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Amendment 2

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

Digital sections and digital line system – Metallic access
networks

Physical layer management for G.fast transceivers

Amendment 2

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

ITU-T G-SERIES RECOMMENDATIONS

TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G.100–G.199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G.450–G.499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G.600–G.699
DIGITAL TERMINAL EQUIPMENTS	G.700–G.799
DIGITAL NETWORKS	G.800–G.899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G.900–G.999
General	G.900–G.909
Parameters for optical fibre cable systems	G.910–G.919
Digital sections at hierarchical bit rates based on a bit rate of 2048 kbit/s	G.920–G.929
Digital line transmission systems on cable at non-hierarchical bit rates	G.930–G.939
Digital line systems provided by FDM transmission bearers	G.940–G.949
Digital line systems	G.950–G.959
Digital section and digital transmission systems for customer access to ISDN	G.960–G.969
Optical fibre submarine cable systems	G.970–G.979
Optical line systems for local and access networks	G.980–G.989
Metallic access networks	G.990–G.999
MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G.1000–G.1999
TRANSMISSION MEDIA CHARACTERISTICS	G.6000–G.6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G.7000–G.7999
PACKET OVER TRANSPORT ASPECTS	G.8000–G.8999
ACCESS NETWORKS	G.9000–G.9999

For further details, please refer to the list of ITU-T Recommendations.



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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Keywords

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

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Table of Contents

		Page
1	Scope.....	1
2	References.....	1
3	Definitions	1
	3.1 Terms defined elsewhere	1
	3.2 Terms defined in this Recommendation.....	2
4	Abbreviations and acronyms	2
5	Management architecture.....	4
6	Network management protocol.....	6
7	Managed objects	6
	7.1 Line configuration objects	19
	7.2 Channel configuration objects	35
	7.3 Data path configuration objects	39
	7.4 Line failures.....	39
	7.5 Channel failures.....	40
	7.6 Data path failures.....	40
	7.7 Line performance monitoring objects	40
	7.8 Channel performance monitoring objects	45
	7.9 Data path performance monitoring objects	46
	7.10 Line test, diagnostics and status objects	46
	7.11 Channel test, diagnostics and status objects	60
	7.12 Data path test, diagnostics and status objects	65
	7.13 Inventory objects	65
	7.14 Link State related managed objects	68
8	Procedures for performance monitoring functions	69
	8.1 Line transmission states.....	69
	8.2 Threshold reports.....	69
	8.3 Unavailable and available state filters	70
	8.4 TR1 filter	71
	8.5 TR2 filter	71
	8.6 Evaluation of TR1	71
	8.7 Evaluation of TR2	71
	8.8 Threshold report evaluation during transmission state changes.....	71
	8.9 Performance history storage in network elements.....	71
	8.10 Register size.....	72
	8.11 Parameter counts	72

	Page
8.12 Date/time-stamping of reports	72
8.13 Inhibiting performance monitoring parameters	72
Annex A to Annex W	73
Annex X – Cross-layer link state objects	74
X.1 Overview of cross-layer link state objects	74
X.2 Cross-Layer Low power Mode Control	74
Appendix I – Broadband Forum considerations on the FTTdp deployment scenario	79
Bibliography	80

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.

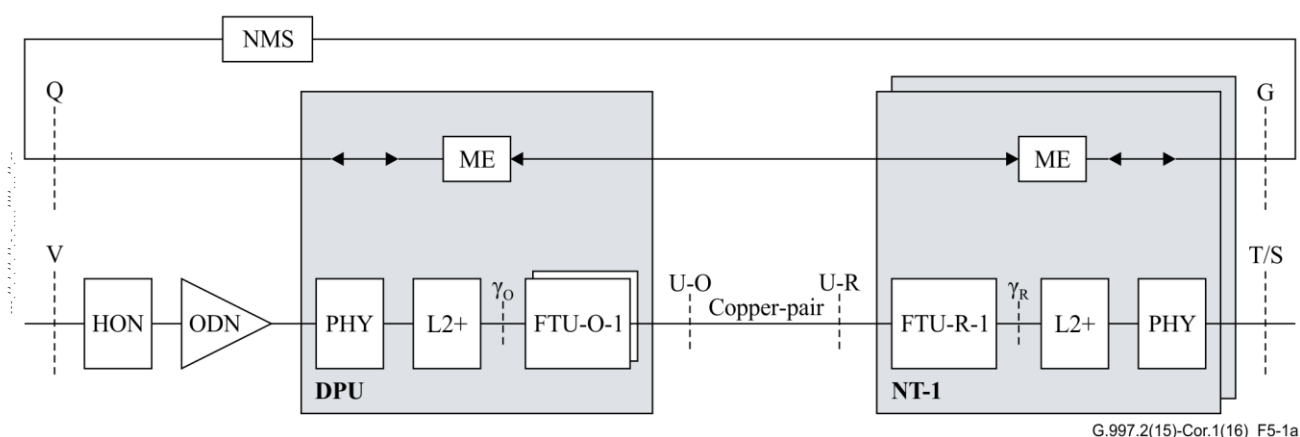


**Figure 5-1a – Reference model of traditional AN deployment
(shown for line 1 in all N lines ($N \geq 1$) connected to an AN)**

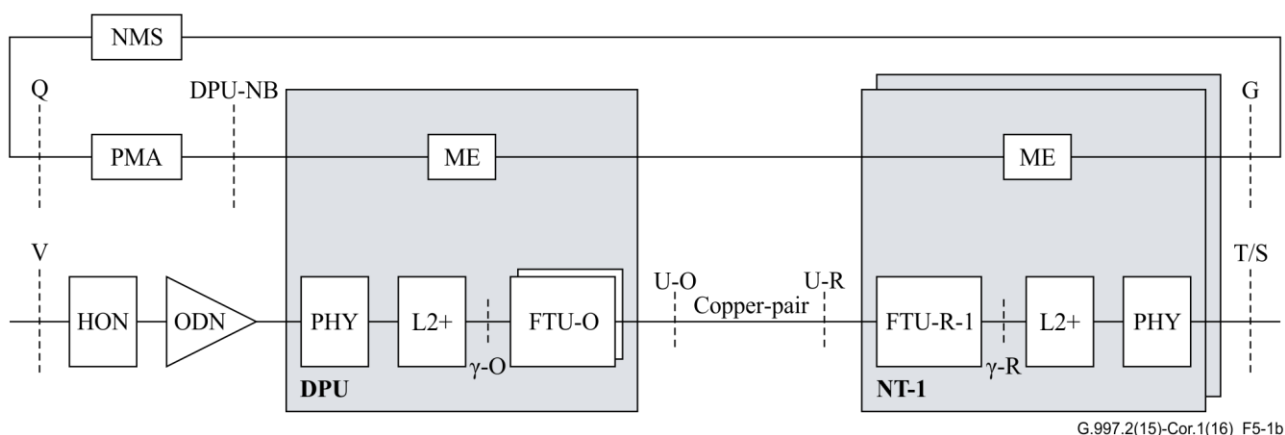


**Figure 5-1b – Reference model of FTTh deployment with PMA and DPU
(shown for line 1 in all N lines ($N \geq 1$) connected to a DPU)**

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].

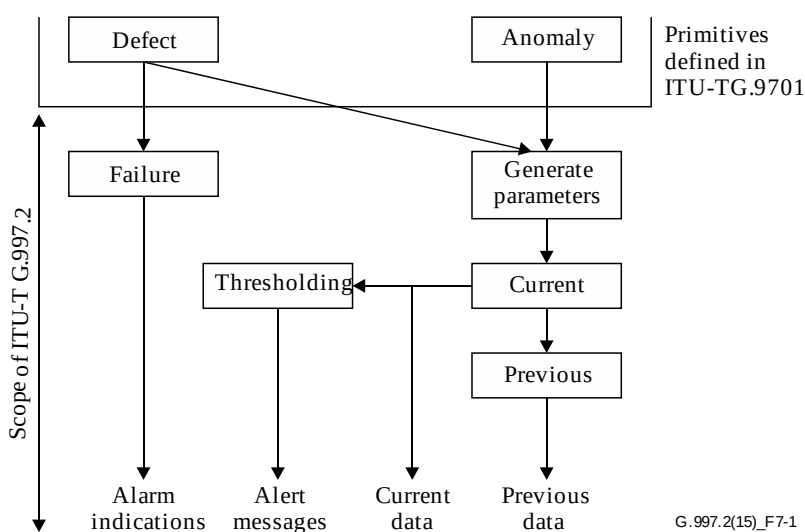


Figure 7-1 – In-service performance monitoring process

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
Profiles		
[ITU-T G.9701] profiles enabling (PROFILES)	7.1.0.1	R/W (M)
Time division Duplexing (TDD)		
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)
Power and spectrum usage		
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)
Noise margins		
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)
Seamless rate adaptation (SRA)		
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)
Fast rate adaptation (FRA)		
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)
Robust management channel (RMC)		
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
Vectoring		
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)
XLOG requested subcarrier group size (XLOGREQds)	7.1.7.3	R/W (O)
XLOG requested disturber index (XLOGDREQds)	7.1.3.4	R/W (O)
Fast-retrain policy		
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)
Update test parameters request		
UPDATE-NE-TEST	7.1.9.1	R/W (M)
UPDATE-FE-TEST	7.1.9.2	R/W (M)
Low power modes		
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
Data rate (downstream/upstream)		
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)
Retransmission (downstream/upstream)		
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)
Low power modes		
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
Near-end (FTU-O) failures		
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)
Far-end (FTU-R) failures		
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)
Initialization failures		
Line init (LINIT) failure	7.4.3.1	R (M)

Table 7-5 – Channel failures

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

Table 7-6 – Data path failures

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

Table 7-7 – Line performance monitoring objects

Category/object	Defined in clause:	DPU-NB interface
Near-end (FTU-O)/Far-end (FTU-R) performance monitoring counters (current/previous 15 min/24 h interval)		
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

Category/object	Defined in clause:	DPU-NB interface
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)
Initialization performance monitoring counters (current/previous 15 min/24 h interval)		
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)
Short interruption performance monitoring counters (current/previous 15 min/24 h interval)		
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)
Near-end (FTU-O)/far-end (FTU-R) initiated OLR/FRA performance monitoring counters (current and previous 15 min/24 h interval)		
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
Profile			
G.9701 profile (PROFILE)	7.10.1.1	Not applicable	R (M)
Initialization			
Initialization success/failure cause (INITSFCAUSE)	7.10.2.1	Not applicable	R (M)
Initialization last transmitted downstream signal (INITLASTSSIGNALds)	7.10.2.2	Not applicable	R (M)
Initialization last received upstream signal (INITLASTSIGNALus)	7.10.2.3	Not applicable	R (M)
Signal–to–noise ratio margin			
SNRMds	7.10.3.1	Not applicable	R (M)
SNRMus	7.10.3.2	Not applicable	R (M)
Upstream power back–off			
UPBOKLE	7.10.4.1	Not applicable	R (M)
UPBOKLE–R	7.10.4.2	Not applicable	R (M)
Actual aggregate transmit power			
ACTATPds	7.10.5.1	FE–G1	R (M)
ACTATPus	7.10.5.2	NE–G1	R (M)
Actual transmit power spectrum density per sub–carrier			
ACTPSDpsds	7.10.6.1	FE–G1	R (M)
ACTPSDpsus	7.10.6.2	NE–G1	R (M)
Channel characteristics per sub–carrier			
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>
Signal–to–noise ratio per sub–carrier			
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)
Quiet line noise per sub–carrier			
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
Active line noise per sub-carrier			
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)
Low power modes			
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)
Bit allocation per sub-carrier on data symbols			
BITSpsds	7.10.11.1	Not applicable	R (M)
BITSpsus	7.10.11.2	Not applicable	R (M)
RMC			
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)
Test parameter time stamps			
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)
OLR time stamps			
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)
Signal attenuation			
SATNds	7.10.15.1	FE-G1	R (M)
SATNus	7.10.15.2	NE-G1	R (M)
Vectoring			
<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
Actual data rates(downstream/upstream)			
Net Data Rate (NDRds/us)	7.11.1.1	Not applicable	R (M)
Expected Throughput (ETRsds/us)	7.11.1.2	Not applicable	R (M)
Gamma Data Rate (GDRds/us)	7.11.1.3	Not applicable	R (M)
Attainable data rates (downstream/upstream)			
Attainable net Data rate (ATTNDRds/us)	7.11.2.1	Not applicable	R (M)
Attainable Expected Throughput (ATTETRsds/us)	7.11.2.2	Not applicable	R (M)
Attainable Gamma Data Rate (ATTGDRds/us)	7.11.2.3	Not applicable	R (M)
Actual impulse noise protection (downstream/upstream)			
ACTINPds/us	7.11.3.1	Not applicable	R (M)
ACTINP_REINds/us	7.11.3.2	Not applicable	R (M)
Actual framer setting (downstream/upstream)			
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)
Test parameters per time interval (downstream/upstream)			
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)
Low power modes (downstream/upstream)			
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-ETRsds/us	7.11.6.3	Not applicable	R(M)
L2.2-ETRsds/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
FTU related inventory		
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 (FTUR_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)
System related inventory		
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)
Link state reporting		
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].