR(f) values. A special value indicates that no measurement could be done for this sub-carrier group because it is out of the upstream MEDLEY set or its transmit power is zero.

**Type:** Array of SNRdescriptor[0...N-1], where N = index of highest supported upstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]), divided by SNRGds, rounded to the higher integer.

**SNRdescriptor:** See SNRpsds in clause 7.10.8.3.

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

#### **7.10.9 Quiet line noise PSD per sub-carrier (QLN)**

##### **7.10.9.1 Downstream QLN measurement time (QLNMTds)**

**Description:** Reports the number of symbols used to measure the downstream QLN(f) values. The object is updated only in L0 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

##### **7.10.9.2 Downstream QLN sub-carrier group size (QLNGds)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the downstream QLN(f) values. The object is updated only in L0 link state.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, and 4.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

##### **7.10.9.3 Downstream QLN(f) (QLNpsds)**

**Description:** Reports the downstream QLN(f) as one value per sub-carrier group. A first special value (255) indicates that the QLN(f) for this sub-carrier group is undetermined. A second special value (254) indicates that no measurement could be done for this sub-carrier group because it is out of the downstream MEDLEY set. A third special value (0) indicates that the QLN(f) for this sub-carrier group is greater than or equal to  $-35\text{dBm/Hz}$ . A fourth special value (251) indicates that the QLN(f) for this sub-carrier group is less than or equal to  $-160.5\text{ dBm/Hz}$ . The object is updated only in L0 link state.

**Type:** Array of QLNdSCRIPTOR[0..N-1], where N = index of highest sub-carrier index in the downstream MEDLEY set, divided by QLNGds, rounded to the higher integer.

**QLNdSCRIPTOR:**

**Type:** 8-bit unsigned integer.

**Unit:** -0.5 dBm/Hz.

**Offset:** -35 dBm/Hz.

**Valid values:** 1..250 (-35.5 to -160 dBm/Hz), 0, 251, 254, 255 (special values).

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

#### 7.10.9.4 Upstream QLN measurement time (QLNMTus)

**Description:** Reports the number of symbols used to measure the upstream QLN(f) values. The object is updated only in L0 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

#### 7.10.9.5 Upstream QLN sub-carrier group size (QLNGus)

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the upstream QLN(f) values. The object is updated only in L0 link state.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, and 4.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

#### 7.10.9.6 Upstream QLN(f) (QLNpsus)

**Description:** Reports the upstream quiet line noise PSD QLN(f) as one value per sub-carrier group. The same special values as for the QLNpsds are defined. The object is updated only in L0 link state.

**Type:** Array of QLNdSCRIPTOR[0..N-1], where N = index of highest sub-carrier index in the upstream MEDLEY set, divided by QLNGus, rounded to the higher integer.

**QLNdSCRIPTOR:** See clause 7.10.9.3.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

#### 7.10.10 Active line noise PSD per sub-carrier (ALN)

##### 7.10.10.1 ALN measurement time (ALNMT)

**Description:** Reports the number of symbols used to measure the ALN(f) values. The object is updated only in L0 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.4 of [ITU-T G.9701].

### 7.10.10.2 ALN sub-carrier group size (ALNG)

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the ALN(f) values. The object is updated only in L0 link state.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, and 4.

**Reference:** Clause 11.4.1.2.4 of [ITU-T G.9701].

### 7.10.10.3 ALN(f) (ALNps)

**Description:** Reports the ALN(f). A first special value (255) indicates that the ALN(f) for this sub-carrier is undetermined. A second special value (254) indicates that no measurement could be done for this sub-carrier because it is out of the downstream MEDLEY set. A third special value (0) indicates that the ALN(f) for this sub-carrier is greater than or equal to  $-35$  dBm/Hz. A fourth special value (251) indicates that the ALN(f) for this sub-carrier is less than or equal to  $-160.5$  dBm/Hz. The object is updated only in L0 link state.

**Type:** Array of ALNdescriptor[0..N-1], where N = index of highest sub-carrier index in the downstream MEDLEY set, divided by ALNG, rounded to the higher integer.

**ALNdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:**  $-0.5$  dBm/Hz.

**Offset:**  $-35$  dBm/Hz.

**Valid values:** 1..250 ( $-35.5$  to  $-160$  dBm/Hz), 0, 251, 254 and 255 (special values).

**Reference:** Clause 11.4.1.2.4 of [ITU-T G.9701].

### 7.10.11 Bit allocation per sub-carrier on data symbols

#### 7.10.11.1 Downstream bits allocation (BITSpsds)

**Description:** Reports the bit allocation values on data symbols in the normal operation interval (NOI) in the downstream direction.

**Type:** Array of BITSdescriptor[0..N-1], where N = index of highest supported downstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]) plus one.

**BITSdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** 1 bit.

**Valid values:** 0..12.

**Reference:** Clause 10.2.1.4 of [ITU-T G.9701].

#### 7.10.11.2 Upstream bits allocation (BITSpsus)

**Description:** Reports the bit allocation values on data symbols in the normal operation interval (NOI) in the upstream direction.

**Type:** Array of BITSdescriptor[0..N-1], where N = index of highest supported upstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]) plus one.

**BITSdescriptor:** See BITSpsds in clause 7.10.10.1.

**Reference:** Clause 10.2.1.4 of [ITU-T G.9701].

## 7.10.12 Robust Management Channel (RMC)

### 7.10.12.1 Downstream signal-to-noise ratio margin for RMC(SNRM-RMCds)

**Description:** Reports the signal-to-noise ratio margin (as defined in clause 11.4.1.1.11 of [ITU-T G.9701]) for the RMC in the downstream direction during the L0 link state. A first special value (−512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (−511) indicates that the signal-to-noise ratio margin is less than or equal to −51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** −512, −511, +511 (special values) and −510...+510 (−51.0 dB to +51.0 dB).

**Reference:** Clause 11.4.1.1.11 of [ITU-T G.9701].

### 7.10.12.2 Upstream signal-to-noise ratio margin for RMC(SNRM-RMCus)

**Description:** Reports the signal-to-noise ratio margin (as defined in clause 11.4.1.1.11 of [ITU-T G.9701]) for the RMC in the upstream direction during the L0 link state. The same special values as for SNRM-RMCds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** −512, −511, +511 (special values) and −510...+510 (−51.0 dB to +51.0 dB).

**Reference:** Clause 11.4.1.1.11 of [ITU-T G.9701].

### 7.10.12.3 Downstream bits allocation for RMC(BITS-RMCpsds)

**Description:** Reports the bit allocation values on RMC sub-carriers in RMC symbols in the downstream direction.

**Type:** Array of BITSRMCdescriptor[0...N-1], where  $N \leq 512$ .

#### **BITSRMCdescriptor:**

**Type:** Record of a sub-carrier index and a bit allocation value.

#### **Sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

#### **Bit allocation value:**

**Type:** 8-bit unsigned integer.

**Unit:** 1 bit.

**Valid values:** 0 and 2...6.

**Reference:** Clause 12.3.4.2.8 of [ITU-T G.9701].

### 7.10.12.4 Upstream bits allocation for RMC(BITS-RMCpsus)

**Description:** Reports the bit allocation values on RMC sub-carriers in RMC symbols in the upstream direction.

**Type:** Array of BITSRMCdescriptor[0...N-1], where  $N =$  index of highest supported upstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]) plus one.

**BITSRMCdescriptor:** See BITS-RMCpsds in clause 7.10.12.3.

**Reference:** Clause 12.3.4.2.7 of [ITU-T G.9701].

### **7.10.13 Test parameter time stamps**

#### **7.10.13.1 Date/time-stamping of near-end test parameter group 1 (STAMP-TEST-NE-G1)**

**Description:** Reports the date/time when the near-end test parameter group 1 that can change during showtime was last updated.

**Type:** string (as defined in clause 8.12)

**Reference:** Clause 11.1 of [ITU-T G.9701].

#### **7.10.13.2 Date/time-stamping of far-end test parameter group 1 (STAMP-TEST-FE-G1)**

**Description:** Reports the date/time when the far-end test parameter group 1 that can change during showtime was last updated.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.1 of [ITU-T G.9701].

#### **7.10.13.3 Date/time-stamping of near-end test parameter group 2 (STAMP-TEST-NE-G2)**

**Description:** Reports the date/time when the near-end test parameter group 2 that can change during showtime was last updated.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.1 of [ITU-T G.9701].

#### **7.10.13.4 Date/time-stamping of far-end test parameter group 2 (STAMP-TEST-FE-G2)**

**Description:** Reports the date/time when the far-end test parameter group 2 that can change during showtime was last updated.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.1 of [ITU-T G.9701].

### **7.10.14 On-line reconfiguration (OLR/FRA) time stamps**

#### **7.10.14.1 Date/time-stamping of last successful downstream bit swap operation (STAMP-BSWds)**

**Description:** Reports the date/time of the last successful FTU-R initiated bit swap execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.2 Date/time-stamping of last successful upstream bit swap operation (STAMP-BSWus)**

**Description:** Reports the date/time of the last successful FTU-O initiated bit swap execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.3 Date/time-stamping of last successful downstream autonomous SRA operation (STAMP-SRAds-)**

**Description:** Reports the date/time of the last successful FTU-R initiated autonomous SRA execution (excluding SRAs in response to TIGA) that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.4 Date/time-stamping of last successful upstream autonomous SRA operation (STAMP-SRAus-)**

**Description:** Reports the date/time of the last successful FTU-O initiated autonomous SRA execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.5 Date/time-stamping of last successful downstream FRA operation (STAMP-FRAds-)**

**Description:** Reports the date/time of the last successful FTU-R initiated FRA execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 13.3.1.1 of [ITU-T G.9701].

#### **7.10.14.6 Date/time-stamping of last successful upstream FRA operation (STAMP-FRAus-)**

**Description:** Reports the date/time of the last successful FTU-O initiated FRA execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 13.3.1.1 of [ITU-T G.9701].

#### **7.10.14.7 Date/time-stamping of last successful downstream RPA operation (STAMP-RPAdS)**

**Description:** Reports the date/time of the last successful FTU-R initiated RPA execution that has modified the bits allocation for the RMC.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.8 Date/time-stamping of last successful upstream RPA operation (STAMP-RPAus)**

**Description:** Reports the date/time of the last successful FTU-O initiated RPA execution that has modified the bits allocation for the RMC.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.9 Date/time-stamping of last successful downstream TIGA operation (STAMP-TIGA)**

**Description:** Reports the date/time of the last successful FTU-O initiated TIGA execution.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

### **7.10.15 Signal Attenuation (SATN)**

#### **7.10.15.1 Downstream signal attenuation (SATNds)**

**Description:** Reports the downstream SATN. A special value (1023) indicates that the value is undetermined. A second special value (0) indicates that the SATN is less than or equal to 0 dB. A third special value (1001) indicates that the SATN is greater than or equal to 100.1dB. The object is updated only in L0 link state.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** 1..1000 (0.1 dB to +100.0 dB), 0, 1001 and 1023 (special values).

**Reference:** Clause 11.4.1.2.7.1 of [ITU-T G.9701].

### **7.10.15.2 Upstream signal attenuation (SATNus)**

**Description:** Reports the upstream SATN. The same special values as for SATNds are defined. The object is updated only in L0 link state.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** 0..1000 (0 dB to +100.0 dB) 0, 1001, and 1023 (special values).

**Reference:** Clause 11.4.1.2.7.2 of [ITU-T G.9701].

### **7.10.16 Low power modes**

#### **7.10.16.1 L2.1 Downstream signal-to-noise ratio margin (L2.1-SNRMds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the downstream direction during the L2.1N and L2.1B link states. A first special value (-512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (-511) indicates that the signal-to-noise ratio margin is less than or equal to -51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

#### **7.10.16.2 L2.1 Upstream signal-to-noise ratio margin (L2.1-SNRMus)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the upstream direction during the L2.1N and L2.1B link states. The same special as for L2.1-SNRMds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

#### **7.10.16.3 L2.2 Downstream signal-to-noise ratio margin (L2.2-SNRMds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the downstream direction during the L2.2 link state. A first special value (-512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (-511) indicates that the signal-to-noise ratio margin is less than or equal to -51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.



**Valid values:** -512, -511,+511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

#### **7.10.16.4 L2.2 Upstream signal-to-noise ratio margin (L2.2-SNRMus)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the upstream direction during the L2.2 link state. The same special values as for L2.2-SNRMds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511,+511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

#### **7.10.16.5 L2 Downstream signal-to-noise ratio margin for RMC (L2-SNRM-RMCds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clause 11.4.1.4 of [ITU-T G.9701]) for the RMC in the downstream direction during the L2.1N, L2.1B and L2.2 link state. A first special value (-512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (-511) indicates that the signal-to-noise ratio margin is less than or equal to -51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clause 11.4.1.1.11 of [ITU-T G.9701].

#### **7.10.16.6 L2 Upstream signal-to-noise ratio margin for RMC (L2-SNRM-RMCus)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clause 11.4.1.4 of [ITU-T G.9701]) for the RMC in the upstream direction during the L2.1N, L2.1B and L2.2 link state. The same special values as for L2-SNRM-RMCds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clause 11.4.1.1.11 of [ITU-T G.9701].

### **7.10.17 Downstream FEXT coupling coefficients (XLOG)**

#### **7.10.17.1 Downstream XLOG disturber index (XLOGDISTds)**

**Description:** Reports the VCE\_port\_index of the disturber line to which the XLOGpsds values apply. A special value 0 indicates that the requested VCE\_port\_index (XLOGDREQds) is invalid.

**Type:** 16-bit unsigned integer.

**Valid values:** 0 (special value) and 1..65535.

**Reference:** Clause 11.4.3.2 of [ITU-T G.9701].

#### **7.10.17.2 Downstream XLOG bandedges (XLOGBANDSds)**

**Description:** Defines the set of sub-carriers for which XLOGpsds is reported. For each band in which XLOGpsds is reported, XLOGBANDSds contains a triplet of (start subcarrier index, stop subcarrier index, group size). The XLOGpsds is reported for all sub-carriers in the band (start

and stop subcarrier inclusive) with index equal to start subcarrier index+m\*group size, with m integer. The object is updated only in L0 link state.

**Type:** Array of XLOGBANDSdescriptor[0...N-1], with  $1 \leq N \leq 8$  or empty if XLOGDISTds=0

**XLOGBANDSdescriptor:**

**Type:** Record of a start sub-carrier index, a stop sub-carrier index and a group size.

**Start sub-carrier index**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**Stop sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**Group size:**

**Type:** 8-bit unsigned integer.

**Valid values:** 1, 2, 4, 8, 16, 32, and 64.

**Reference:** Clause 11.4.1.2.9 of [ITU-T G.9701].

**7.10.17.3 Downstream FEXT coupling (XLOGpsds)**

**Description:** Reports the downstream Xlog(f) as one value per sub-carrier group. A first special value (255) indicates that the Xlog(f) for this sub-carrier group is undetermined. A second special value (254) indicates that no measurement could be done for this sub-carrier group. A third special value (0) indicates that the Xlog(f) for this sub-carrier group is greater than or equal to +40.0 dB. A fourth special value (251) indicates that the Xlog(f) for this sub-carrier group is less than or equal to -85.5 dB. The object is updated only in L0 link state.

**Type:** Array of XLOGdescriptor[0..N-1], with  $1 \leq N \leq 512$  or empty if XLOGDISTds=0.

**XLOGdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** -0.5 dB.

**Offset:** 40 dB.

**Valid values:** 1...250 (39.5 to -85 dB) 0, 251, 254 and 255 (special values).

**Reference:** Clause 11.4.1.2.8 of [ITU-T G.9701].

**7.11 Channel test, diagnostics and status objects**

**7.11.1 Actual data rates**

**7.11.1.1 Net data rate (NDRds/us)**

**Description:** Reports the NDR as defined in clause 11.4.1.1.1 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the NDR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.1 of [ITU-T G.9701].

### 7.11.1.2 Expected throughput (ETRds/us)

**Description:** Reports the expected throughput as defined in clause 11.4.1.1.3 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the ETR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

### 7.11.1.3 Gamma Data Rate (GDRds/us)

**Description:** Reports the NDR as defined in clause 7.11.1.1, lowered by any throughput capability limitations remaining in the DRA or L2+ functions, assuming no user data is transmitted over all the other lines. A special value ( $2^{32}-1$ ) indicates that the GDR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** None.

## 7.11.2 Attainable data rates

### 7.11.2.1 Attainable net data rate (ATTNDRds/us)

**Description:** Reports the attainable NDR as defined in clause 11.4.1.1.2 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the attainable NDR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-1$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.2 of [ITU-T G.9701].

### 7.11.2.2 Attainable expected throughput (ATTETRds/us)

**Description:** Reports the attainable expected throughput as defined in clause 11.4.1.1.4 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the attainable expected throughput is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.4 of [ITU-T G.9701].

### 7.11.2.3 Attainable gamma data rate (ATTGDRds/us)

**Description:** Reports the attainable NDR (as defined in clause 7.11.2.1), lowered by any throughput capability limitations remaining in the DRA or L2+ functions, assuming no user data is transmitted over all the other Lines, and assuming MAXGDR (as defined in clause 7.2.1.3) is configured to its maximum valid value. A special value ( $2^{32}-1$ ) indicates that the attainable GDR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** None.

### 7.11.3 Actual impulse noise protection

#### 7.11.3.1 Actual INP against SHINE (ACTINPds/us)

**Description:** Reports the actual INP against SHINE as defined in clause 11.4.1.1.4 of [ITU-T G.9701]. A special value indicates an actual INP against SHINE of 2047 symbols or higher.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0...2046 (0 to 2046 symbols) and 2047 (special value).

**Reference:** Clause 11.4.1.1.4 of [ITU-T G.9701].

#### 7.11.3.2 Actual INP against REIN (ACTINP\_REINds/us)

**Description:** Reports the actual INP against REIN as defined in clause 11.4.1.1.5 of [ITU-T G.9701]. A special value indicates an actual INP against REIN of 63 symbols or higher.

**Type:** 8-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0...62 (0 to 62 symbols) and 63 (special value).

**Reference:** Clause 11.4.1.1.5 of [ITU-T G.9701].

### 7.11.4 Actual framer settings

#### 7.11.4.1 DTU FEC codeword length (DTU-NFECds/us)

**Description:** Reports the DTU FEC codeword length as defined in clause 9.3 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Unit:** 1 byte.

**Valid values:** 32..255 (32 to 255 bytes).

**Reference:** Clause 9.3 of [ITU-T G.9701].

#### 7.11.4.2 DTU FEC redundancy (DTU-RFECds/us)

**Description:** Reports the DTU FEC codeword redundancy as defined in clause 9.3 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Unit:** 1 byte.

**Valid values:** 2, 4, 6, 8, 10, 12, and 16 (2, 4, 6, 8, 10, 12, and 16 bytes).

**Reference:** Clause 9.3 of [ITU-T G.9701].

#### 7.11.4.3 Number of FEC codewords per DTU (DTU-Qds/us)

**Description:** Reports the number of FEC codewords per DTU as defined in clause 9.3 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Valid values:** 1...16.

**Reference:** Clause 9.3 of [ITU-T G.9701].

### **7.11.5 Test parameters per time interval**

#### **7.11.5.1 Error-free bits current 15 minutes (EFB-C15Mds/us)**

**Description:** Reports the number of error-free bits (see clause 11.4.1.1.6 of [ITU-T G.9701]) passed over the alpha reference point at the receiver, divided by 65536, in the current 15 min interval.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 (0 to  $2^{16} \times (2^{32} - 1)$  bits).

**Reference:** Clause 11.4.1.1.6 of [ITU-T G.9701].

#### **7.11.5.2 Error-free bits previous 15 minutes (EFB-P15Mds/us)**

**Description:** Reports the number of error-free bits (see clause 11.4.1.1.6 of [ITU-T G.9701]) passed over the alpha reference point at the receiver, divided by 65536, in the previous 15 min interval.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 (0 to  $2^{16} \times (2^{32} - 1)$  bits).

**Reference:** Clause 11.4.1.1.6 of [ITU-T G.9701].

#### **7.11.5.3 Error-free bits current 24 hours (EFB-C24Hds/us)**

**Description:** Reports the number of error-free bits (see clause 11.4.1.1.6 of [ITU-T G.9701]) passed over the alpha reference point at the receiver, divided by 65536, in the current 24 h interval.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 (0 to  $2^{16} \times (2^{32} - 1)$  bits).

**Reference:** Clause 11.4.1.1.6 of [ITU-T G.9701].

#### **7.11.5.4 Error-free bits previous 24 hours (EFB-P24Hds/us)**

**Description:** Reports the number of error-free bits (see clause 11.4.1.1.6 of [ITU-T G.9701]) passed over the alpha reference point at the receiver, divided by 65536, in the previous 24 h interval.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 (0 to  $2^{16} \times (2^{32} - 1)$  bits).

**Reference:** Clause 11.4.1.1.6 of [ITU-T G.9701].

#### **7.11.5.5 Minimum error-free throughput current 15 minutes (MINEFTR-C15Mds/us)**

**Description:** Reports the minimum error-free throughput (see clause 11.4.1.1.3 of [ITU-T G.9701]) over the current 15 min interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32} - 1$  kbit/s).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

#### **7.11.5.6 Minimum error-free throughput previous 15 minutes (MINEFTR-P15Mds/us)**

**Description:** Reports the minimum error-free throughput (see clause 11.4.1.1.3 of [ITU-T G.9701]) over the previous 15 min interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

#### **7.11.5.7 Minimum error-free throughput current 24 hours (MINEFTR-C24Hds/us)**

**Description:** Reports the minimum error-free throughput (see clause 11.4.1.1.3 of [ITU-T G.9701]) over the current 24 h interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

#### **7.11.5.8 Minimum error-free throughput previous 24 hours (MINEFTR-P24Hds/us)**

**Description:** Reports the minimum error-free throughput (see clause 11.4.1.1.3 of [ITU-T G.9701]) over the previous 24 h interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

### **7.11.6 Low power modes**

#### **7.11.6.1 L2.1 Net data rate (L2.1-NDRds/us)**

**Description:** Reports the NDR in L2.1N and L2.1B link states as defined in clause 11.4.1.1.12 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the NDR is undetermined. The object is updated only in L2.1N and L2.1B link states.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.12 of [ITU-T G.9701].

#### **7.11.6.2 L2.2 Net data rate (L2.2-NDRds/us)**

**Description:** Reports the NDR in L2.2 link state as defined in clause 11.4.1.1.13 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the NDR is undetermined. The object is updated only in L2.2 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.13 of [ITU-T G.9701].

### 7.11.6.3 L2.1 Expected throughput (L2.1-ETRs/us)

**Description:** Reports the expected throughput in L2.1N and L2.1B link state as defined in clause 11.4.1.1.14 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the expected throughput is undetermined. The object is updated only in L2.1N and L2.1B link states.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.14 of [ITU-T G.9701].

### 7.11.6.4 L2.2 Expected throughput (L2.2\_ETRs/us)

**Description:** Reports the expected throughput in L2.2 link state as defined in clause 11.4.1.1.15 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the expected throughput is undetermined. The object is updated only in L2.2 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.15 of [ITU-T G.9701].

## 7.12 Data path test, diagnostics and status objects

No data path test, diagnostics and status objects are defined.

## 7.13 Inventory objects

### 7.13.1 FTU related inventory

#### 7.13.1.1 FTU-O ITU-T G.994.1 vendor ID (FTUO\_GHS\_VENDOR)

**Description:** Reports the FTU-O [ITU-T G.994.1] vendor ID as inserted by the FTU-O in the [ITU-T G.994.1] CL message and as defined in clause 9.3.3.1 of [ITU-T G.994.1].

**Type:** string (8 binary octets).

**Reference:** Clause 9.3.3.1 of [ITU-T G.994.1].

#### 7.13.1.2 FTU-R ITU-T G.994.1 vendor ID (FTUR\_GHS\_VENDOR)

**Description:** Reports the FTU-R [ITU-T G.994.1] vendor ID as inserted by the FTU-R in the [ITU-T G.994.1] CLR message and as defined in clause 9.3.3.1 of [ITU-T G.994.1].

**Type:** string (8 binary octets).

**Reference:** Clause 9.3.3.1 of [ITU-T G.994.1].

#### 7.13.1.3 FTU-O version number (FTUO\_VERSION)

**Description:** Reports the FTU-O version number as inserted by the FTU-O in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]). It is for version control and is vendor specific information.

**Type:** string (up to 16 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### 7.13.1.4 FTU-R version number (FTUR\_VERSION)

**Description:** Reports the FTU-R version number as inserted by the FTU-R in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]). It is for version control. It shall contain the FTU-R firmware version and the FTU-R model. Both shall be encoded in this order and separated by a space character, i.e., "<FTU-R firmware version><space><FTU-R model>".

**Type:** string (up to 16 ASCII characters).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### 7.13.1.5 FTU-O self-test result (FTUO\_SELFTEST)

**Description:** Reports the results from the most recent self-test procedure, initiated at power-up (see clause 12.1.2 of [ITU-T G.9701]). The first octet of the self-test result is 00<sub>hex</sub> if the self-test passed and 01<sub>hex</sub> if the self-test failed. The interpretation of the other octets is vendor discretionary and can be interpreted in combination with the FTU-O [ITU-T G.994.1] vendor ID and DPU system vendor ID.

**Type:** string (4 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### 7.13.1.6 FTU-R self-test result (FTUR\_SELFTEST)

**Description:** Reports the results from the most recent self-test procedure, initiated either at power-up (see clause 12.1.2 of [ITU-T G.9701]) or by the perform self-test eoc command (see clause 12.2.2.6.1 of [ITU-T G.9701]). The first octet of the self-test result is 00<sub>hex</sub> if the self-test passed and 01<sub>hex</sub> if the self-test failed. The interpretation of the other octets is vendor discretionary and can be interpreted in combination with the FTU-R [ITU-T G.994.1] vendor ID and the NT system vendor ID.

**Type:** string (4 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### 7.13.1.7 ITU-T G.9701 profile support (FTUO\_PROFILES)

**Description:** Reports for each profile whether the FTU-O supports operation according to that profile.

**Type:** Array of PROFILEDescriptor[0...N-1] with N=3.

##### PROFILEDescriptor:

**Type:** boolean.

**Valid values:** false (not supported) and true (supported).

##### Bit representation

0 [ITU-T G.9701] profile 106a.

1 [ITU-T G.9701] profile 106b.

2 [ITU-T G.9701] profile 212a.

**Reference:** Clause 6 of [ITU-T G.9701].

#### 7.13.1.8 ITU-T G.9701 profile support (FTUR\_PROFILES)

**Description:** Reports for each profile whether the FTU-R supports operation according to that profile.

**Type:** Array of PROFILEDescriptor[0...N-1] with N=3.

##### PROFILEDescriptor:

**Type:** boolean.

**Valid values:** false (not supported) and true (supported).



## **Bit representation**

0 [ITU-T G.9701] profile 106a.

1 [ITU-T G.9701] profile 106b.

2 [ITU-T G.9701] profile 212a.

**Reference:** Clause 6 of [ITU-T G.9701].

### **7.13.2 System related inventory**

#### **7.13.2.1 DPU system vendor ID (DPU\_SYSTEM\_VENDOR)**

**Description:** Reports the DPU system vendor ID as inserted by the FTU-O in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]) and as defined in clause 9.3.3.1 of [ITU-T G.994.1].

**Type:** string (8 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### **7.13.2.2 NT system vendor ID (NT\_SYSTEM\_VENDOR)**

**Description:** Reports the NT system vendor ID as inserted by the FTU-R in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]) and as defined in clause 9.3.3.1 of [ITU-T G.994.1].

**Type:** string (8 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### **7.13.2.3 DPU system serial number (DPU\_SYSTEM\_SERIALNR)**

**Description:** Reports the DPU serial number as inserted by the FTU-O in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]). It is vendor specific information. The combination of DPU system vendor ID and DPU system serial number creates a unique number for each DPU.

**Type:** string (up to 32 ASCII characters).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### **7.13.2.4 NT system serial number (NT\_SYSTEM\_SERIALNR)**

**Description:** Reports the NT system serial number as inserted by the FTU-R in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]). It shall contain the NT system serial number, the NT model and the NT firmware version. All shall be encoded in this order and separated by space characters, i.e., "<NT serial number><space><NT model><space><NT firmware version>". The combination of NT system vendor ID and NT system serial number creates a unique number for each NT.

**Type:** string (up to 32 ASCII characters).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### **7.13.2.5 VCE ID (VCE ID)**

**Description:** For the line in a vectored group, the 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.

**Type:** 8-bit unsigned integer.

**Valid values:** 0 (special value) and 1..255.

**Reference:** Clause 11.4.6.1.1 of [ITU-T G.9701].

### **7.13.2.6 VCE port index (VCE\_PORT\_INDEX)**

**Description:** For the line in a vectored group, the 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. The combination of VCE ID and VCE port index creates a unique identifier for each vectored FTU-O/-R.

**Type:** 16-bit unsigned integer.

**Valid values:** 0 (special value) and 1..65535.

**Reference:** Clause 11.4.6.1.2 of [ITU-T G.9701].

## **7.14 Link State related managed objects**

### **7.14.1 Link State Configuration**

#### **7.14.1.1 Link state forced (LS-FORCED)**

**Description:** Forces the link to transition and to remain in the selected link state.

**Type:** enumeration

**Valid values:** 0 .. 4

- 0 No link state forced
- 1 L0 link state forced
- 2 L2.1N link state forced
- 3 L2.1B link state forced
- 4 L2.2 link state forced

**Default value:** 0 (no link state forced)

**Reference:** Clause 12.1.1.7.1 of [ITU-T G.9701].

#### **7.14.1.2 Link state enabling (LS-ENABLE)**

**Description:** Selects the set of allowed low power mode states.

**Type:** enumeration

**Valid values:** 0 .. 3

- 0 L0 and L3 enabled (L2.1N, L2.1B, L2.2 disabled).
- 1 L0, L3 and L2.1N enabled (L2.1B, L2.2 disabled).
- 2 L0, L3, L2.1N and L2.1B enabled (L2.2 disabled).
- 3 L0, L3, L2.1N, L2.1B and L2.2 enabled.

**Default value:** 3 (L0, L3, L2.1N, L2.1B and L2.2 enabled)

**Reference:** Clause 12.1.1.7.2 of [ITU-T G.9701].

### **7.14.2 Link State Status Reporting**

#### **7.14.2.1 Link state (LINK-STATE)**

**Description:** Reports the actual link state

**Type:** enumeration.

**Valid values:** 1..5

- 1 L0 link state

- 2 L2.1N link state
- 3 L2.1B link state
- 4 L2.2 link state
- 5 L3 link state

**Reference:** Clause 12.1.1.7.3 of [ITU-T G.9701].

#### **7.14.2.2 Link state at update of near-end test parameter group 1 (LINK-STATE-TEST-NE-G1)**

**Description:** Report the link state during which near-end test parameters group 1 were updated.

**Type:** enumeration.

**Valid values:** 1..4.

- 1 L0 link state
- 2 L2.1N link state
- 3 L2.1B link state
- 4 L2.2 link state

**Reference:** Clause 12.1.1.7.3 of [ITU-T G.9701].

#### **7.14.2.3 Link state at update of far-end test parameter group 1 (LINK-STATE-TEST-FE-G1)**

**Description:** Report the link state during which far-end test parameters group 1 were updated.

**Type:** enumeration.

**Valid values:** 1..4.

- 1 L0 link state
- 2 L2.1N link state
- 3 L2.1B link state
- 4 L2.2 link state

**Reference:** Clause 12.1.1.7.3 of [ITU-T G.9701].

### **8 Procedures for performance monitoring functions**

The functions described in this clause can be performed inside or outside the network element.

#### **8.1 Line transmission states**

A line can be in one of two transmission states:

- 1) unavailable state;
- 2) available state.

The transmission state is determined from SES/non-SES data and the transceiver state SHOWTIME/non-SHOWTIME. The unavailable state is defined in clause 11.4.4.5 of [ITU-T G.9701]. A G.fast line is in the available state when it is not in the unavailable state.

#### **8.2 Threshold reports**

A threshold report (TR) is an unsolicited error performance report from a DPU over its DPU-NB interface with respect to either a 15-minute or 24-hour evaluation period. TRs can only occur when

the concerned direction is in the available state. The performance counter thresholds are listed in Table 8-1 and Table 8-2. The TRs related to near-end and far-end ES, SES and UAS are mandatory and other TRs are optional. Threshold reports 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.

Entries in Tables 8-1 and 8-2 labelled with names containing the separator "/" represents multiple objects whose names are obtained by considering all combinations of the elements isolated with the separator. For example, the entry labelled with the name A/B\_C/D\_E/F represents eight objects with names A\_C\_E, A\_C\_F, A\_D\_E, A\_D\_F, B\_C\_E, B\_C\_F, B\_D\_E, B\_D\_F.

**Table 8-1 – Line performance counter thresholds**

Category/object	Counter defined in clause:	DPU-NB interface	T/S interface
<i>Near-end (FTU-O)/far-end (FTU-R) performance monitoring thresholds (15 min/24 h interval)</i>			
THRESHOLD_NE/FE_15/24_ES	7.7.8	R/W (M)	N/A
THRESHOLD_NE/FE_15/24_SES	7.7.9	R/W (M)	N/A
THRESHOLD_NE/FE_15/24_LOSS	7.7.10	R/W (O)	N/A
THRESHOLD_NE/FE_15/24_LORS	7.7.11	R/W (O)	N/A
THRESHOLD_NE/FE_15/24_UAS	7.7.12	R/W (M)	N/A
<i>Initialization performance monitoring thresholds (15 min/24 h interval)</i>			
THRESHOLD_15/24_FULL_INITS	7.7.13	R/W (O)	N/A
THRESHOLD_15/24_FAILEDFULL_INITS	7.7.14	R/W (O)	N/A
THRESHOLD_15/24_FAST_INITS	7.7.15	R/W (O)	N/A
THRESHOLD_15/24_FAILEDFAST_INITS	7.7.16	R/W (O)	N/A
<i>Short interruption performance monitoring thresholds (24 h interval)</i>			
THRESHOLD_24_SPONT_INTRPT	7.7.19	R/W (O)	N/A

**Table 8-2 – Channel performance monitoring thresholds**

Category/object	Counter defined in clause:	DPU-NB interface	T/S interface
<i>Near-end (FTU-O)/far-end (FTU-R) performance monitoring thresholds (15 min/24 h interval)</i>			
THRESHOLD_NE/FE_15/24_CV	7.8.4	R/W (O)	N/A
THRESHOLD_NE/FE_15/24_RTXUC	7.8.6	R/W (O)	N/A
THRESHOLD_NE/FE_15/24_RTXTX	7.8.7	R/W (O)	N/A

### 8.3 Unavailable and available state filters

The unavailable state filter is a rectangular sliding window with a default length of 10 s and a 1 s granularity of the slide. The length of the sliding window is configured through the REINIT\_TIME\_THRESHOLD line configuration object (see clauses 7.1.8.7 and 7.1.8.8).

The available state filter is also a rectangular sliding window with a default length of 10 s and a 1 s granularity of the slide. The length of the sliding window is configured through the REINIT\_TIME\_THRESHOLD line configuration object (see clauses 7.1.8.7 and 7.1.8.8).

#### **8.4 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.

#### **8.5 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.

#### **8.6 Evaluation of TR1**

For second counters, the parameters are counted separately, second by second, over each 15 min rectangular fixed window period. The threshold values shall be programmable over the range 0 to 900 with default value 0. A value of 0 indicates that the threshold is disabled.

For event counters, the parameters are counted separately, one by one, over each 15 min rectangular fixed window period. The threshold values shall be programmable over the range 0 to the maximum value of the counter with default value 0. A value of 0 indicates that the threshold is disabled.

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 on the DPU-NB interface 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.

#### **8.7 Evaluation of TR2**

For second counters, the parameters are counted separately over each 24 h period. The threshold values shall be programmable over the range 0 to 86400 with default value 0. A value of 0 indicates that the threshold is disabled.

For event counters, the parameters are counted separately over each 24 h period. The threshold values shall be programmable over the range 0 to the maximum value of the counter with default value 0. A value of 0 indicates that the threshold is disabled.

The DPU 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.

#### **8.8 Threshold report evaluation during transmission state changes**

Care should be taken to ensure that threshold reports are correctly generated and parameter counters are correctly processed during changes in the transmission state. This implies that all threshold reports should be delayed by the length of the sliding window in the unavailable state filter (see clause 8.3).

#### **8.9 Performance history storage in network elements**

Performance history storage at the DPU shall consist of the current and previous 15 min and 24 h parameter registers listed in clause 7. Support of performance history storage beyond the current and previous 15 min and 24 h parameter registers listed in clause 7 is not defined.

It is expected that the PMA at appropriate times pulls parameter register values from the DPU in order to store a performance history beyond the current and previous 15 min and 24 h parameter registers listed in clause 7.

As a minimum, a measured time and an invalid data flag shall be provided for each stored interval for each direction for each monitored transmission entity. For example, an invalid data flag is set to indicate that the data stored is incomplete or otherwise invalid when:

- the data has been accumulated over a period of time that is less than the nominal accumulation period duration;
- the data in the current interval is suspect because a terminal is restarted or a register is reset in the middle of an accumulation period;
- the data is incomplete in an accumulation period. For example, an incoming transmission failure or defect may prevent complete collection of far-end performance reports;
- the line is not configured (in which case the PM data and measured time are set to ZERO).

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

### **8.10 Register size**

The register size is 32 bits. 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.

### **8.11 Parameter counts**

If the line is in AdminStatus="up", then performance monitoring counters shall be active, irrespective of the actual link state of the line.

If the line is in AdminStatus="down", then all performance monitoring counters shall be frozen, including the UAS counter.

All active parameter counts shall be actual (within a tolerance of 1 s) counts for the 15 min and 24 h filtering period.

### **8.12 Date/time-stamping of reports**

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

The date/time-stamp is a string of ASCII characters formatted as "\d{4}-\d{2}-\d{2}T\d{2}:\d{2}:\d{2}(\.\d+)?"+ "(Z|[\+|-]\d{2}:\d{2})" (see [b-IETF RFC 6021] and [b-IETF RFC 3339]).

Equipment clock accuracy requirements are for further study.

### **8.13 Inhibiting performance monitoring parameters**

The accumulation of certain performance parameters is inhibited during certain periods. Inhibition of performance monitoring parameters is defined in clause 11.4.4.6 of [ITU-T G.9701].

## **Annex A to Annex W**

Annexes A to W have been intentionally left blank.

## Annex X

### Cross-layer link state objects

(This annex forms an integral part of this Recommendation.)

#### X.1 Overview of cross-layer link state objects

Table X.1 gives an overview of the managed objects used to manage the cross-layer functionality specified in Annex Z of [ITU-T G.9701]. It used the same convention as used in the tables of the managed object of the clause 7.

**Table X.1 – Cross-layer link state objects**

<u>Category/Object</u>	<u>Defined in clause:</u>	<u>DPU-NB</u>
<b><u>LRCC management</u></b>		
<u>Link State Control (LINK_STATE_CTRL)</u>	<u>X.2.1.1</u>	<u>R/W (O)</u>
<b><u>L0 to L2.1 trigger criteria</u></b>		
<u>L0 L2.1N TRIGR THRESH QAds/us</u>	<u>X.2.2.1</u>	<u>R/W (O)</u>
<u>L0 L2.1N TRIGR PERIOD QAds/us</u>	<u>X.2.2.2</u>	<u>R/W (O)</u>
<u>L0 L2.1N TRIGR PERSIST QAds/us</u>	<u>X.2.2.3</u>	<u>R/W (O)</u>
<b><u>L2.1N to L0 trigger criteria</u></b>		
<u>L2.1N L0 TRIGR THRESH QFds/us</u>	<u>X.2.3.1</u>	<u>R/W (O)</u>
<u>L2.1N L0 TRIGR PERSIST QFds/us</u>	<u>X.2.3.2</u>	<u>R/W (O)</u>
<b><u>L2.1B to L2.2 trigger criteria</u></b>		
<u>L2.1B L2.2 TRIGR THRESH QAds/us</u>	<u>X.2.4.1</u>	<u>R/W (O)</u>
<u>L2.1B L2.2 TRIGR PERIOD QAds/us</u>	<u>X.2.4.2</u>	<u>R/W (O)</u>
<u>L2.1B L2.2 TRIGR PERSIST QAds/us</u>	<u>X.2.4.3</u>	<u>R/W (O)</u>
<b><u>L2.2 to L2.1B trigger criteria</u></b>		
<u>L2.2 L2.1B TRIGR THRESH QFds/us</u>	<u>X.2.5.1</u>	<u>R/W (O)</u>
<u>L2.2 L2.1B TRIGR PERSIST QFds/us</u>	<u>X.2.5.2</u>	<u>R/W (O)</u>
<b><u>Addition battery criteria</u></b>		
<u>L0 L2.1B TRIGR PERSIST BAT</u>	<u>X.2.6.1</u>	<u>R/W (O)</u>
<u>L2.1N L2.1B TRIGR PERSIST BAT</u>	<u>X.2.6.2</u>	<u>R/W (O)</u>
<u>L2.1B L2.1N TRIGR PERSIST BAT</u>	<u>X.2.6.3</u>	<u>R/W (O)</u>
<u>L2.2 L2.1N TRIGR PERSIST BAT</u>	<u>X.2.6.4</u>	<u>R/W (O)</u>

#### X.2 Cross-Layer Low power Mode Control

##### X.2.1 LRCC management

###### X.2.1.1 Link State Control (LINK\_STATE\_CTRL)

**Description:** Selects the operation mode for link state control

**Type:** enumeration

**Valid values:** 0,1

0 Vendor discretionary control



1 Control according to Annex Z of [ITU-T G.9701]

Default value: 0 (Vendor discretionary control)

Reference: Table Z.14 of [ITU-T G.9701]

## X.2.2 L0 to L2.1N trigger criteria

### X.2.2.1 L0 L2.1N TRIGR THRESH QAd/us

Description: Defines the L0 L2.1N bytes arriving trigger criteria for the L0 to L2.1N trigger criteria: the threshold for bytes arriving (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively) in trigger period L0\_L2.1N\_TRIGR\_PERIOD\_QA aggregated over all queues.

Type: 8-bit unsigned integer.

Unit: 1000 byte

Valid values: 1 .. 127 (1 to 127 kbytes)

Default value: 32 (32 kbytes)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

### X.2.2.2 L0 L2.1N TRIGR PERIOD QAd/us

Description: Defines the period over which the bytes arriving (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively) metrics are accumulated for the L0 to L2.1N trigger criteria.

Type: 8-bit unsigned integer.

Unit: 1 millisecond

Valid values: 6 .. 255 (6 to 255 ms)

Default value: 255 (255 ms)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

### X.2.2.3 L0 L2.1N TRIGR PERSIST QAd/us

Description: Defines the persistency guard time for the bytes arriving trigger criteria (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively), for the L0 to L2.1N trigger criteria.

Type: 16-bit unsigned integer.

Unit: 1 second

Valid values: 1 .. 4095 (1 to 4095 seconds)

Default value: 1200 (1200 seconds)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

## X.2.3 L2.1N to L0 trigger criteria

### X.2.3.1 L2.1N L0 TRIGR THRESH QFd/us

Description: Defines the L2.1N\_L0 queue fill trigger criteria: the threshold for queue fill (QFD<sub>A</sub> or QFU<sub>A</sub> for downstream and upstream processing respectively) aggregated over all queues.

Type: 16-bit unsigned integer.

Unit: 1 byte

Valid values: 64.. 65535 (bytes)

Default value: 32768 (bytes)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

### X.2.3.2 L2.1N L0 TRIGR PERSIST QFds/us

Description: Defines the persistency guard time for L2.1N to L0 trigger criteria.

Type: 8-bit unsigned integer.

Unit: 1 millisecond

Valid values: 0 .. 255 (0 to 255 ms)

Default value: 100 (100 ms)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

### X.2.4 L2.1B to L2.2 trigger criteria

#### X.2.4.1 L2.1B L2.2 TRIGR THRESH QAdS/us

Description: Defines the L2.1B L2.2 bytes arriving trigger criteria for the L2.1B to L2.2 trigger criteria: the threshold for bytes arriving (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively) in trigger period L2.1B L2.2 TRIGR PERIOD QA aggregated over all queues.

Type: 8-bit unsigned integer.

Unit: 1 byte

Valid values: 1.. 255 (1 to 255 bytes)

Default value: 1 (1 byte)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

#### X.2.4.2 L2.1B L2.2 TRIGR PERIOD QAdS/us

Description: Defines the period over which the bytes arriving (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively) metrics are accumulated for the L2.1B to L2.2 trigger criteria.

Type: 8-bit unsigned integer.

Unit: 1 millisecond

Valid values: 6 .. 255 (6 to 255 ms in step of 1 ms)

Default value: 6 (6 ms)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

#### X.2.4.3 L2.1B L2.2 TRIGR PERSIST QAdS/us

Description: Defines the persistency guard time for the L2.1B to L2.2 trigger criteria.

Type: 8-bit unsigned integer.

Unit: 1 second

Valid values: 0 .. 255 (0 to 255 s)

Default value: 1 (1 s)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

### X.2.5 L2.2 to L2.1B trigger criteria

#### X.2.5.1 L2.2 L2.1B TRIGR THRESH QFds/us

Description: Defines the L2.2 L2.1B queue fill trigger criteria: the threshold for queue fill (QFD<sub>A</sub> or QFU<sub>A</sub> for downstream and upstream processing respectively) aggregated over all queues.

Type: 16-bit unsigned integer.

Unit: 1 byte

Valid values: 64 .. 65535 (64 to 65535 bytes)

Default value: 255 (255 bytes)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

#### **X.2.5.2 L2.2 L2.1B TRIGR PERSIST QFds/us**

Description: Defines the persistency guard time for the L2.2 to L2.1B trigger criteria.

Type: 8-bit unsigned integer.

Unit: 10 milliseconds

Valid values: 1 .. 255 (10 to 2550 ms in step of 10 ms)

Default value: 60 (600 ms)

Reference: Clause Z.6.2.3.1 of [ITU-T G.9701]

#### **X.2.6 Additional battery (BAT) criteria**

##### **X.2.6.1 L0 L2.1B TRIGR PERSIST BAT**

Description: Defines the persistency guard time for the L0 to L2.1B battery trigger criterion.

Type: 8-bit unsigned integer.

Unit: 1 millisecond

Valid values: 0 .. 255 (0 to 255 ms)

Default value: 1 (1 ms)

Reference: Clause Z.6.2.3.2 of [ITU-T G.9701]

##### **X.2.6.2 L2.1N L2.1B TRIGR PERSIST BAT**

Description: Defines the persistency guard time for the L2.1N to L2.1B battery trigger criterion.

Type: 8-bit unsigned integer.

Unit: 1 millisecond

Valid values: 0 .. 255 (0 to 255 ms)

Default value: 1 (1 ms)

**Reference:** Clause Z.6.2.3.2 of [ITU-T G.9701]

### **X.2.6.3 L2.1B L2.1N TRIGR PERSIST BAT**

**Description:** Defines the persistency guard time for the L2.1B to L2.1N battery trigger criterion.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 0 .. 255 (0 to 255 ms)

**Default value:** 1 (1 ms)

**Reference:** Clause Z.6.2.3.2 of [ITU-T G.9701]

### **X.2.6.4 L2.2 L2.1N TRIGR PERSIST BAT**

**Description:** Defines the persistency guard time for the L2.2 to L2.1N battery trigger criterion.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 0 .. 255 (0 to 255 ms)

**Default value:** 1 (1 ms)

**Reference:** Clause Z.6.2.3.2 of [ITU-T G.9701]

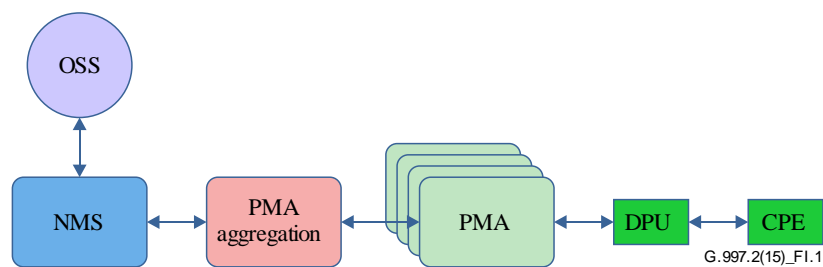
## Appendix I

### Broadband Forum considerations on the FTTdp deployment scenario

(This appendix does not form an integral part of this Recommendation.)

As the DPU is deployed closer to the customer premises, the number of ports on a DPU gets smaller and more DPUs are deployed throughout the network. Distribution points are at locations where local power is not available. In this case, the DPU may be reverse powered where the power comes from the customer premises, sharing the same copper pair with the data service, or the DPU may be forward powered where the power comes from a nearby network power node via copper pairs to the DPU from the network power node.

Reverse powering is one aspect of FTTdp that must be accounted for in the management architecture. Reverse powering of the DPU means that it can be powered down at any time without the network operator's advance knowledge or control. Most network management systems would treat such a spontaneous loss of power as a fault condition and raise an alarm, which is clearly not appropriate for FTTdp. This gave rise to the concept of a PMA, which acts as a management proxy for the DPU when it was unpowered. Figure I.1 shows the high-level PMA architecture as defined in the Broadband Forum



**Figure I.1 – High-level PMA architecture (source: Broadband Forum)**

In this architecture, there is a one to one correspondence between a PMA instance and the DPU it manages. These instances are then aggregated up to higher order management systems. This aggregation function may be realized as part of a PMA server that manages multiple DPUs, an intermediate system that aggregates PMAs residing on lower order systems, or as part of the NMS function.

The PMA uses NETCONF plus a Broadband Forum defined YANG model to manage the DPU. The definitions of the managed objects defined in clause 7 translate into YANG data model syntax (see [b-IETF RFC 6020]), for example as follows:

```
leaf <managed object name> {
  description "<Description>";
  type <Type> {
    range "<Valid values>"; }
  units "<Unit>";
  default "<Default value>";
  reference "<Reference>";
}
```

## Bibliography

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