अनिवार्य आवश्यकताओं का अनुलग्नक

सं०: टीईसी/एसडी/डीडी/टीसीपी-222/2.26/ दिसंबर **2024**

ANNEXURES TO ERs

No.: TEC/TC/DD/TCP-222/2.26/ December 2024

अनिवार्य आवश्यकताओं में इंगित मानकों का विवरण

संस्करण- 2.26

DETAILS OF STANDARDS SPECIFIED IN ESSENTIAL REQUIREMENTS

VERSION-2.26

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IMPORTANT NOTICE

1. ***The RFC documents of IETF are subject to periodic revision. Hence, wherever RFCs are mentioned in the ERs/ Annexures to ERs, the offered product shall meet either the referred RFC or its latest/ later version. Wherever, a feature of the RFC is mentioned, product shall comply with the part of the RFC specifying the feature.***

2. ***Similarly, this applies to other standards of IEC, EN, CISPR, ETSI, ITU, IEEE, TEC etc.***

DISCLAIMER

1. ***The Annexures and Appendices in this document are being reviewed and the updated version shall be uploaded on MTCTE Portal www.mtcte.tec.gov.in from time to time.***
2. ***Feedback for corrections, if any, may be sent on email to help.mtcte.tec@gov.in with copy to sanjai.kumar67@gov.in***

Annexure-A1: Safety Requirement for Communication Equipment

ParameterGroup: **SAFETY**

S. No.	Parameter Name	Standard	Limits/ Test Levels	Applicability/ Remarks
A1.1	IT Equipment Safety	IS 13252 part 1: 2010 Amd 2013 &Amd 2015 "Information Technology Equipment –Safety- Part 1: General Requirements" or equivalent IEC standard –EN/IEC 60950-1:2005+A1:2009+A2:2013 "Information Technology Equipment –Safety- Part 1: General Requirements. Additional Requirement: • For Outdoor Nodes- IEC 60950-22 OR EN/IEC 62368-1:2018 or later version	Compliance to clauses applicable to the EUT	• Compliance to Annexure Y (or other relevant Annexure, if any) of EN/IEC 62368- 1: 2018 or later version is must for outdoor installations.
A1.2	Ingress Protection	IEC 60529	Compliance to clauses applicable to the EUT	For outdoor products.
A.1.3	Automatic Laser Shut-Down (ALS) / Automatic Power Shut-Down (APSD)	ITU-T G.664. IEC 60825. Annex-A1	Compliance to clauses applicable to the EUT	Applicable for 'ER on PON family products'

Annexure-A2: Safety Requirement for Battery in portable equipment

Parameter Group: **SAFETY**

S. No.	**Parameter Name**	**Standard**	**Limits/ Test Levels**	**Applicability/ Remarks**
A2.1	Battery Safety	IS 16046:2015 OR EN/IEC 62133:2012	Compliance to clauses applicable to the EUT	Applicable only if it is portable equipment and uses secondary cells and batteries containing alkaline or non-acid electrolyte. BIS certificate or test reports from BIS approved labs in respect of batteries shall be accepted and repeat testing of batteries is not required.

Annexure-A3: Safety Requirement for Radio Communication Equipment (Other than CPE)

Parameter Group: **SAFETY**

S. No.	**Parameter Name**	**Standard**	**Limits/ Test Levels**	**Applicability/ Remarks**
A3.1	IT Equipment Safety for Radio Products (Other than CPE)	EN/IEC 60215:2016	Compliance to clauses applicable to the EUT	

Annexure-B: EMI/ EMC Requirement

(Additional details, referred clauses and Tables in TEC EMI EMC document TEC/SD/DD/EMC-221/05/OCT-16)

Parameter Group: EMC

S. No.	Parameter Name	Standard	Limits/ Test Levels	Applicability/ Remarks
B.1	Conducted emission - Class A	CISPR32 (2015+A1:2019))/EN 55032	**AC/ DC Power input/ output ports:** As per applicable Table(s) in CISPR 32. **Telecom Ports:** As per Table 8B of Annexure B1 and applicable Table(s) in CISPR 32.	Conducted Emission for Class A equipment as per applicable clauses/ ranges.

S. No.	Parameter Name	Standard	Limits/ Test Levels	Applicability/ Remarks
B.2	Radiated emission - Class A	CISPR32 (2015+A1:2019)/EN 55032	For CISPR 32: Limits for Class A Radiated Emissions from applicable Tables of CISPR 32 for distances of 3m or 10m. Note: For 3m measuring distance, EUT size should be as such it fits in a cylindrical area of diameter 1m. For other equipment, measuring distance of 10m is applicable.	Radiated Emission for Class A equipment as per applicable clauses/ ranges.
B.3	Conducted emission - Class B	CISPR32 (2015+A1:2019)/EN 55032	AC/ DC Power input/ output ports: As per applicable Table(s) in CISPR 32/EN 55032 Telecom Ports: As per applicable Table(s) in CISPR 32/EN 55032	Conducted Emission for Class B equipment as per applicable clauses/ ranges.

S. No.	Parameter Name	Standard	Limits/ Test Levels	Applicability/ Remarks
B.4	Radiated emission - Class B	CISPR32 (2015 +A1:2019)/EN 55032	For CISPR 32: Limits for Class B Radiated Emissions from applicable Tables of CISPR 32 for distances of 3m or 10m. Note: For 3m measuring distance, EUT size should be as such it fits in a cylindrical area of diameter 1m. For other equipment, measuring distance of 10m is applicable.	Radiated Emission for Class B equipment as per applicable clauses/ ranges.
B.5	Immunity to Electrostatic Discharge	EN/IEC 61000-4-2(2008) Contact discharge	Level 2 {± 4 kV}, or higher voltage; Performance Criteria B	
B.6	Immunity to Electrostatic Discharge	EN/IEC 61000-4-2(2008) Air discharge	Level 3 {± 8 kV} or higher voltage; Performance Criteria B	
B.7	Immunity to Electrostatic Discharge- Level-4	EN/IEC 61000-4-2(2008) Contact Discharge	Level 4 {± 8 kV}; Performance Criteria B	
B.8	Immunity to Electrostatic Discharge- Level-4	EN/IEC 61000-4-2(2008) Air Discharge	Level 4 {± 15 kV}; Performance Criteria B	

S. No.	Parameter Name	Standard	Limits/ Test Levels	Applicability/ Remarks
B.9	Immunity to radiated RF	EN/IEC 61000-4-3(2010) or EN/IEC 61000-4-3(2020)	i. Test level 2 {Test field strength of 3 V/m} for 80 MHz to 1 GHz; Performance Criteria A. ii. Test level 3 {Test field strength of 10 V/m} for 800 MHz to 960 MHz & 1.4 to 6.0 GHz,; Performance Criteria A	Clauses applicable to Telecom Equipment or Telecom Terminal Equipment with voice interface.
B.10	Immunity to radiated RF	EN/IEC 61000-4-3(2010) or EN/IEC 61000-4-3(2020)	80 MHz to 6.0 GHz: Test level 2 {Test field strength of 3 V/m}: Performance Criteria A	Clauses applicable to Telecom Terminal Equipment without voice interface.
B.11	Immunity to fast transients (burst)	EN/IEC 61000-4-4(2012) AC/DC Power Lines	Test Level 2 (1.0 kV): Performance Criteria B	Not applicable for devices having in-built or replaceable battery
B.12	Immunity to fast transients (burst)	EN/IEC 61000-4-4(2012) Signal/Control/Data/Telecom Lines	Test level 2 (0.5kV): Performance Criteria B	Not applicable for mobile devices having only radio interface
B.13	Immunity to surges	EN/IEC 61000-4-5(2014) line to ground – power port	2kV: Performance Criteria B	Not applicable for devices having in-built or replaceable battery
B.14	Immunity to surges	EN/IEC 61000-4-5(2014) line to line – power port	1kV: Performance Criteria B	Not applicable for devices having in-built or replaceable battery
B.15	Immunity to surges	EN/IEC 61000-4-5(2014) Common mode – telecom ports	2kV: Performance Criteria C	Not applicable for mobile devices having only radio interface

S. No.	Parameter Name	Standard	Limits/ Test Levels	Applicability/ Remarks
B.16	Immunity to conducted disturbance induced by Radio frequency fields	EN/IEC 61000-4-6(2013): AC/DC lines & signal control /telecom lines.	Test level 2 {3 V r.m.s.}: Performance Criteria A 150 kHz to 80 MHz	Not applicable for mobile devices having only radio interface
B.17	Immunity to voltage dips & short interruption: Voltage dip corresponding to a reduction of supply voltage of 30% for 500ms (i.e. 70 % supply voltage for 500ms)	EN/IEC 61000-4-11(2004) or EN/IEC 61000-4-11(2020)	Performance criteria B	Applicable to AC power ports
B.18	Immunity to voltage dips & short interruption: Voltage dip corresponding to a reduction of supply voltage of 60% for 200ms; (i.e. 40% supply voltage for 200ms).	EN/IEC 61000-4-11(2004) or EN/IEC 61000-4-11(2020)	Performance criteria C	Applicable to AC power ports
B.19	Immunity to voltage dips & short interruption: Voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s.	EN/IEC 61000-4-11(2004) or EN/IEC 61000-4-11(2020)	Performance criteria C	Applicable to AC power ports

S. No.	Parameter Name	Standard	Limits/ Test Levels	Applicability/ Remarks
B.20	Immunity to voltage dips & short interruption: Voltage interruption corresponding to a reduction of supply voltage of >95% for 10ms.	EN/IEC 61000-4-11(2004) or EN/IEC 61000-4-11(2020)	Performance criteria B	Applicable to AC power ports.
B.21	Immunity to voltage dips & short interruption: Voltage Interruption with 0% of supply for 10ms.	EN/IEC 61000-4-29	Performance criteria B	Applicable to DC power ports
B.22	Immunity to voltage dips & short interruption: Voltage Interruption with 0% of supply for 30ms, 100ms, 300ms and 1000ms.	EN/IEC 61000-4-29	Performance criteria C	Applicable to DC power ports
B.23	Immunity to voltage dips & short interruption: Voltage dip corresponding to 40% & 70% of supply for 10ms, 30 ms.	EN/IEC 61000-4-29	Performance criteria B	Applicable to DC power ports

S. No.	Parameter Name	Standard	Limits/ Test Levels	Applicability/ Remarks
B.24	Immunity to voltage dips & short interruption: Voltage dip corresponding to 40% & 70% of supply for 100ms, 300ms and 1000 ms.	EN/IEC 61000-4-29	Performance criteria C	Applicable to DC power ports
B.25	Immunity to voltage dips & short interruption: Voltage variations corresponding to 80% and 120% of supply for 100 ms to 10s as per Table 1c of IEC 61000-4-29	EN/IEC 61000-4-29	Performance criteria B	Applicable to DC power ports

Note: Minimum required information related to EMI/EMC parameters has been captured in Annex-B to facilitate the applicants. However, for further details/clarity in this regard, TEC document for EMI/EMC standard – TEC/SD/DD/EMC-221/05/OCT-16 may kindly be referred to.

In case of any conflict, the TEC document for EMI/EMC standard shall prevail.

Note: Conducted and Radiated Emissions will be Class B for ONT/ONU intended primarily for use in the domestic environment. Conducted and Radiated Emissions will be as per Class A for chasis based OLT equipment and Class B for residential OLT equipment

Note: Applicable for ONT/ONU product under ER on PON family only. “OEM has a choice to get either product tested for AC voltage dip test (EN/IEC: 61000-4-11) with external AC-DC adopter or DC voltage dip test (EN/IEC:61000-4-29) on ONT/ONU power port. Detail of same has to be declared in Bill of Material (BOM).”

Note: Applicable for Product variant OLT in ER on PON family: “The performance criteria specified under B-22(Immunity to voltage dips & short interruptions: Voltage interruptions with 0% of supply for 10ms) clause of the annexure B under annexure to ERs may be modified as Performance criteria C for OLT equipment deployed and connected in telecom centre in which the battery backup is permanently connected to the DC distribution system. . Bill of Material should clearly specify about permanent battery back-up connection status during operation and this information should be mentioned on MTCTE certificate.

Note for IoT Devices

1. Tracking device- (i) As per TC division letter no. ID – 6-6/2021-TC/TEC (Pt 1) dated 12.05.2022 it has been clarified that tracking device which are integral part of Completely Build Units (CBUs) i.e. complete vehicles whether comes fitted with imported vehicle or imported /sourced locally for fitment in locally manufactured vehicles, shall not be covered under MTCTE. Genuine Service parts sourced locally or imported as replacement for fitment in CBUs are also not covered under MTCTE. Tracking Device if sold separate and standalone unit (i.e. neither as an integral partof vehicle nor as a genuine service part for replacement in CBUs) will be covered under MTCTE.

   (ii) In case of Vehicle tracking device, Testing of EMI/ EMC/Safety/ GNSS (Global Navigation Satellite System) are to done as per IS 16833 standards and test report from designated lab* is pre-requisite before going for testing of interfaces and other parameters in as mentioned in the ER.

   (iii) For conducted and radiated emission refer B.1 to B.4 as per applicability.

2. Immunity to Surges - For Non- Rechargeable fixed battery-operated device without any telecom or power port, this test is not applicable.

3. If Smart Electricity Meter is tested as per IS 16444 from the BIS recognized lab, then no separate EMI/EMC & Safety testing is required for MTCTE Certification. However, the testing of rest of the test parameters of ER of Smart Electricity Meter would be required from TEC designated lab(s). (Refer letter no 6-6/2021-TC/TEC dated 28.10.2022 fom TC division, TEC).

Annexure- B1: Emission limits as per CISPR22

Parameter Group: EMC

The value of the limits from "CISPR 22 (2008)" at clause-6 [and reproduced below in tables 4(a), 4(b) & 5(a), 5(b)] shall be used for class B and class A equipment respectively. Further, the limits of table 5 may also be used for equipment in Telecommunication Centres.
Alternatively, the Limits as per Table 4 (a1) & 5 (a1) for measuring distance of 3m are also acceptable , as applicable , in place of Table 4 (a) & 5 (a) respectively.

a)Limits below 1 GHz

Table 4(a): Limits for unwanted radiated emission of "Class B" equipment at a measuring distance of 10m.

Frequency range	Limits (quasi-peak)
30-230 MHz	30 dB (µV/m)
230- 1000 MHz	37dB (µ V/m)
Note: 1) The lower limit shall apply at the transitionFrequency. *Note: 2) Additional provisions may be required for cases where interference occurs.*	

Table 5(a): Limits for unwanted radiated emission of "Class A" equipment (for Telecommunication Centres) at a measuring distance of 10m.

Frequency range	Limits (quasi-peak)
30-230 MHz	40 dB (µV/m)
230- 1000 MHz	47 dB (µV/m)
Note: 1) The lower limit shall apply at the transition Frequency. Note: 2) Additional provisions may be required forcases where interference occurs.	

***Note**:*

Limits are shown here for a measurement distance of 10m. However, measurements made using alternative test sites are also acceptable in accordance with CISPR 22 including clause No. 10.4.5.

Table 4(a1): Limits for unwanted radiated emission of "Class B" Equipment at a measuring distance of 3 m.

Frequency range	limits (quasi – peak)
30 – 230 MHz	40.5 dB (μV/m)
230 – 1000 MHz	47.5 dB (μV/m)
Notes: 1. The lower limits shall apply at transition frequency 2. Additional provisions may be required for cases where interference occurs.	

Table 5 (a1): Limits for unwanted radiated emission of "Class A" Equipment at a measuring distance of 3 m.

Frequency range	limits (quasi – peak)
30 – 230 MHz	50.5 dB (μV/m)
230 – 1000 MHz	57.5 dB (μV/m)
Notes: *1.The lower limits shall apply at transition frequency* *2. Additional provisions may be required for cases where interference occurs.*	

b) Limits above 1 GHz

The EUT shall meet the following limits when measured in accordance with the prescribed method and the conditional testing procedure as described.

Table 4(b): Limits for radiated disturbance of "Class B" Eqpt. at a measurement distance of 3 m.

Frequency range GHz	**Average limit** dB (μV/m)	**Peak limit** dB (μV/m)
1 to 3	50	70
3 to 6	54	74
NOTE: *The lower limit applies at the transition frequency.*		

Table 5(b): Limits for radiated disturbance of "Class A" Eqpt. at a measurement distance of 3 m.

Frequency range GHz	**Average limit** dB (μV/m)	**Peak limit** dB (μV/m)
1 to 3	56	76
3 to 6	60	80
NOTE :*The lower limit applies at the transition frequency.*		

Limits for conducted emission

For Class A equipment

Table 7: Limit of conducted emission (disturbance) at the main ports of Class A Telecom Equipment

Frequency range	Limit (Quasi -Peak)	Limit (Average)
0.15 – 0.5 MHz	79 dB (μV)	66 dB (μV)
0.5-30 MHz	73 dB (μV)	60 dB (μV)
Note: The lower limit shall apply at the transition Frequencies.		

Table 8(B): Limits for conducted common mode (asymmetric mode) emissions from telecommunication ports of Class A equipment (intended for use in telecommunication centers only).

Frequency rangeMHz	Voltage limits dB (μV)		Current limits dB (μA)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 to 0.5	97 to 87	84 to 74	53 to 43	40 to 30
0.5 to 30	87	74	43	30
Note 1: The limits decrease linearly with the logarithm of the frequency in the range 0.15 MHz to 0.5 MHz. *Note 2: The current and voltage disturbance limits are derived foruse with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 150 Ω are telecommunication port under test (conversion factor is 20 log_{10}150/1= 44 dB).*				

For Class B equipment

Table 6: Limits of conducted emission (disturbance) at the mains ports of Class B Telecom Equipment

Frequency range	Limit (Quasi -Peak)	Limit (Average)
0.15 -0.5 MHz	66-56 dB (μV)	56-46 dB (μV)
0.5-5 MHz	56 dB (μV)	46 dB (μV)
5-30 MHz	60 dB (μV)	50 dB (μV)
Note: 1) The lower limit shall apply at the transition Frequencies. Note: 2) The limits decreases linearly with logarithm of the Frequency in the range 0.15 MHz to 0.50 MHz.		

Table 8(A): Limits for conducted common mode (asymmetric mode) emission from telecommunication ports for class B equipment.

Frequency rangeMHz	Voltage limits dB (μV)		Current limits dB (μA)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 to 0.5	84 to 74	74 to 64	40 to 30	30 to 20
0.5 to 30	74	64	30	20
Note 1: The limits decrease linearly with the logarithm of the frequency in the range 0.15 MHz to 0.5 MHz. Note 2: The current and voltage disturbance limits are derived foruse with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 150 Ω are telecommunication port under test (conversion factor is 20 $\log_{10}150/1$= 44 dB).				

Conditional testing procedure for 1-6 GHz testing:

a. The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes.
b. If the highest frequency of the internal sources of the EUT is less than 108 MHz, the measurement shall only be made up to 1 GHz.
c. If the highest frequency of the internal sources of the EUT is between 108 MHz and 500 MHz, the measurement shall only be made up to 2 GHz.
d. If the highest frequency of the internal sources of the EUT is between 500 MHz, and 1 GHz, the measurement shall only be made up to 5 GHz.
e. If the highest frequency of the internal sources of the EUT is above 1 GHz, the measurement shall be made up to 5 times the highest frequency or 6 GHz, whichever is less.

Class A and Class B equipment definition:

a. **Class B equipment:** "Class B" Telecom equipment is intended primarily for use in the domestic environment and may include:
    i. equipment with no fixed place of use; for example, portable equipment powered by built- in batteries;
    ii. Telecommunication terminal equipment powered by a telecommunication network;
    iii. Personal computers and auxiliary connected equipment.
b. **Class A equipment:** Class A Telecom equipment is a category of all other Telecom Equipments which satisfies class A Telecom Equipment limits but not the class B limits. Such equipment may cause Radio Interference in the domestic environment.

Annexure-C1: Frequency Band of Operation for Non-Cellular Radio Equipment

Parameter Group: Radio Conformance (RADCONF)

S. No.	Parameter Name	Standard	Limits/ Values	Applicability/ Remarks
C1.1	Frequency Band For MRTS	Latest NFAP issued by WPC.	300/400 MHz or 800 MHz	MRTS Equipment Testing procedure as per applicable ENxxx standard mentioned in Annexure C3
C1.2	Frequency for HF equipment	Latest NFAP issued by WPC	3 MHz to 30 MHz	HF Equipment Testing procedure as per applicable ENxxx/FCC standard mentioned in Annexure C3
C1.3	Frequency for UHF/ VHF equipment	Latest NFAP issued by WPC	30 MHz to 1000 MHz	VHF/UHF Equipment Testing procedure as per applicable ENxxx standard mentioned in Annexure C3
C1.4	Frequency for PTP Radio Interface	Latest NFAP issued by WPC.	6/ 7/ 13/ 15/ 18/ 23 GHz. Applicable for full or split outdoor unit.	Point to Point Microwave Fixed Radio Systems Testing procedure as per EN 302 217-2
C1.5	Frequency for PMP Radio Interface	Latest NFAP issued by WPC.	10.5/ 26/ 28 GHz. Applicable for full or split outdoor unit	Point to Multi-Point Microwave Fixed Radio Systems Testing procedure as per EN 302 326-2
C1.6	Frequency of Operation - Satellite Equipment	Latest NFAP issued by WPC.	Lower C-band Receive Frequency 3.400-3.700GHz Trans Frequency 6.425-6.725GHz *Note- The equipmentmay operate in part of the bands or cover the full bands listed.*	Testing procedure as per Appendix- II, Test-2 OR ETSI EN 301 xxx / ETSI EN 303 xxx (as per applicability defined in Annex C3)
C1.7	Frequency of Operation - Satellite Equipment	Latest NFAP issued by WPC.	Normal C-band Receive Frequency 3.700-4.200GHz Trans Frequency 5.925-6.425GHz	Testing procedure as per Appendix- II, Test-2 OR ETSI EN 301 xxx / ETSI EN 303 xxx (

			Note- The equipmentmay operate in part of the bands or cover the full bands listed.	as per applicability defined in Annex C3)
C1.8	Frequency of Operation - Satellite Equipment	Latest NFAP issued by WPC.	Extended C-band Receive Frequency 4.500-4.800 GHz Trans Frequency 6.725-7.025 GHz *Note- The equipmentmay operate in part of the bands or cover the full bandslisted.*	Testing procedure as per Appendix- II, Test-2 OR ETSI EN 301 xxx / ETSI EN 303 xxx (as per applicability defined in Annex-C3)
C1.9	Frequency of Operation - Satellite Equipment	Latest NFAP issued by WPC.	Ku band Receive Frequency 10.7-11.7 GHz 12.2-12.75 GHz Trans Frequency 12.75-13.25GHz 13.75-14.0GHz 14.0-14.5 GHz Note- The equipment may operate in part of the bands or cover the full bands listed.	Testing procedure as per Appendix- II, Test-2 OR ETSI EN 301 xxx / ETSI EN 303 xxx / ETSI EN 302 xxx (as per applicability defined in Annex - C3)
C1.10	Frequency for E-Band Radio Interface	Latest NFAP issued by WPC.	71-76/81-86 GHz. Note- The equipment may operate in part of the bands or cover the full bands listed.	Testing procedure as per EN 302 217-2
C1.11	Frequency for V-Band PTP Radio Interface	Latest NFAP issued by WPC.	57-64 GHz Note- The equipment may operate in part of the bands or cover the full bands	Testing procedure as per ETSI EN 302 217-2

			listed	
C1.12	Frequency for V-Band PMP Radio Interface	Latest NFAP issued by WPC.	57-64 GHz Note- The equipment may operate in part of the bands or cover the full bands listed	Testing procedure as per ETSI EN 303 722 or ETSI EN 302 567
C1.13	Frequency of Operation - Satellite Equipment	Latest NFAP issued by WPC.	Ka band Receive Frequency: 17.7-21.2 GHz Trans Frequency: 27-31 GHz Note- The equipment may operate in part of the bands or cover the full bands listed	Testing procedure as per: Appendix-II, Test-2 OR ETSI EN 301 xxx / ETSI EN 303 xxx (as per applicability defined in Annex C3)

Note: Frequency of operation requirements is as per the latest NFAP issued by WPC and the requirements in NFAP supersede the requirements listed here.

Annexure-C2: Transmitted Power/ EIRP for Non-Cellular Radio Equipment

Parameter Group: Radio Conformance (RADCONF)

S. No.	Parameter Name	Standard	Limits/ Values	Applicability/ Remarks
C2.1	Max RF Power Output MRTS Base Stn	As per DoT/WPC license conditions	100 W	MRTS Base Stations Testing procedure as per applicable ENxxx standard mentioned Annexure C3
C2.2	Max RF Power Output MRTS Mobile Stn	As per DoT/WPC license conditions	30 W	MRTS Fixed Mobile Equipment Testing procedure as per applicable ENxxx standard mentioned Annexure C3
C2.3	Max RF Power Output for MRTS Handheld Stn	As per DoT/WPC license conditions	3 W	MRTS Handheld Equipment Testing procedure as per applicable ENxxx standard mentioned Annexure C3
C2.4	Max RF Power Output for MRTS Fixed Stn	As per DoT/WPC license conditions	30W	MRTS Fixed Equipment Testing procedure as per applicable ENxxx standard mentioned Annexure C3
C2.5	Max Transmit Power for HF Base Stn	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	HF Base Stations Testing procedure as per applicable ENxxx/FCC standard mentioned Annexure C3
C2.6	Max Transmit Power for HF HH Stn	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	HF Handheld Equipment Testing procedure as per applicable ENxxx/FCC standard mentioned Annexure C3
C2.7	Max Transmit Power for HF Mob Stn	As per	As per	HF Mobile Equipment Testing procedure as per applicable

		DoT/WPC license conditions	DoT/WPC prescribed limit	ENxxx/FCC standard mentioned Annexure C3
C2.8	Max Transmit Power for HF Fixed Stn	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	HF Fixed Equipment Testing procedure as per applicable ENxxx/FCC standard mentioned Annexure C3
C2.9	Max Transmit Power for UHF/VHF Base Stn	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	VHF/UHF Base Station Testing procedure as per applicable ENxxx standard mentioned Annexure C3
C2.10	Max Transmit Power for UHF/VHF HH Stn	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	VHF/UHF Handheld Equipment Testing procedure as per applicable ENxxx standard mentioned Annexure C3
C2.11	Max Transmit Power for UHF/VHF Mob Stn	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	VHF/UHF Mobile Equipment Testing procedure as per applicable ENxxx standard mentioned Annexure C3
C2.12	Max Transmit Power for UHF/VHF Fixed Stn	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	VHF/UHF Fixed Equipment Testing procedure as per applicable ENxxx standard mentioned Annexure C3
C2.13	Transmit Power for PTP Radio interface	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	Point to Point Microwave Fixed Radio Systems Testing procedure as per EN 302 217-2 or Appendix-II, Test-3
C2.14	Transmit Power for PMP Radio Interface	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	Point to Multi- Point Microwave Fixed Radio Systems Testing procedure as per EN 302 326-2 or Appendix-II, Test-3

C2.15	Transmit Power - Satellite Equipment	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	Testing procedure as per Appendix- II, Test-2 OR ETSI EN 301 xxx / ETSI EN 303 xxx / ETSI EN 302 xxx (as per applicability defined in Annex C3)
C2.16	Maximum Transmit Power for E-Band Radio interface	As per DoT/WPC license conditions OR TEC Standard 36060:2022	As per DoT/WPC prescribed limit	Testing procedure as per ETSI EN 302 217-2
C2.17	Maximum Transmit Power for V-Band PTP Radio interface	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	Testing procedure as per ETSI EN 302 217-2
C2.18	Maximum Transmit Power for V-Band PMP Radio interface	As per DoT/WPC license conditions	As per DoT/WPC prescribed limit	Testing procedure as per ETSI EN 303 722 or ETSI EN 302 567

Note*: *EIRP requirements i.e. Limits/Values shall be as per the latest NFAP and GSRs issued by WPC, DoT and the requirements in NFAP and GSRs supersede the requirements listed here.

Annexure-C3: Radio Conformance Requirement for Non-Cellular Radio Equipment

Parameter Group: Radio Conformance (RADCONF)

S. No.	**Equipment Name**	**Parameter Name**	**Standard**	**Limits/ Values**	**Applicability/ Remarks**
C3.1	MRTS Equipment	Conformance to standards for MRTS	ETSI EN 300 113	Compliance	Applicable for equipment meant for transmission of data and/or speech and having antenna connector
C3.2	MRTS Equipment	Conformance to standards for MRTS	ETSI EN 300 390	Compliance	Applicable for equipment meant for transmission of data and/or speech and having integral antenna
C3.3	MRTS Equipment	Conformance to standards for MRTS	ETSI EN 300 086	Compliance	Applicable for equipment meant for analogue speech and having internal or external RF connector
C3.4	MRTS Equipment	Conformance to standards for MRTS	ETSI EN 300 296	Compliance	Applicable for equipment meant for analogue speech and having integral antenna
C3.5	MRTS Equipment	Conformance to standards for MRTS	ETSI EN 300 219	Compliance	Applicable for equipment meant to transmit signals to initiate specific receiver response
C3.6	MRTS Equipment	Conformance to standards for MRTS	ETSI EN 300 341	Compliance	Applicable for equipment, using integral antenna, meant to transmit signals to initiate specific receiver response

C3.7	MRTS Equipment	Conformance to standards for MRTS	ETSI EN 301 166	Compliance	Applicable for equipment meant for transmission of data and/or speech and operating on narrow band channels (<10KHz) and having antenna connector
C3.8	MRTS Equipment	Conformance to standards for MRTS	ETSI EN 302 561	Compliance	Applicable for Terrestrial Trunked Radio (TETRA)
C3.9	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 113	Compliance	Applicable for equipment meant for transmission of data and/or speech and having antenna connector
C3.10	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 390	Compliance	Applicable for equipment meant for transmission of data and/or speech and having integral antenna
C3.11	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 086	Compliance	Applicable for equipment meant for analog speech and having internal or external RF connector
C3.12	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 296	Compliance	Applicable for equipment meant for analog speech and having integral antenna
C3.13	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 219	Compliance	Applicable for equipment meant to transmit signals to initiate specific receiver response

C3.14	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 341	Compliance	Applicable for equipment, using integral antenna, meant to transmit signals to initiate specific receiver response
C3.15	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 783	Compliance	Applicable for commercial amateur radio equipment.
C3.16	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 720	Compliance	Applicable for UHF On-board vessels communication systems.
C3.17	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 301 925	Compliance	Applicable for Radiotelephone transmitters and receivers for maritime mobile service operating in VHF band
C3.18	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 301 178	Compliance	Applicable for portable VHF radiotelephone equipment for the maritime mobile service (for non-GMDSS applications only)
C3.19	VHF/UHF Equipment	Conformance to standards for Equipment used in VHF/UHF Radio Systems	ETSI EN 300 698	Compliance	Applicable for Radio telephone transmitters and receivers for the maritime mobile service operating in the VHF bands used on inland waterway
C3.20	HF Equipment	HF Radio Systems	ETSI EN 300 433	Compliance	Applicable to Citizen band (CB) Radio equipment.

C3.21	HF Equipment	HF Radio Systems	ETSI EN 303 402	Compliance	Applicable to maritime mobile transmitters and receivers.
C3.22	HF Equipment	HF Radio Systems	ETSI EN 301 783	Compliance	Applicable to commercially available amateur radio equipment.
C3.23	HF Equipment	HF Radio Systems	FCC CFR47 Part 90	Compliance	Applicable to private HF land mobile Radios
C3.24	PTP Microwave Fixed Radio Systems	PTP Fixed Digital Radio Conformance	ETSI EN 302 217-2	Compliance	Applicable for full or split outdoor unit of Point to Point Microwave Fixed Radio Systems
C3.25	PMP Microwave Fixed Radio Systems	PMP Fixed Digital Radio Conformance	ETSI EN 302 326-2	Compliance	Applicable for full or split outdoor unit of Point to Point Microwave Fixed Radio Systems
C3.26	GSO VSAT/GSO User Terminal (static)	Conformance to standards for Satellite	Compliance to ETSI EN 301 443	Compliance	For C Band
C3.27	GSO VSAT/ GSO User Terminal (static)	Conformance to standards for Satellite	Compliance to ETSI EN 301 428	Compliance	For Ku Band

C3.28	GSO VSAT/GSO User Terminal (Static)	Conformance to standards for Satellite	Compliance to ETSI EN 301 360/ EN 301 459	Compliance	For Ka Band
C3.29	GSO VSAT/GSO User Terminal (ESIM/TES)	Conformance to standards for Satellite	Compliance to ETSI EN 301 447	Compliance	For C Band
C3.30	GSO VSAT/GSO User Terminal (ESIM/TES)	Conformance to standards for Satellite	Compliance to ETSI EN 302 186/ EN 302 340/ EN 302 977	Compliance	For Ku Band
C3.31	GSO VSAT/GSO User Terminal (ESIM/TES)	Conformance to standards for Satellite	Compliance to ETSI EN 303 978	Compliance	For Ka Band
C3.32	NGSO User Terminal (static)	Conformance to standards for Satellite	Compliance to ETSI EN 303 980 / ETSIEN 303 981	Compliance	For Ku Band
C3.33	NGSO User Terminal (static)	Conformance to standards for Satellite	Compliance to ETSI EN 303 699	Compliance	For Ka Band
C3.34	NGSO User Terminal (ESIM or TES)	Conformance to standards for Satellite	ETSI EN 303 980 / ETSIEN 303 981	Compliance	For Ku Band

C3.35	NGSO User Terminal (ESIM or TES)	Conformance to standards for Satellite	ETSI EN 303 979	Compliance	For Ka Band
C3.36	NGSO Integrated Gateway	Conformance to standards for Satellite	ETSI EN 303 980 / ETSIEN 303 981	Compliance	For Ku Band
C3.37	NGSO Integrated Gateway	Conformance to standards for Satellite	ETSI EN 303 699	Compliance	For Ka Band
C3.38	E- Band Microwave Fixed Radio Systems	E-band_Tx/Rx Separation	As per TEC Standard 36060:2022 OR ETSI EN 302 217-2	Compliance	Applicable to all E-Band Microwave Fixed Radio Systems Testing procedure as per ETSI EN 302 217-2
C3.39		E-Band_Co-channel_C/I	As per TEC Standard 36060:2022 OR ETSI EN 302 217-2	Compliance	

C3.40		E-Band_Adjacent_Channel_C/I	As per TEC Standard 36060:2022 OR ETSI EN 302 217-2	Compliance	
C3.41		E-Band_TX_Spurious_Harmonics	As per TEC Standard 36060:2022 OR ETSI EN 302 217-2	Compliance	
C3.42	V-Band Microwave Fixed Radio Systems	V-Band PTP Fixed Radio Conformance	ETSI EN 302 217-2	Compliance	Applicable to all V-Band Microwave PTP Fixed Radio Systems Testing procedure as per ETSI EN 302 217-2
C3.43		V-Band PMP Fixed Radio Conformance	ETSI EN 303 722 or ETSI EN 302 567	Compliance	Applicable to all V-Band Microwave PMP Fixed Radio Systems Testing procedure as per ETSI EN 303 722 or ETSI EN 302 567

Note to Annexure -C:

1. “Frequency of operation” and “maximum transmitted power “shall be entered in BOM file as per guidelines of WPC/DOT.
2. Usage scenario of equipment shall be entered in BOM. Various Usage Scenarios for different types of equipment like MRTS equipment, VHF/UHF/HF Radio are listed in Annexure-C3 along-with the applicable EN standard. There may be multiple ENs applicable for a single usage scenario as per the applicability mentioned. For example - HF Radio intended for Maritime usage in Citizen Band will have to get conformance against both EN standard mentioned in Annexure C3.20 & Annexure C3.21.

   Type of VHF/UHF/HF/MRTS equipment- Base station fixed mobile transportable equipment; handheld, base band processing equipment etc. shall be entered in BOM.
3. Usage scenario of NGSO User terminal or other satellite equipment shall be entered in BOM. For instance, User terminal can be static terminal or moveable terminal like Earth Stations in Motion (ESIM) or portable terminal like Transportable Earth Station (TES) etc. Various usage scenarios of satellite equipment are mentioned in Annexure C3 along with the applicable EN standard(s)
4. For all types of equipment covered in Annexure C, the Radio Conformance Requirements (Limits/Values) listed in Annexure C3 do not include Limits/Values for RF technical parameters - Frequency of operation and Transmit power, which are explicitly mentioned in Annexure C1 and Annexure C2. These RF parameters are governed by National regulations as listed in Annexure C1 andC2.

Annexure-D: Parameters for 2-wire PSTN Lines, Trunks lines and CPEs connected thereon (INT2W & CPE2W)

Parameter Group: 2-Wire Interface (INT2W) and CPEs connected on 2-Wire (CPE2W)

S. No.	Equipment Name	Parameter Name	Standard	Limits/ Values	Applicability/ Remarks
D.1	2-Wire CPEs and Interfaces	Longitudinal/ Transverse Conversion Loss	Q.552 Clause 2.2.2 & Figure 2 / TBR.21 Clause 4.4.3	As in Figure 2, Annexure-D4	**Refer Note 1**
D.2	2-Wire CPEs and Interfaces	Return Loss	Q.552 Clause 2.2.1.2 and Figure 1	As in Figure 1, Annexure-D4	
D.3	2-Wire CPEs and Interfaces	Over Voltage/ Over Current Protection	K.21	Compliance	Compliance of this test only if port is connected to external lines e.g. in case of xDSL lines.
D.4	2-Wire CPEs and Interfaces	Maximum Loop Current	ETSI EN 300 001	< 60 mA	
D.5	2-Wire CPEs and Interfaces	Idle State Current	ETSI EN 300 001	< 40 µA/ 130µA	Without/ with CLIP display
D.6	2-Wire CPEs and Interfaces	Insulation Test	ETSI EN 300 001	≥ 5 MΩ	**Refer Note 1**
D.7	2-Wire CPEs and Interfaces	Resistance to Earth	TBR-21 Clause 4.4.4	≥ 10 MΩ	
D.8	2-wire Trunk Line	DC Resistance	ETSI TBR-21 Clause 4.4.1	≥ 1 MΩ	
D.9	2-wire Trunk Line	Minimum Current on MGW Trunk Line	ETSI EN 300 001	≥ 60 µA	
D.10	Telephones/ Fax with Handset	Acoustic Shock Absorption	P.360 Clause 4.1	Compliance	
D.11	Audio Conferencing	Voice Conference	Functional Test	Compliance	

	Equipment	Verification			
D.12	Fax, Modem	Transmit Power for Fax Machine/ Modem	T.4 Clause 6	-3dBm to -15 dBm	
D.13	Fax	Receiver Sensitivity for FAX	T.4 Clause 7	> -43 dBm	
D.14	Modem	Receiver Signal for Modem	V.34 (para 6.6)	> -43 dBm ON < -48 dBm OFF	
D.15	2-wire line and trunk	Transmission of DTMF Signals	Q.23 Clause 6 and 7	Compliance	
D.16	2- Wire Trunk	Current on Junction/ Trunk Line in PABX		< 60 mA	

Note 1: This test is exempted provided an undertaking should be submitted by the supplier that 2-wire equipment is not intended to be connected to

Annexure-D1: ISDN Layer-III Specifications Test

Parameter Group: ISDN Conformance (ISDNCONF)

S. No.	Equipment Name	Parameter Name	Standard	Limits/ Values	Applicability/ Remarks
D1.1	ISDN BRI and PRI	Layer III specification Messages for circuit-mode connection basic call control.	Q.931 Applicable to ISDN BRI and PRI	Compliance	
D1.2		ALERTING	Clause no. 3.1.1		
D1.3		CALL PROCEEDING	Clause no. 3.1.2		
D1.4		CONNECT	Clause no. 3.1.3		
D1.5		SETUP	Clause no. 3.1.14		
D1.6		SETUP ACKNOWLEDGE	Clause no. 3.1.15		
D1.7		DISCONNECT	Clause no. 3.1.5		
D1.8		RELEASE	Clause no. 3.1.9		
D1.9		D1.10 **RELEASE** COMPLETE	Clause no. 3.1.10		
D1.11		Bearer capability	Clause no. 4.5.5		
D1.12		Called party number	Clause no. 4.5.8		

D1.13		Calling party number	Clause no. 4.5.10		
D1.14		Channel identification	Clause no. 4.5.13		
D1.15		Normal call clearing	As per Table 6-5		
D1.16		Call clearing User Busy	As per Table 6-5		
D1.17		Call clearing Invalid number format or incomplete number	As per Table 6-5		
D1.18		Call clearing No answer	As per Table 6-5		

Annexure-D2: Parameters for Cordless Telephone

Parameter Group: Radio Conformance (RADCONF)

Note: Maximum Range shall be 100 m.

S. No.	Parameter Name	Frequency	Power	Remarks
D2.1	Frequency band of Operation and Transmit Power – Base Unit only	1610, 1640, 1675, 1690 KHz	Transmit power < 500 mW	
D2.2	Frequency band of Operation and Transmit Power – Base and Remote Unit	26.375, 26.475, 26.575, 26.625, 46.675, 46.725, 46.775, 46.825, 46.830, 49.845, 49.860, 49.875 MHz.	Transmit power < 500 mW for Base Unit Transmit Power < 200 mW for Remote Unit	
D2.3	Frequency band of Operation and Transmit Power – Remote Unit only	150.360, 150.750, 150.850, 150.950 MHz.	Transmit power < 50 mW	
D2.4	Transmitted frequency by Base Unit	46.610, 46.630, 46.670, 46.710, 46.730, 46.770, 46.830, 46.870, 46.930, 46.970, 43.720, 43.740, 43.820, 43.840, 43.920, 43.960, 44.120, 44.160, 44.180, 44.200, 44.320, 44.360, 44.400, 44.460, 44.480 MHz	RF Power < 500 mW	

S. No.	Parameter Name	Frequency	Power	Remarks
D2.5	Transmitted frequency by Handset	49.670, 49.845, 49.860, 49.770, 49.875, 49.830, 49.890, 49.930, 49.990, 49.970, 48.760, 48.840, 48.860, 48.920, 49.020, 49.080, 49.100, 49.160, 49.200, 49.240, 49.280, 49.360, 49.400, 49.460, 49.500 MHz	RF Power < 100 mW	
D2.6	Frequency of Operation	926-926.5 MHz	Very low power Cordless Phone	
D2.7	Frequency and Power for FHSS	2.4-2.4835 GHz	Power < 100 mW Power Spectral Density < 100 mW/100 KHz EIRP	
D2.8	D2.9 Frequency and Power for other modulation types	2.4-2.4835 GHz	Power < 100 mW Power Spectral Density < 10 mW/1 MHz EIRP	
D2.10	Frequency and Power in 5 GHz band	5.150-5.350 and 5.725-5.875 GHz	Mean EIRP < 200 mW Power Spectral Density < 10 mW/1 MHz EIRP	
D2.11	Maximum Frequency Deviation	5 Khz		
D2.12	Transmitter narrowband spurious emission	30 MHz- 1 GHz	When operating: < -36dBm, When in stand-by: < -57 dBm.	
D2.13	Transmitter narrowband spurious emission	>1GHz-12.75GHz	When operating: < -30dBm, When in stand-by: < -47 dBm.	
D2.14	Transmitter narrowband spurious emission	>1.8GHz-1.9GHz and 5.15 GHz-5.3 GHz	When operating: < -47dBm, When in stand-by: < -47 dBm.	
D2.15	Transmitter wideband spurious emission	30 MHz-1GHz	When operating: < -86dBm/Hz, When in stand-by: < -107 dBm/Hz.	
D2.16	Transmitter wideband spurious emission	>1GHz-12.75GHz	When operating: < -80dBm/Hz, When in stand-by: < -97 dBm/Hz.	

S. No.	Parameter Name	Frequency	Power	Remarks
D2.17	Transmitter wideband spurious emission	>1.8GHz-1.9GHz and 5.15 GHz-5.3 GHz	When operating: < -97dBm/Hz, When in stand-by: < -97 dBm/Hz.	
D2.18	Receiver narrowband spurious emission	30 MHz-1GHz	< -57 dBm	
D2.19	Receiver narrowband spurious emission	>1GHz-12.75GHz	< -47 dBm	
D2.20	Receiver wideband spurious emission	30 MHz-1GHz	< -107 dBm/Hz	
D2.21	Receiver wideband spurious emission	>1GHz-12.75GHz	< -97 dBm/Hz	

Annexure-D3: CCS#7 Conformance Parameters

Parameter Group: ISDN Conformance (ISDNCONF)

S. No.	Parameter Name	Individual Parameter Name	Standard	Test no.	Applicability/ Remarks
D3.1	CCS#7 MTP2 Parameters	Timer T2	ITU-T Q.781. Annex-D3	Test 1.2	Signaling Gateway and Media Gateway
D3.2	CCS#7 MTP2 Parameters	Timer T3	ITU-T Q.781. Annex-D3	Test 1.3	
D3.3	CCS#7 MTP2 Parameters	Timer T4 and T1	ITU-T Q.781. Annex-D3	Test 1.4	
D3.4	CCS#7 MTP2 Parameters	Normal Alignment	ITU-T Q.781. Annex-D3	Test 1.5	
D3.5	CCS#7 MTP2 Parameters	Emergency Alignment T4E	ITU-T Q.781. Annex-D3	Test 1.19	
D3.6	CCS#7 MTP3 Parameters	SignallingLinkset deactivation	ITU-T Q.782. Annex-D3	Test 1.2	
D3.7	CCS#7 MTP3 Parameters	SignallingLinkset activation	ITU-T Q.782. Annex-D3	Test 1.3	
D3.8	CCS#7 MTP3 Parameters	Message with Invalid DPC	ITU-T Q.782. Annex-D3	Test 2.2	
D3.9	CCS#7 MTP3 Parameters	Message with erroneous SI	ITU-T Q.782. Annex-D3	Test 2.3	
D3.10	CCS#7 MTP3 Parameters	Additional CBD	ITU-T Q.782. Annex-D3	Test 4.3	
D3.11	CCS#7 MTP3 Parameters	No acknowledgement to first CBD	ITU-T Q.782. Annex-D3	Test 4.4	
D3.12	CCS#7 MTP3 Parameters	Inhibition of available link	ITU-T Q.782. Annex-D3	Test7.1.1	
D3.13	CCS#7 MTP3 Parameters	Inhibition of unavailable link	ITU-T Q.782. Annex-D3	Test 7.1.2	
D3.14	CCS#7 MTP3 Parameters	Signaling Link test: After activation of a link	ITU-T Q.782. Annex-D3	Test 12.1	
D3.15	CCS#7 ISUP Parameters	Reset Received	ITU-T Q.784. Annex-D3	Test 1.2.1	

S. No.	Parameter Name	Individual Parameter Name	Standard	Test no.	Applicability/ Remarks
D3.16	CCS#7 ISUP Parameters	Reset Sent	ITU-T Q.784. Annex-D3	Test 1.2.2	Signaling Gateway
D3.17	CCS#7 ISUP Parameters	Circuit Group Reset Received	ITU-T Q.784. Annex-D3	Test 1.2.5	
D3.18	CCS#7 ISUP Parameters	Circuit Group Reset Sent	ITU-T Q.784. Annex-D3	Test 1.2.6	
D3.19	CCS#7 ISUP Parameters	CGB and CGU Received	ITU-T Q.784. Annex-D3	Test 1.3.1.1	
D3.20	CCS#7 ISUP Parameters	CGB and CGU Sent	ITU-T Q.784. Annex-D3	Test 1.3.1.2	
D3.21	CCS#7 ISUP Parameters	Circuit Blocking received	ITU-T Q.784. Annex-D3	Test 1.3.2.1	
D3.22	CCS#7 ISUP Parameters	Circuit Blocking sent	ITU-T Q.784. Annex-D3	Test 1.3.2.2	

Annexure-D4: Figures

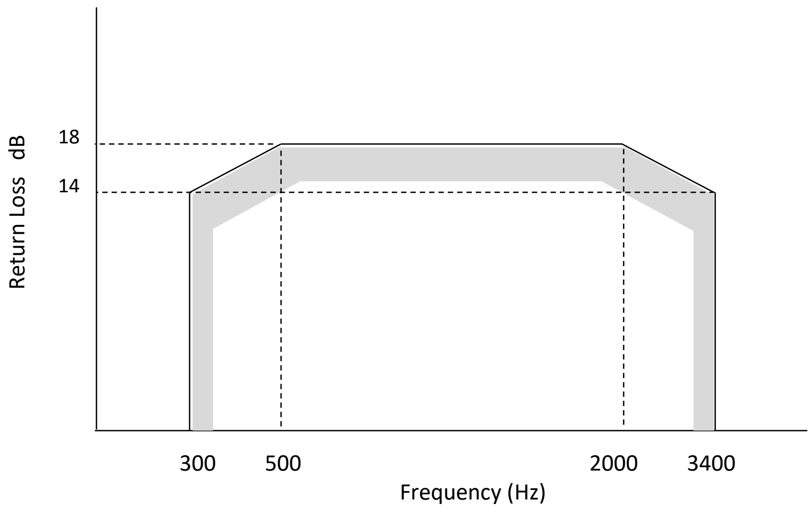


Fig. 1: Minimum Value of return Loss

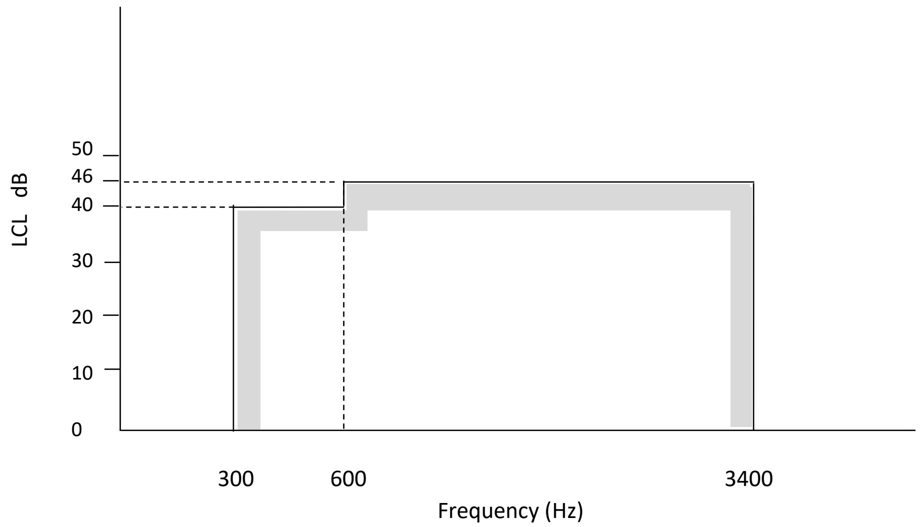


Fig. 2: Minimum Value of LCL

Annexure-F: Frequency of Operation for Cellular Wireless Interfaces and Equipment

Parameter Group: Cellular (CELLULAR)

S. No.	Technology	Parameter Name	Standard	Limits/ Values	Applicability/ Remarks	Test Procedure
F.1	CDMA2000	Frequency of Operation		Latest NFAP issued by WPC.		Appendix - II Test 36
F.2	2G/ GSM/ GPRS/ EDGE	Frequency of Operation		Latest NFAP issued by WPC.		Appendix - II Test 36
F.3	3G/ WCDMA/ HSPA	Frequency of Operation		Latest NFAP issued by WPC.		Appendix - II Test 36
F.4	4G/ LTE/ LTE-A	Frequency of Operation		Latest NFAP issued by WPC.		Appendix - II Test 36
F.5	5G FR1, FR2 and interworking with other Radios	Frequency of Operation		Latest NFAP issued by WPC.		Appendix - II Test 36
F.6	BTS with MSR	BTS with MSR Operating Frequency		Latest NFAP issued by WPC.		Appendix - II Test 36
F.7	BTS with AAS	BTS with AAS Operating Frequency		Latest NFAP issued by WPC.		Appendix - II Test 36

Annexure-F1: Radio Conformance Test for Base Transceiver Station (BTS) and Compact Cellular Network (CCN)

using 2G/ GSM/ GPRS/ EDGE Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard	Clause	Applicability/ Remarks
F1.1	GSM BTS Transmitter Parameters	Adjacent channel power	3GPP TS 51.021	Clause 6.5	
F1.2		Wideband noise and intra BSS intermodulation attenuation in multicarrier operation	3GPP TS 51.021	Clause 6.12	
F1.3		Spurious emissions from the transmitter antenna connector	3GPP TS 51.021	Clause 6.6	
F1.4		Mean transmitted RF carrier power	3GPP TS 51.021	Clause 6.3	
F1.5		Intermodulation attenuation	3GPP TS 51.021	Clause 6.7	
F1.6		Intra Base Station System intermodulation attenuation	3GPP TS 51.021	Clause 6.8	
F1.7		Radiated spurious emissions	3GPP TS 51.021	Clause 8	
F1.8	GSM BTS Receiver Parameters	Static Reference Sensitivity Level	3GPP TS 51.021	Clause 7.3	
F1.9		Reference interference level	3GPP TS 51.021	Clause 7.5	
F1.10		Blocking Characteristics	3GPP TS 51.021	Clause 7.6	
F1.11		Intermodulation characteristics	3GPP TS 51.021	Clause 7.7	
F1.12		AM suppression	3GPP TS 51.021	Clause 7.8	
F1.13		Spurious emissions from the receiver antenna connector	3GPP TS 51.021	Clause 7.9	

Annexure-F2: Radio Conformance Test for NodeB and Compact Cellular Network (CCN) using 3G/WCDMA/HSPA Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard	Clause	Applicability/ Remarks
F2.1	WCDMA NodeB Transmitter Parameters	Spectrum emission mask	3GPP TS 25.141	Clause 6.5.2.1	NodeB and CCN
F2.2		Adjacent Channel Leakage Power Ratio (ACLR)	3GPP TS 25.141	Clause 6.5.2.2	
F2.3		Spurious emissions	3GPP TS 25.141	Clause 6.5.3	
F2.4		Base station output power	3GPP TS 25.141	Clause 6.2	
F2.5		Transmitter intermodulation	3GPP TS 25.141	Clause 6.6	
F2.6	WCDMA NodeB Receiver Parameters	Spurious Emissions	3GPP TS 25.141	Clause 7.7	
F2.7		Blocking characteristics	3GPP TS 25.141	Clause 7.5	
F2.8		Intermodulation characteristics	3GPP TS 25.141	Clause 7.6	
F2.9		Adjacent Channel Selectivity (ACS)	3GPP TS 25.141	Clause 7.4	
F2.10		Reference sensitivity level	3GPP TS 25.141	Clause 7.2	
F2.11	WCDMA NodeB Home BTS AdjChl Op Power	Home base station output power for adjacent channel protection	3GPP TS 25.141	Clause 6.4.6	NodeB

Annexure-F3: Radio Conformance Test for eNodeB and Compact Cellular Network (CCN) using 4G/LTE/LTE-A Technology

Parameter Group: Cellular (CELLULAR)

S. No.	**Parameter Name**	**Individual Parameter Name**	**Standard**	**Clause**	**Applicability/ Remarks**
F3.1	LTE eNodeB Transmitter Parameters	Operating band unwanted emissions	3GPP TS 36.141	Clause 6.6.3	eNodeB and CCN
F3.2		Adjacent Channel Leakage Power Ratio (ACLR)	3GPP TS 36.141	Clause 6.6.2	
F3.3		Transmitter spurious emissions	3GPP TS 36.141	Clause 6.6.4	
F3.4		Base station output power	3GPP TS 36.141	Clause 6.2	
F3.5		Transmitter intermodulation	3GPP TS 36.141	Clause 6.7	
F3.6	LTE eNodeB Receiver Parameters	Receiver spurious emissions	3GPP TS 36.141	Clause 7.7	
F3.7		Blocking	3GPP TS 36.141	Clause 7.6	
F3.8		Receiver intermodulation	3GPP TS 36.141	Clause 7.8	
F3.9		Adjacent Channel Selectivity (ACS) and narrow-band blocking	3GPP TS 36.141	Clause 7.5	
F3.10		Reference sensitivity level	3GPP TS 36.141	Clause 7.2	
F3.11	LTE eNodeB Home BS Parameters	Home BS output power for adjacent UTRA channel protection : Applicable to Home base Station only	3GPP TS 36.141	Clause 6.2.6	eNodeB
F3.12		Home BS output power for adjacent E-UTRA channel protection: Applicable to Home base Station only	3GPP TS 36.141	Clause 6.2.7	
F3.13		Home BS output power for co-channel E-UTRA protection: Applicable to Home base Station only	3GPP TS 36.141	Clause 6.2.8	

Annexure-F4: Radio Conformance Test for Base Station (BS) using Multi Standard Radio (MSR) Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard	Clause	Applicability/ Remarks
F4.1	BS with MSR Transmitter Parameters	Base Station output power	3GPP TS 37.141	Clause 6.2	BS with MSR
F4.2		Transmitter spurious emissions	3GPP TS 37.141	Clause 6.6.1	
F4.3		Operating band unwanted emissions	3GPP TS 37.141	Clause 6.6.2	
F4.4		Adjacent Channel Leakage Power Ratio (ACLR)	3GPP TS 37.141	Clause 6.6.4	
F4.5		Transmitter intermodulation	3GPP TS 37.141	Clause 6.7	
F4.6	BS with MSR Receiver Parameters	Receiver spurious emissions	3GPP TS 37.141	Clause 7.6	
F4.7		In-band selectivity and blocking or In Band Blocking and Narrow band Blocking	3GPP TS 37.141	Clause 7.4	
F4.8		Out-of-band blocking	3GPP TS 37.141	Clause 7.5	
F4.9		Receiver intermodulation	3GPP TS 37.141	Clause 7.7	
F4.10		Reference sensitivity level	3GPP TS 37.141	Clause 7.2	

Annexure-F5: Radio Conformance Test for Base station (BS) using Active Antenna System (AAS)

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard	Clause	Applicability/ Remarks
F5.1	BS with AAS Transmitter Parameters	Base Station output power	3GPP TS 37.145-1	Clause 6.2	BS with AAS
F5.2		Spurious emission	3GPP TS 37.145-1	Clause 6.6.6	
F5.3		Operating band unwanted emission	3GPP TS 37.145-1	Clause 6.6.5	
F5.4		Adjacent Channel Leakage Power Ratio	3GPP TS 37.145-1	Clause 6.6.3	
F5.5		Spectrum emission mask	3GPP TS 37.145-1	Clause 6.6.4	
F5.6		Transmitter intermodulation	3GPP TS 37.145-1	Clause 6.7	
F5.7	BS with AAS Receiver Parameters	Reference sensitivity level	3GPP TS 37.145-1	Clause 7.2	
F5.8		Adjacent channel selectivity and narrowband blocking or In Band Blocking and Narrow band Blocking	3GPP TS 37.145-1	Clause 7.4	
F5.9		Blocking or out-of-band blocking	3GPP TS 37.145-1	Clause 7.5	
F5.10		Receiver spurious emissions	3GPP TS 37.145-1	Clause 7.6	
F5.11		Receiver intermodulation	3GPP TS 37.145-1	Clause 7.7	

Annexure-F6: Radio Conformance Test for Cellular Wireless Repeaters using 2G/GSM Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard	Clause	Applicability/ Remarks
F6.1	GSM Repeater Station Parameters	Output Power	3GPP TS 45.005	Clause 4.1.2	
F6.2		Spurious emissions	3GPP TS 51.026	Clause 5	
F6.3		Frequency Error	3GPP TS 51.026	Clause 8	
F6.4		Intermodulation Attenuation	3GPP TS 51.026	Clause 6	
F6.5		Out of Band Gain	3GPP TS 51.026	Clause 7	

Annexure-F7: Radio Conformance Test for Cellular Wireless Repeaters using 3G/WCDMA ULTRA FDD Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard	Clause	Applicability/ Remarks
F7.1	WCDMA Repeater Station Parameters	Output Power	3GPP TS 25.143	Clause 6	
F7.2		Out of band emission	3GPP TS 25.143	Clause 9.1	
F7.3		Spurious emissions	3GPP TS 25.143	Clause 9.2	
F7.4		Input intermodulation	3GPP TS 25.143	Clause 11	
F7.5		Out of band gain	3GPP TS 25.143	Clause 8	
F7.6		Adjacent Channel Rejection Ratio	3GPP TS 25.143	Clause 13	
F7.8		Output intermodulation	3GPP TS 25.143	Clause 12	

Annexure-F8: Radio Conformance Test for Cellular Wireless Repeaters using 4G/LTE FDD Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard		Applicability/ Remarks
F8.1	LTE Repeater Station Parameters	Output Power	3GPP TS 36.143 Clause 6		
F8.2		Operating band unwanted emissions	3GPP TS 36.143 Clause 9.1		
F8.3		Spurious emissions	3GPP TS 36.143 Clause 9.2		
F8.4		Input intermodulation	3GPP TS 36.143 Clause 11		
F8.5		Out of band gain	3GPP TS 36.143 Clause 8		
F8.6		Adjacent Channel Rejection Ratio	3GPP TS 36.143 Clause 13		
F8.7		Output intermodulation	3GPP TS 36.143 Clause 12		

Annexure-F9: Radio Conformance Test for Devices having Cellular Wireless Interface using CDMA2000 Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard		Applicability/Remarks
F9.1	CDMA Int Parameters	Transmitter Maximum output power	1x: S0011 Clause 4.4.5	EN 301 908-04 (CDMA) Clause 4.2.3	Test setup and test procedure along with the equipment required to conduct test must be included as available for Test 39 otherwise evaluation of applications of Labs for CAB/CB accreditation not possible.
F9.2		Transmitter Spectrum emissions mask	1x: S0011 Clause 4.5.1	EN 301 908-04 (CDMA) Clause 4.2.2	Same as above
F9.3		Transmitter spurious emissions in active mode (Conducted)	1x: S0011 Clause 4.5.1	EN 301 908-04 (CDMA) Clause 4.2.2	Same as above
F9.4		Receiver spurious emission in idle mode (Conducted)	1x: S0011 Clause 3.6	EN 301 908-04 (CDMA) Clause 4.2.5	Same as above
F9.5		Receiver Adjacent Channel Selectivity (ACS)		EN 301 908-04 (CDMA) Clause 4.2.8	Same as above
F9.6		Receiver In-band blocking		EN 301 908-04 (CDMA) Clause 4.2.6	Same as above
The following parameter "Frequency Stability" and "Power control Absolute Power Tolerance" shall be applicable for End Point Devices for Environmental Mentoring only.					
F9.7		Frequency Stability	1x: S0011 4.1	EN 301 908-04 (CDMA)	Compliance to given Standard Test setup and test procedure along with the equipment required to conduct test must be included as available for Test 39 otherwise evaluation of applications of Labs for CAB/CB accreditation not possible.

F9.8		Receiver Reference Sensitivity Level		EN 301 908-04 (CDMA)	Compliance to given Standard Test setup and test procedure along with the equipment required to conduct test must be included as available for Test 39 otherwise evaluation of applications of Labs for CAB/CB accreditation not possible.

Annexure-F10: Radio Conformance Test for Devices having Cellular Wireless Interface using GSM/ GPRS/ EDGE Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard		Applicability/Remarks
F10.1	GSM Int Parameters	Transmitter Maximum output power	3GPP TS 51 010-1 Clause 13.3	EN 301 511 (GSM) Clause 4.2.5	GSM Test setup and test procedure along with the equipment required to conduct test must be included as available for Test 39 otherwise evaluation of applications of Labs for CAB/CB accreditation not possible.
F10.2		Transmitter Maximum output power	3GPP TS 51 010-1 Clause 13.16.2	EN 301 511 (GSM) Clause 4.2.10	GPRS/ EDGE Same as above.
F10.3		Output RF Spectrum	3GPP TS 51 010-1 Clause 13.4	EN 301 511 (GSM) Clause 4.2.6	GSM Same as above.
F10.4		Output RF Spectrum	3GPP TS 51 010-1 Clause 13.16.3	EN 301 511 (GSM) Clause 4.2.11	GPRS/ EDGE Same as above.

S. No.	Parameter Name	Individual Parameter Name	Standard		Applicability/Remarks
F10.5		Spurious emissions (MS allocated a channel)	3GPP TS 51 010-1 Clause 12.1.1	EN 301 511 (GSM) Clause 4.2.12	GSM Same as above.
F10.6		Spurious emission (MS in idle mode)	3GPP TS 51 010-1 Clause 12.1.2	EN 301 511 (GSM) Clause 4.2.13	GSM Same as above.
F10.7		Frequency Error and phase error	3GPP TS 51 010-1 Clause 13.1	EN 301 511 (GSM) Clause 4.2.1	GSM Same as above.
F10.8		Frequency Error and phase error	GPRS:3GPP TS 51 010-1 Clause 13.16.1	EN 301 511 (GSM) Clause 4.2.4	GPRS/ EDGE Same as above.
F10.9		Reference sensitivity level (speech channels)	3GPP TS 51 010-1 Clause 14.2.1	EN 301 511 (GSM) Clause 4.2.42	GSM Same as above.
F10.10		Adjacent Channel Rejection (speech channels)	3GPP TS 51 010-1 Clause 14.5.1	EN 301 511 (GSM) Clause 4.2.38	GSM Same as above.
F10.11		Receiver blocking	3GPP TS 51 010-1 Clause 14.7.1	EN 301 511 (GSM) Clause 4.2.20	GSM Same as above.

Annexure-F11: Radio Conformance Test for Devices having Cellular Wireless Interface using WCDMA/ HSPA Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard		Applicability/Remarks
F11.1	WCDMA Int Parameters	Transmitter Maximum output power	3GPP TS 34.121-1 Clause 5.2	EN 301 908-2 (UMTS) Clause 4.2.2	Test setup and test procedure along with the equipment required to conduct test must be included as available for Test 39 otherwise evaluation of applications of Labs for CAB/CB

S. No.	Parameter Name	Individual Parameter Name	Standard		Applicability/Remarks
					accreditation not possible.
F11.2		Transmitter Spectrum emissions mask	3GPP TS 34.121-1 Clause 5.9	EN 301 908-2 (UMTS) Clause 4.2.3	Same as above
F11.3		Transmitter spurious emissions	3GPP TS 34.121-1 Clause 5.11	EN 301 908-2 (UMTS) Clause 4.2.4	Same as above
F11.4		Receiver spurious emission	3GPP TS 34.121-1 Clause 6.8	EN 301 908-2 (UMTS) Clause 4.2.10	Same as above
F11.5		Transmitter Minimum Output Power	3GPP TS 34.121-1 Clause 5.4.3	EN 301 908-2 (UMTS) Clause 4.2.5	Same as above
F11.6		Receiver Reference sensitivity level	3GPP TS 34.121-1 Clause 6.2	EN 301 908-2 (UMTS) Clause 4.2.13	Same as above
F11.7		Receiver Adjacent Channel Selectivity (ACS)	3GPP TS 34.121-1 Clause 6.4	EN 301 908-2 (UMTS) Clause 4.2.6	Same as above
F11.8		Receiver In-band blocking	3GPP TS 34.121-1 Clause 6.5.2.1	EN 301 908-2 (UMTS) Clause 4.2.7	Same as above
The following parameter "Frequency Stability" shall be applicable for End Point Devices for Environmental Mentoring only.					
F11.9		Frequency Stability	3GPP TS 34.121-1 5.3	EN 301 908-2 (UM3GPP TS)	Compliance to given Standard.

Annexure-F12: Radio Conformance Test for Devices having Cellular Wireless Interface using LTE/ LTE-A Technology

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard		Applicability/Remarks
F12.1	LTE Int Parameters	Maximum output power	3GPP TS 36.521-1 Clause 6.2.2	EN 301 908-13 (LTE) Clause 4.2.2	Test setup and test procedure along with the equipment required to conduct test must be included as available for Test 39 otherwise evaluation of applications of Labs for CAB/CB accreditation not possible.
F12.2		Spectrum emissions mask	3GPP TS 36.521-1 Clause 6.6.2.1	EN 301 908-13 (LTE) Clause 4.2.3	Same as above
F12.3		Spurious emissions	3GPP TS 36.521-1 Clauses 6.6.3.1, 6.6.3.2, 6.6.3.3	EN 301 908-13 (LTE) Clause 4.2.4	Same as above
F12.4		Receiver spurious emission	3GPP TS 36.521-1 Clause 7.9	EN 301 908-13 (LTE) Clause 4.2.10	Same as above
F12.5		Receiver Reference Sensitivity level	3GPP TS 36.521-1 Clause 7.3	EN 301 908-13 (LTE) Clause 4.2.12	Same as above
F12.6		Receiver Adjacent Channel Selectivity (ACS)	3GPP TS 36.521-1 Clause 7.5	EN 301 908-13 (LTE) Clause 4.2.6	Same as above
F12.7		Receiver In-band blocking	3GPP TS 36.521-1 Clause 7.6.1	EN 301 908-13 (LTE) Clause 4.2.7	Same as above
The following parameter “Frequency Stability” and “Power control Absolute Power Tolerance” shall be applicable for End Point Devices for Environmental Mentoring only.					
F12.8		Frequency Stability	3GPP TS 36.521-1 6.5	EN 301 908-13 (LTE)	Compliance to given Standard.
F12.9		Power control Absolute Power Tolerance	3GPP TS 36.521-1 6.3.5.1	EN 301 908-13 (LTE)	Compliance to given Standard.

Annexure-F13: Radio Conformance Test for Devices having Cellular Wireless Interface using 5G NR-FR1 and FR2 interworking with other Radios

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard
F12.10	5G NR- FR1 and FR2 interworking with other Radios	Additional Spectrum emissions mask for inter-band EN-DC within FR1	3GPP TS 38.521-3 Clause 6.5B.2.3.2
F12.11		Additional Spurious emissions for inter-band EN-DC within FR1	3GPP TS 38.521-3 Clause 6.5B.4.3
F12.12		Adjacent channel leakage ratio for Inter-band EN-DC including FR2 2CCs	3GPP TS 38.521-3 Clause 6.5B.2.4.3
F12.13		Adjacent channel leakage ratio for inter-band EN-DC within FR1	3GPP TS 38.521-3 Clause 6.5B.2.3.3
F12.14		Adjacent channel selectivity for inter-band EN-DC within FR1 2CCs	3GPP TS 38.521-3 3GPP TS 38.521-3 Clause 7.5B.3
F12.15		Adjacent channel selectivity for intra-band contiguous EN-DC 2CCs	3GPP TS 38.521-3 Clause 7.5B.1
F12.16		General spurious emissions for inter-band EN-DC within FR1	3GPP TS 38.521-3 Clause 6.5B.3.3.1
F12.17		General spurious emissions for intra-band contiguous EN-DC	3GPP TS 38.521-3 Clause 6.5B.3.1.1
F12.18		Inband blocking for inter-band EN-DC within FR1-2CCs	3GPP TS 38.521-3 Clause 7.6B.2.3
F12.19		Inband blocking for intra-band contiguous EN-DC in FR1-2CCs	3GPP TS 38.521-3 Clause 7.6B.2.1
F12.20		Minimum output power for EN-DC Inter-band including FR2	3GPP TS 38.521-3 Clause 6.3B.1.4
F12.21		Minimum Output Power for intra-band contiguous EN-DC	3GPP TS 38.521-3 Clause 6.3B.1.1
F12.22		Minimum output power for intra-band EN-DC within FR1	3GPP TS 38.521-3 Clause 6.3B.1.3
F12.23		Narrow band blocking for inter band EN DC within FR1 2CCs	3GPP TS 38.521-3 Clause 7.6B.4.3
F12.24		Narrow band blocking for intra band contiguous EN DC in FR1 2CCs	3GPP TS 38.521-3 Clause 7.6B.4.1
F12.25		Out-of-band blocking for inter-band EN-DC within FR1-2CCs	3GPP TS 38.521-3 Clause 7.6B.3.3

F12.26		Out-of-band blocking for intra-band contiguous EN-DC in FR1-2CCs	3GPP TS 38.521-3 Clause 7.6B.3.1
F12.27		Reference sensitivity for EN-DC within FR1 3CCs	3GPP TS 38.521-3 Clause 7.3B.2.3_1.1
F12.28		Reference sensitivity for inter-band EN-DC including FR2	3GPP TS 38.521-3 Clause 7.3B.2.4
F12.29		Reference sensitivity for inter-band EN-DC within FR1 2CCs	3GPP TS 38.521-3 Clause 7.3B.2.3
F12.30		Reference sensitivity for intra-band contiguous EN-DC 2CCs	3GPP TS 38.521-3 Clause 7.3B.2.1
F12.31		Spectrum emissions mask for inter- band EN-DC within FR1	3GPP TS 38.521-3 Clause 6.5B.2.3.1
F12.32		Spectrum emissions mask for inter-band EN-DC including FR2 (2 CCs)	3GPP TS 38.521-3 Clause 6.5B.2.4.1
F12.33		Spurious emission band UE co-existence for intra-band contiguous EN-DC	3GPP TS 38.521-3 Clause 6.5B.3.1.2
F12.34		Spurious emissions band UE co-existence for inter-band within FR1	3GPP TS 38.521-3 Clause 6.5B.3.3.2
F12.35		Spurious Emissions for EN DC within FR1 3CCs	3GPP TS 38.521-3 Clause 7.9B.3 1.1
F12.36		Spurious Emissions for inter band EN DC within FR1 2CCs	3GPP TS 38.521-3 Clause 7.9B.3
F12.37		Spurious emissions for intra band contiguous EN DC in FR1 2CCs	3GPP TS 38.521-3 Clause 7.9B.1
F12.38		Spurious Response for inter band EN DC within FR1 2CCs	3GPP TS 38.521-3 Clause 7.7B.3
F12.39		Spurious Response for intra band contiguous EN DC in FR1 2CCs	3GPP TS 38.521-3 Clause 7.7B.1
F12.40		UE Maximum Output Power for Inter-Band EN-DC including FR2 - EIRP and TR	3GPP TS 38.521-3 Clause 6.2B.1.4.1
F12.41		UE Maximum Output Power for Inter-Band EN-DC including FR2 - Spherical Coverage	3GPP TS 38.521-3 Clause 6.2B.1.4.2
F12.42		UE Maximum Output Power for Inter-Band EN-DC within FR1	3GPP TS 38.521-3 Clause 6.2B.1.3
F12.43		UE Maximum Output Power for Intra-Band Contiguous EN-DC	3GPP TS 38.521-3 Clause 6.2B.1.1

F12.44		Wideband Intermodulation for inter band EN DC in FR1 2CCs	3GPP TS 38.521-3 Clause 7.8B.2.3
F12.45		Wideband Intermodulation for intra band contiguous EN DC in FR1	3GPP TS 38.521-3 Clause 7.8B.2.1

Annexure-F14: Radio Conformance Test for Devices having Cellular Wireless Interface using 5G NR-FR1

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard
F14.1	5G NR- FR1	Additional spectrum emission mask-Transmitter	3GPP TS 38.521-1 Clause 6.5.2.3
F14.2		Additional spectrum emission mask for UL MIMO	3GPP TS 38.521-1 Clause 6.5D.2.3
F14.3		Additional spurious emissions	3GPP TS 38.521-1 Clause 6.5.3.3
F14.4		Additional spurious emissions for UL MIMO	3GPP TS 38.521-1 Clause 6.5D.3.3
F14.5		Adjacent channel selectivity	3GPP TS 38.521-1 Clause 7.5
F14.6		Adjacent channel selectivity for 2DL CA	3GPP TS 38.521-1 Clause 7.5A.1
F14.7		Adjacent channel selectivity for UL-MIMO	3GPP TS 38.521-1 Clause 7.5D
F14.8		General spurious emissions-Transmitter	3GPP TS 38.521-1 Clause 6.5.3.1
F14.9		General spurious emissions for UL MIMO	3GPP TS 38.521-1 Clause 6.5D.3.1
F14.10		In-band Blocking for CA-2DL CA	3GPP TS 38.521-1 Clause 7.6A.2.1
F14.11		Inband Blocking	3GPP TS 38.521-1 Clause 7.6.2
F14.12		Inband blocking for UL-MIMO	3GPP TS 38.521-1 Clause 7.6D.2
F14.13		Minimum output power	3GPP TS 38.521-2 Clause 6.3.1
F14.14		Narrow band blocking	3GPP TS 38.521-1 Clause 7.6.4
F14.15		Narrow band blocking for CA-2DL CA	3GPP TS 38.521-1 Clause 7.6A.4.1
F14.16		Narrow band blocking for UL-MIMO	3GPP TS 38.521-1 Clause 7.6D.4

F14.17		NR ACLR	3GPP TS 38.521-1 Clause 6.5.2.4.1
F14.18		NR ACLR for UL MIMO	3GPP TS 38.521-1 Clause 6.5D.2.4.1
F14.19		Out-of-band blocking	3GPP TS 38.521-1 Clause 7.6.3
F14.20		Out-of-band blocking for UL-MIMO	3GPP TS 38.521-1 Clause 7.6D.3
F14.21		Reference sensitivity power level	3GPP TS 38.521-1 Clause 7.3.2
F14.22		Reference sensitivity power level for 2DL CA without exception	3GPP TS 38.521-1 Clause 7.3A.1
F14.23		Reference sensitivity power level for UL-MIMO	3GPP TS 38.521-1 Clause 7.3D.2
F14.24		Spectrum Emission Mask-5G NR FR1	3GPP TS 38.521-1 Clause 6.5.2.2
F14.25		Spectrum emission Mask for UL MIMO	3GPP TS 38.521-1 Clause 6.5D.2.2
F14.26		Spurious emission for 2DL CA	3GPP TS 38.521-1 Clause 7.9A.1
F14.27		Spurious emission for UE co-existence	3GPP TS 38.521-1 Clause 6.5.3.2
F14.28		Spurious emission for UE co-existence for UL MIMO	3GPP TS 38.521-1 Clause 6.5D.3.2
F14.29		Spurious emissions-5G NR FR1	3GPP TS 38.521-1 Clause 7.9
F14.30		Spurious response	3GPP TS 38.521-1 Clause 7.7
F14.31		Spurious response for 2DL CA	3GPP TS 38.521-1 Clause 7.7A.1
F14.32		Spurious response for UL-MIMO	3GPP TS 38.521-1 Clause 7.7D
F14.33		UE Maximum Output Power	3GPP TS 38.521-1 Clause 6.2.1
F14.34		UE maximum output power for UL-MIMO	3GPP TS 38.521-1 Clause 6.2D.1
F14.35		UE maximum output power reduction for UL-MIMO	3GPP TS 38.521-1 Clause 6.2D.2
F14.36		UTRA ACLR	3GPP TS 38.521-1 Clause 6.5.2.4.2
F14.37		UTRA ACLR for UL MIMO	3GPP TS 38.521-1 Clause 6.5D.2.4.2
F14.38		Wide band Intermodulation	3GPP TS 38.521-1 Clause 7.8.2
F14.39		Wide band Intermodulation for CA-2DL CA	3GPP TS 38.521-1 Clause 7.8A.2.1
F14.40		Wide band Intermodulation for UL-MIMO	3GPP TS 38.521-1 Clause 7.8D.2

Annexure-F15: Radio Conformance Test for Devices having Cellular Wireless Interface using 5G NR-FR2

Parameter Group: Cellular (CELLULAR)

S. No.	Parameter Name	Individual Parameter Name	Standard
F15.1	5G NR- FR2	Adjacent channel leakage ratio	3GPP TS 38.521-2 Clause 6.5.2.3
F15.2		Minimum Output Power-Transmitter	3GPP TS 38.521-1 Clause 6.3.1
F15.3		Reference sensitivity power level	3GPP TS 38.521-1 Clause 7.3.2
F15.4		Spectrum Emission Mask-5G NR FR2	3GPP TS 38.521-2 Clause 6.5.2.1
F15.5		UE maximum output power-EIRP and TRP	3GPP TS 38.521-2 Clause 6.2.1.1
F15.6		UE maximum output power-Spherical coverage	3GPP TS 38.521-2 Clause 6.2.1.2
F15.7		UE maximum output power reduction	3GPP TS 38.521-2 Clause 6.2.2
F15.8		UE maximum output power with additional requirements	3GPP TS 38.521-2 Clause 6.2.3

Annexure-G1: Parameters for Radio Interfaces for equipment operating in delicensed frequency bands

Parameter Group: Radio Conformance (RADCONF)

S. No.	Parameter Name	Standard/ Parameter	Limits/ Values	Applicability/Remarks
G1.1	Frequency for WiFi equipment	DoT WPC GSR No. 45(E), 1048(E)	**2.4 GHZ Band:** 2.4-2.4835 GHz as per WPC GSR 45(E) **5 GHz Band:** 5.150-5.250 GHz, 5.250-5.350 GHz, 5.470-5.725 GHz, 5.725-5.875 GHz as per WPC GSR 1048(E)	Wifi Interface Test procedure as per Appendix-II Test-1
G1.2	Frequency for PTP/ PMP Fixed Radio Interface	DoT WPC GSR No. 45(E), 1048(E)	**2.4 GHZ Band:** 2.4-2.4835 GHz as per WPC GSR 45(E) **5 GHz Band**: 5.150- 5.250 GHz, 5.725-5.875 GHz as per WPC GSR 1048(E)	PTP/ PMP Wireless Access Equipment Test procedure as per Appendix-II Test-1

Annexure-G2: Parameters for Radio Interfaces for equipment operating in delicensed frequency bands

Parameter Group: Radio Conformance (RADCONF)

S. No.	Parameter Name	Standard/ Parameter	Limits/ Values	Remarks
G2.1	EIRP for all equipment operating in 2.4 GHz	As per Latest NFAP and GSRs issued by DoT WPC	< 4 W (36dBm) Maximum output power of transmitter ≤ 1 W (30 dBm) in spread of 10 MHz or higher. (As per GSR 45(E).	Wifi Interface & PTP/PMP Wireless Access Equipment in 2.4 GHz Testing as per EN 300 328 or Appendix-II Test-1
G2.2	EIRP for RLAN/ WLAN equipment operating in 5 GHz	Latest NFAP and GSRs issued by DoT WPC	Maximum conducted output power and Antenna Gain as per limits mentioned in **WPC GSR 1048(E)** based on type of equipment, its operational/deployment characteristics and specific condition related to Antenna Gain for different frequency bands i.e. **5.150-5.250 GHz, 5.250- 5.350 GHz and 5.470-5.725 GHz and 5.725-5.875 GHz**. **EIRP limit =** Maximum conducted output power + Antenna Gain	Wifi Interface Testing as per EN 301893 or EN 302 502 as applicable; or Appendix-II Test-1

S. No.	Parameter Name	Standard/ Parameter	Limits/ Values	Remarks
G2.3	EIRP for PTP/ PMP fixed Radio systems operating in 5 GHz	Latest NFAP and GSRs issued by DoT WPC	Maximum conducted output power and Antenna Gain as per limits mentioned in **WPC GSR 1048(E)** based on type of equipment, its operational/deployment characteristics and specific condition related to Antenna Gain for different frequency bands i.e. **5.150-5.250 GHz, 5.250- 5.350 GHz and 5.470-5.725 GHz and 5.725-5.875 GHz**. **EIRP limit =** Maximum conducted output power + Antenna Gain	PTP/PMP Wireless Access Equipment in 5 GHz Testing as per EN 301 893 or EN 302 502, as applicable ; or Appendix-II Test-1

Annexure-G3: Parameters for Radio Interfaces for equipment operating in delicensed frequency bands

Parameter Group: Radio Conformance (RADCONF)

S. No.	Parameter Name	Standard/ Parameter	Applicability/Limits/ Values	Remarks
G3.1	Radio Conformance for all Wi-Fi equipment operating in 2.4 GHz	ETSI EN 300 328 or FCC CFR47 Part15.247 or FCC CFR47 Part 15.249	**Refer in ETSI EN 300 328:-** **Clause 4.2** -Applicable category of equipment on basis of FHSS and non FHSS **Clause 4.3 and sub clauses**– Conformance tests as per category in clause 4.2 with limits in sub clauses **Clause 5** – Test methods For equipment conforming to FCC CFR 47 Part 15.247 / FCC CFR 47 Part 15.249 Radio Conformance shall be taken as indicated in the Standard therein. However, the test method shall be as per clause 5 of ETSI EN 300 328.	Wi-Fi Interface & PTP/PMP Wireless Access Equipment in 2.4 GHz ***Note:*** *Radio conformance requirements/limits, mentioned in NFAP and GSR 45 (E) issued by WPC, which inter alia include effective radiated power, output power of transmitter, shall supersede the requirements listed here or in aforementioned International standards.* *However, for Test methods corresponding to such quantities, ETSI EN 300 328 standard shall be applicable*
G3.2	Radio Conformance for RLAN/WLAN Wi-Fi	ETSI EN 301 893 or	Test requirements and limits as per EN 301 893 for frequency bands i.e. 5.150-5.250 GHz, 5.250-5.350 GHz 5.470-5.725 GHz and **5.725-5.875 GHz***.	Wi-Fi Interface

	equipment operating in 5 GHz	or FCC CFR47 Part 15.407	Or Test requirements and limits as per FCC CFR 47 Part 15.407 for **5.150-5.250 GHz, 5.250- 5.350 GHz, 5.470-5.725 GHz and 5.725-5.875 GHz**	***Note:*** *Radio conformance requirements/limits, mentioned in NFAP and GSR 1048 (E) issued by WPC, which inter alia include EIRP, power spectral density, conducted output power, bandwidth, out of band emission, shall supersede the requirements listed here or in aforementioned International standards.* *However, for Test methods corresponding to such quantities, aforementioned standards shall be applicable*
G3.3	Radio Conformance for PTP/PMP Wireless Access Equipment operating in 5 GHz	ETSI EN 301 893 or ETSI EN 302 502, as applicable or FCC CFR47 Part 15.249 Or FCC CFR47 Part	Test requirements and limits as per EN 301 893 for frequency band 5.150- 5.250 GHz, 5.250-5.350 GHz, 5.470-5.725 GHz Test requirements and limits as per EN 302 502 for frequency band 5.725-5.875 GHz Except clauses 4.2.4, 4.2.6 and 4.2.8 of EN 302 502 in **5.725-5.875 GHz band**) or Test requirements and limits as per FCC CFR 47	PTP/PMP Wireless Access Equipment or PTP/PMP Fixed Radio system in 5 GHz. ***Note:*** *Radio conformance requirements/limits, mentioned in NFAP and GSR 1048 (E) issued by WPC, which inter alia include EIRP, power spectral density, conducted output power, bandwidth, out of*

		15.407	Part 15.407 for **5.150-5.250 GHz, 5.250- 5.350 GHz, 5.470-5.725 GHz and 5.725-5.875 GHz** **Or** Test requirements and limits as per FCC CFR47 Part 15.249 **for 5.725-5.875 GHz**	*band emission, shall supersede the requirements listed here or in aforementioned international standards.* *However, for Test methods corresponding to such quantities, aforementioned standards shall be applicable.*

***Note – Standard ETSI EN 301 893 doesn't directly refer to frequency band 5.725-5.875 GHz for WLAN/RLAN equipment but the same may be referred for conformance testing for 5.725-5.875 GHz band as well.**

Annexure-G4 Bluetooth Low Energy (BLE)/ ZigBee/6LowPAN working frequency band 2.400 to 2.4835 GHz

S. No.	Parameter Name	Standard/ Parameter	Applicability/Limits/ Values	Remarks
G4.1	Frequency of Operation of Interface	Latest NFAP Annexure-1	2.4 GHz to 2.4835 GHz (As per WPC GSR 45(E))	Test Setup No. 41
G4.2	EIRP for Interface	ETSI EN 300 328 V2.2.2 (2019-07)	≤ 4W (36 dBm) As per WPC GSR 45(E)	Test Setup No. 42 (Test as per ETSI EN 300 328 V2.2.2 (2019-07) clause 5.4.2.2)
G4.3	Maximum Transmit Power / RF Ouput Power of Interface	ETSI EN 300 328 V2.2.2 (2019-07)	≤ 1 W (30dBm) As per WPC GSR 45(E) (ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.2 or 4.3.2.2 may be referred)	Test Setup No. 42 (Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.2.2)
G4.4	Power Spectral Density	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.2.3 (*Only for non-FHSS equipment)*	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.3)
G4.5	Duty cycle, Tx-Sequence, Tx-gap	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.3 or 4.3.2.4 *(Only for non-Adaptive equipment)*	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.2)
G4.6	Accumulated Transmit time, Frequency Occupation & Hopping Sequence	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.4 *(Only for FHSS equipment)*	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.4)

S. No.	Parameter Name	Standard/ Parameter	Applicability/Limits/ Values	Remarks
G4.7	Hopping Frequency Separation	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.5 *(Only for FHSS equipment)*	(Test as per ETSI EN 300 328 V2.2.2 (2019-07) clause 5.4.5)
G4.8	Medium Utilization (MU) factor	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.6 or 4.3.2.5 *(Only for non-Adaptive equipment)*	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.2)
G4.9	Adaptivity	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.7 or 4.3.2.6 *(Only for Adaptive equipment)*	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.6)
G4.10	Occupied Channel Bandwidth	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.8 or 4.3.2.7	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.7)
G4.11	Transmitter unwanted emission in the OOB domain	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.9 or 4.3.2.8	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.8)
G4.12	Transmitter unwanted emissions in the spurious domain	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.10 or 4.3.2.9	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.9)
G4.13	Receiver spurious emissions	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.11 or 4.3.2.10	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.10)
G4.14	Receiver Blocking	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.12 or 4.3.2.11	(Test as per ETSI EN 300 328 V2.2.2 (2019-07)clause 5.4.11.2)

S. No.	Parameter Name	Standard/ Parameter	Applicability/Limits/ Values	Remarks
G4.15	Geo-location capability	ETSI EN 300 328 V2.2.2 (2019-07)	As per ETSI EN 300 328 V2.2.2 (2019-07) clause 4.3.1.13 or 4.3.2.12 *(Only for equipment with geo-location capability)*	

Annexure-G5 LoRa/ SigFox/ RFID / RF Mesh working in frequency band 865 MHz to 867 MHz

S. No.	Parameter Name	Standard/ Parameter	Applicability/Limits/ Values	Remarks
G5.1	Frequency of Operation of Interface	Latest NFAP Annexure-1	865 MHz to 867 MHz (As per WPC GSR 564(E))	
G5.2	EIRP for Interface	ETSI EN 300 220-2 V3.2.1 (2018-06)	< 4 W As per WPC GSR 564 (E)	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.2.2
G5.3	Maximum Transmit Power	ETSI EN 300 220-2 V3.2.1 (2018-06)	< 1 W As per WPC GSR 564 (E)	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.2.2
G5.4	Unwanted emissions in the spurious domain	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.2.2	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.9.3

S. No.	Parameter Name	Standard/ Parameter	Applicability/Limits/ Values	Remarks
G5.5	TX effective radiated power	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.1	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.2.2
G5.6	TX Maximum e.r.p spectral density	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.2 *(Applies to EUT using annex B bands I, L. Applies to EUT using DSSS or wideband techniques other than FHSS modulation, using annex C band X.)*	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.3.2
G5.7	TX Duty cycle	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.3 *(Not applicable to EUT with polite spectrum access where permitted in annex B, table B.1 or annex C, table C.1 or any NRI.)*	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.5.2
G5.8	TX Occupied bandwidth / Carrier bandwidth	ETSI EN 300 220-2 V3.2.1 (2018-06)	200 KHz (As per GSR 564 (E)) (Ref : ETSI EN 300 220-2 V3.2.1 clause 4.3.4)	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.6.3
G5.9	TX out of band emissions	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.5 *(Applies to EUT with OCW > 25 kHz.)*	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.8.3
G5.10	TX Transient	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.6	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.10.3
G5.11	TX Adjacent channel power	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.7 *(Applies to EUT with OCW ≤ 25 kHz)*	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.11.3

S. No.	Parameter Name	Standard/ Parameter	Applicability/Limits/ Values	Remarks
G5.12	TX behaviour under low voltage conditions	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.8 *(Applies to battery powered EUT.)*	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.12.3
G5.13	TX Adaptive power control	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.9 (*Applies to EUT with adaptive power control using annex C band AA.*)	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.13.3
G5.14	TX FHSS	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.10 *(Applies to FHSS EUT)*	Declaration to be made by Manufacturer as per ETSI EN 300 220-2 V3.1.1 clause 4.3.10.3
G5.15	TX Short term behaviour	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.3.11 (*Applies to EUT using annex C bands Y, Z, AA, AB, AC, AD*)	Test as per ETSI EN 300 220-1 clause 5.5.2
G5.16	RX sensitivity	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.4.1 *(Applies to EUT with polite spectrum access.)*	Test as per ETSI EN 300 220-1 clause 5.14.3
G5.17	Clear channel assessment threshold	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.5.2 *(Applies to EUT with polite spectrum access.)*	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.21.2.3
G5.18	Polite spectrum access timing parameters	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.5.3 *(Applies to EUT with polite spectrum access.)*	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.21.3.2
G5.19	RX Blocking	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.4.2	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.18.6

S. No.	Parameter Name	Standard/ Parameter	Applicability/Limits/ Values	Remarks
G5.20	Adaptive Frequency Agility	ETSI EN 300 220-2 V3.2.1 (2018-06)	As per ETSI EN 300 220-2 V3.2.1 clause 4.5.4 *(Applies to EUT with AFA.)*	Test as per ETSI EN 300 220-1 V3.1.1 clause 5.21.4

Annexure-G6 RFID/ NFC working in frequency bands 50KHz to 200KHz or 13.553 MHz to 13.567MHz

S. No.	Parameter Name	Standard/ Paramete r	Applicability/Limits/ Values	Remarks
G6.1	Frequency of Operation of Interface	Latest NFAP Annexure-1	50KHz to 200KHz (As per WPC GSR 90 (E)) And / OR 13.553 MHz to 13.567MHz (As per WPC GSR 884(E))	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.2.
G6.2	Permitted range of operating frequencies	Latest NFAP Annexure-1	50KHz to 200KHz And / OR 13.553 MHz to 13.567MHz	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.1, the permitted range of operating frequencies used by the EUT shall be declared by the manufacturer.
G6.3	Modulation bandwidth	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.3	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.3.
G6.4	Transmitter H-field requirements	ETSI EN 300 330 V2.1.1 (2017-02)	50KHz to 200KHz (As per WPC GSR 90 (E)) OR 13.553 MHz to 13.567MHz (As per WPC GSR 884(E))	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.4.

S. No.	Parameter Name	Standard/ Paramete r	Applicability/Limits/ Values	Remarks
			(Ref: ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.4)	
G6.5	Transmitter RF carrier current	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.5 *(Only for equipment under class 3 in clause 6.1.2)*	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.5.
G6.6	Transmitter radiated E-field	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.6 *(Only for equipment under class 3 in clause 6.1.2)*	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.6.
G6.7	Transmitter conducted spurious emissions	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.7 *(Only for equipment under class 3 in clause 6.1.2)*	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.7.
G6.8	Transmitter radiated spurious domain emission limits < 30 MHz	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.8	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.8.
G6.9	Transmitter radiated spurious domain emission limits > 30 MHz (NA)	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.9 *(For equipment under class 1, 2 and 4 in clause 6.1.2)*	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.9
G6.10	Transmitter Frequency stability	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.3.10 *(Only for channelized systems)*	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.2.10
G6.11	Receiver spurious emissions	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.4.2 *(Does only apply to receivers which a not co-located with*	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.3.1

S. No.	Parameter Name	Standard/ Paramete r	Applicability/Limits/ Values	Remarks
			transmitters)	
G6.12	Adjacent channel selectivity	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.4.3 *(Only for channelized systems in clause 4.4.1)*	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.3.2
G6.13	Receiver blocking or desensitization	ETSI EN 300 330 V2.1.1 (2017-02)	As per ETSI EN 300 330 V2.1.1 (2017-02) clause 4.4.4 *(Not for tagging systems in clause 4.4.1)*	Test as per ETSI EN 300 330 V2.1.1 (2017-02) clause 6.3.3

Annexure-H: Ethernet Interface Parameters Parameter Group: Ethernet Interface (INTETH)

Note: DUT needs to be tested only for those interface ranges (SR, LR, ER, FR, etc) which are mentioned in the Bill of Materials (BOM) submitted by applicant.

The new additional proposed ranges have been highlighted below

S.No.	Interface Name	Parameter Name	Standard	Limits / Values	Applicability / Remarks
H.1	Gigabit Ethernet Electrical or 10 100 1000 Base T Ethernet	Link Speed and Auto Negotiation GE	IEEE 802.3		Appendix-II, Test 4
H.2	Fast Ethernet Electrical or 10/100 Base T Ethernet	Link Speed and Auto Negotiation GE	IEEE 802.3		Appendix-II, Test 4
H.3	Gigabit Ethernet Optical	Average Launch Power for 1 GE Opt	clause 38.3.1 Transmitter optical specifications of IEEE 802.3 2018 Sec-3, Short Haul	Max shall be lesser of hazard level 1 safety limit as def by 38.7.2 or avg receive power (max) def by table 38-4 Min = -9.5 dBm	
			clause 38.4.1 Transmitter optical specifications of IEEE 802.3 2018 Section-3, Long Haul	Max = -3 dBm Min = -11.5 dBm for 62.5 µm MMF, - 11.5 dBm for 50 µm MMF, - 11.0 dBm for SMF	
H.4	Gigabit Ethernet Optical	Wavelength for 1 GE opt	IEEE 802.3z CL.38, Short Haul	770 – 860 nm	
			IEEE 802.3z CL.38, Long Haul	1270 – 1355 nm	
H.5	Gigabit Ethernet Optical	Receiver Sensitivity for 1 GE Opt	clause 38.3.2 Receiver optical specifications of IEEE 802.3 2018 Section-3, short haul	-17 dBm	
			38.4.2, long haul	-19 dBm	
H.6	10 Gigabit Ethernet Optical	Wavelength for 10 GE Int	IEEE 802.3ae Cl 52, Short Haul	840 - 860 nm	
			IEEE 802.3ae Cl 52, Long Haul	1260 – 1355 nm	
			IEEE 802.3 2018, ER	1530 – 1565 nm	
H.7	10 Gigabit Ethernet	Receiver	table 52-9 for SR, 52-13 for LR	-11.1 dBm	

	Optical	Sensitivity for 10 GE Int	and 52-17 for ER of IEEE 802.3ae		
			specifications, SR		
			LR	-12.6 dBm	
			ER	-14.1 dBm	
H.8	10 Gigabit Ethernet Optical	Average Launch Power for 10 GE Opt	table 52-7 for SR, 52-12 for LR and 52-16 for ER of IEEE 802.3ae specifications, Short Haul	Max shall be lesser of the hazard level 1 safety limit as def by 52.10.2 or the avg receive power(max) def by table 52-9 Min = -7.3 dBm	
			Long Haul	Max = 0.5 dBm Min = -8.2 dBm	
			ER	Max = 4.0 dBm Min = -4.7 dBm	
H.9	40 Gigabit Ethernet Optical	Average Launch Power for 40 GE Opt	Table 86-6 for SR4 and 87-7 for LR4, ER4 of IEEE 802.3ba specifications, SR4	Max = 2.4 dBm Min = -7.6 dBm	
			IEEE 802.3ba LR4	Max = 2.3 dBm Min = -7 dBm	
			IEEE 802.3ba ER4	Max=4.5 dBm Min=-2.7 dBm	
H.10	40 Gigabit Ethernet Optical	Wavelength for 40 GE opt	IEEE 802.3ba, SR4	840 – 860 nm	
			IEEE 802.3ba, LR4, ER4	1264.5 to 1277.5 nm 1284.5 to 1297.5 nm 1304.5 to 1317.5 nm 1324.5 to 1337.5 nm	
H.11	40 Gigabit Ethernet Optical	Receiver Sensitivity for 40 GE Opt	Table 86-8 for SR4 and 87-8 for LR4 of IEEE 802.3ba specifications, SR4	-5.4 dBm	
			LR4	-11.5 dBm	
			ER4	-19 dBm	
H.12	100 Gigabit Ethernet Optical	Average Launch Power for 100 GE Opt	Table 86-6 for SR10, 88-7 for LR4/ER4 of IEEE 802.3ba specifications, SR10	Max = 2.4 dBm Min = -7.6 dBm	
			SR4	Max = 2.4dBm Min = -8.4dBm	Table 95-6 of IEEE Std 802.3-2022

			LR4	Max = 4.5 dBm Min = -4.3 dBm	
			ER4	Max=2.9 dBm Min=-2.9 dBm	.
			FR1, Table 140.6 of IEEE 802.3cu	Min = -3.1dBm, Max= 4 dBm	
H.13	100 Gigabit Ethernet Optical	Wavelength for 100 GE Opt	IEEE 802.3ba, SR10	840 – 860 nm	
			SR4	840 to 860 nm	Table 95-6 of IEEE Std 802.3-2022
			LR4/ER4	1294.53 to 1296.59 nm 1299.02 to 1301.09 nm 1303.54 to 1305.63 nm 1308.09 to 1310.19 nm	Test may be carried out against any of the specified wavelength range
			FR1, Table 140.6 of IEEE 802.3cu	1304.5 to 1317.5 nm	
H.14	100 Gigabit Ethernet Optical	Receiver Sensitivity for 100 GE Opt	Table 86-8 for SR10, 88-8 for LR4/ER4 of IEEE 802.3ba specifications, SR10	-5.4 dBm	
			SR4	-5.2 dBm (Stressed)	Table 95-7 of IEEE Std 802.3-2022
			LR4	-8.6 dBm	
			ER4	-21.4 dBm	
			FR1, Table 140.7 of IEEE 802.3cu	-4.5 dbm for TECQ<1.4dbm / -5.9dBm+TECQ for 1.4dB<=TECQ<=3.4dBm	
H.15	Fast Ethernet Optical	Average Launch Power for FE Opt	IEEE 802.3 (2018), 100BASE-LX10, Table 58-3 (Long Wavelength)	-8 dBm (Max.) -15 dBm (Min.)	
			IEEE 802.3 (2018), 100BASE-BX10 Table 58-5 (Bi-directional Long Wavelength)	-8 dBm (Max.) -14 dBm (Min.)	
H.16	Fast Ethernet Optical	Wavelength for FE opt	IEEE 802.3 (2018), 100BASE-LX10,	1260 to 1360 nm	

			Table 58-3 (Long Wavelength)		
			IEEE 802.3 (2018), 100BASE-BX10 Table 58-5 (Bi-directional Long Wavelength)	1480 to 1580 nm (100BASE-BX10-D) 1260 to 1360 nm (100BASE-BX10-U)	
H.17	Fast Ethernet Optical	Receiver Sensitivity for FE Opt	IEEE 802.3 (2018), 100BASE-LX10, Table 58-4 (Long Wavelength)	-25 dBm	
			IEEE 802.3 (2018), 100BASE-BX10 Table 58-6 (Bi-directional Long Wavelength)	-28.2 dBm	
H.18	25 Gigabit Ethernet Optical	Average Launch Power for 25 GE Opt	Table 114-6 for LR of IEEE 802.3- 2018	Max=2 dBm Min=-7 dBm	
			SR	Max = 2.4dBm Min = -8.4dBm	Table 95-6 as mentioned in Section 112.6.1 of IEEE Std 802.3-2022
			ER	Max=6 dBm Min=-3 dBm	
H.19	25 Gigabit Ethernet Optical	Wavelength for 25 GE Opt	LR	1295-1325 nm	
			SR	840 to 860 nm	Table 95-6 as mentioned in Section 112.6.1 of IEEE Std 802.3-2022
			ER	1295-1310 nm	
H.20	25 Gigabit Ethernet Optical	Receiver Sensitivity for 25 GE Opt	LR	-12 dBm	
			SR	-5.2 dBm (Stressed)	Table 95-7 as mentioned in Section 112.6.2 of IEEE Std 802.3-2022
			ER	-19 dBm	
H.21	50 Gigabit Ethernet Optical	Average Launch	As per table 139.6 of IEEE 802.3cn,	Max = 3 dbm, Min = -4.1 dbm	
		Power for 50 GE Opt	FR		
			SR	Max=4dBm	Table-138-8 of IEEE

				Min=-6.5dBm	802.3-2022
			LR	Max = 4.2 dbm, Min = -4.5 dbm	
			ER	Max = 6.6 dbm, Min = 0.4 dbm	
H.22	50 Gigabit Ethernet Optical	Receiver Sensitivity for 50 GE Opt	As per table 139.7 of IEEE 802.3cn, FR	= max (–6.9, SECQ – 8.3) (dBm)	
			SR	= max (–6.5, SECQ – 7.9) (dBm)	Table-138-9 of IEEE 802.3-2022
			LR	= max (–8.4, SECQ – 9.8) (dBm)	
			ER	= max (–15.1, SECQ – 16.5) (dBm)	
H.23	50 Gigabit Ethernet Optical	Wavelength for 50 GE Opt	As per table 139.6 of IEEE 802.3cn SR	1304.5 to 1317.5 nm (for FR, LR & ER cases) 840 to 860 nm	Table-138-8 of IEEE 802.3-2022
H.24	200 Gigabit Ethernet Optical	Average Launch Power for 200 GE Opt	Table-121-6 for DR-4, 122-9 for LR4 and FR4 of IEEE 802.3cn , DR4 SR4 LR4 FR4	Max=3 dBm Min=-5.1 dBm Max=4dBm Min=-6.5dBm Max=5.3 dBm Min=-3.4 dBm Max=4.7dBm Min=-4.2 dBm	Table-138-8 of IEEE 802.3-2022
H.25	200 Gigabit Ethernet Optical	Wavelength for 200 GE Opt	DR4	1304.5 to 1317.5 nm	
			SR4	840 to 860 nm	Table-138-8 of IEEE 802.3-2022
			LR4	1294.53 to 1296.59 nm 1299.02 to 1301.09 nm 1303.54 to 1305.63 nm 1308.09 to 1310.19 nm	Test may be carried out against any of the specified wavelength range
			FR4	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 Units (nm) to be mentioned 1324.5 to 1337.5	Test may be carried out against any of the specified wavelength range

H.26	200 Gigabit Ethernet Optical	Receiver Sensitivity for 200 GE Opt Average launch power, each lane(max)	DR4	max(-6.1,SECQ -7.5) dBm [ref-Equation (121-13)]	
			SR4	= Max(–6.5, SECQ – 7.9)	Table 138-9 IEEE 802.3-2022
			LR4	max(-7.2,SECQ -8.6) dBm [ref-Equation (122-2)]	
			FR4	max(-5.5,SECQ -6.9) dBm [ref-Equation (122-1)]	
H.27	400 Gigabit Ethernet Optical	Average Launch Power for 400 GE Opt Average launch power, each lane	Table-124-6 for DR-4, 122-10 for LR8 and FR8 of IEEE 802.3cn , DR4	Max=4 dBm Min=-2.9 dBm	
			SR8	Max=4dBm Min=-6.5dBm	Table-138-8 of IEEE 802.3-2022
			LR8	Max=5.3 dBm Min=-2.8 dBm	
			FR8	Max=5.3 dBm Min=-3.5 dBm	
H.28	400 Gigabit Ethernet Optical	Wavelength for 400 GE Opt	Table-124-6 for DR4, 122-10 forLR8 and FR8, DR4	1304.5 to 1317.5 nm	
			SR8	840 to 860 nm	Table-138-8 of IEEE 802.3-2022
			LR8 and FR8	1272.55 to 1274.54 nm 1276.89 to 1278.89 nm 1281.25 to 1283.27 nm 1285.65 to 1287.68 nm 1294.53 to 1296.59 nm 1299.02 to 1301.09 nm 1303.54 to 1305.63 nm 1308.09 to 1310.19 nm	Test may be carried out against any of the specified wavelength range
H.29	400 Gigabit Ethernet Optical	Receiver Sensitivity for 400 GE Opt	DR4	max(-3.9,SECQ -5.3) dBm [ref-Equation (124-1)]	
			SR8	= Max(–6.5, SECQ – 7.9)	Table 138-9 IEEE 802.3-2022
			LR8	max(-6.6,SECQ -8) dBm [ref-Equation (122-5)]	
			FR8	max(-4.8,SECQ -6.2) dBm [ref-Equation (122-4)	

ANNEXURE-H2: Technical Requirements of Hypervisor

Parameter Group: Hypervisor

S. No.	Parameter Name	Standard / Parameter	Test Specifications	Remarks
H2.1	Resiliency	OPNFV Release 2019.12 (Clause 8.1.1)	OpenStack Services HA test specifications	As per acceptable Limits defined under OPNFV Release 2019.12
H2.2	Resiliency	OPNFV Release 2019.12 (Clause 8.1.4)	Stress Test Specification	
H2.3	Role Based Access Control	OPNFV Release 2019.12 (Clause 8.1.2)	Patrole Tempest Tests	
H2.4	Role Based Access Control	OPNFV Release 2019.12 (Clause 8.1.3)	Patrole Tempest Tests Depend on Vxlan	
H2.5	Role Based Access Control	OPNFV Release 2019.12 (Clause 8.1.6)	Tempest Identity v3 test specification	
H2.6	Scheduling	OPNFV Release 2019.12 (Clause 8.1.9)	VM Resource Scheduling on Multiple Nodes test specification	
H2.7	Image Services	OPNFV Release 2019.12 (Clause 8.1.7)	Tempest Image test specification	
H2.8	Network Security Group	OPNFV Release 2019.12 (Clause 8.1.5)	Tempest Compute test specification	
H2.9	Interoperability	OPNFV Release 2019.12 (Clause 8.1.13)	OpenStack Interoperability test specification	
H2.10	Networking	OPNFV Release 2019.12 (Clause 8.1.8)	IPv6 test specification	
H2.11	Networking	OPNFV Release 2019.12 (Clause 8.1.10)	Tempest Network API test specification	
H2.12	Networking	OPNFV Release 2019.12 (Clause 8.1.11)	Tempest Network Scenario test specification	
H2.13	Networking	OPNFV Release 2019.12 (Clause 8.1.14)	Neutron Trunk Port Tempest Tests	
H2.14	Networking	OPNFV Release 2019.12 (Clause 8.1.16)	Tempest Volume test specification	
H2.15	Networking	OPNFV Release 2019.12 (Clause 8.1.18)	Vping test specification	
H2.16	Networking	OPNFV Release 2019.12 (Clause 8.1.19)	VPN test specification	
H2.17	Life Cycle Events	OPNFV Release 2019.12 (Clause 8.1.15)	Common virtual machine life cycle events test specification	

Annexure-I: PDH Interface Parameters

Parameter Group: PDH Interface (INTPDH)

S. No.	Interface Name	Parameter Name	Standard/ Parameter	Limits/ Values	Applicability/ Remarks
I.1	2Mbps-E1	Input Jitter Tolerance for 2 Mbps Int	G.823 / ETSI TBR-4	Fig 13,Clause No.-7.1.2	
I.2	2Mbps-E1	Input Return Loss for 2 Mbps Int	G.703 / ETSI TBR-4 Cl. 9.3.1	51 to 102 (kHz)-12dB 102 to 2048(kHz)-18dB 2048 to 3072(kHz)-14dB	
I.3	2Mbps-E1	Nominal Bit Rate with Tolerance 2 Mbps Int	G.703 / ETSI TBR-4 Cl. 9.2.3	2048Kbps	
I.4	2Mbps-E1	Output Jitter for 2 Mbps Int	G.823 / ETSI TBR-4	20 to 100 kHz -1.5(UIpp) 18 k to 100kHz-0.2(UIpp)	
I.5	2Mbps-E1	Pulse Mask for 2 Mbps Int	G.703/ ETSI TBR-4	Figure 11-1,clause-11.2	
I.6	ISDN PRI	Input Jitter Tolerance for PRI	G.823, I.431, ETSI TBR-4		
I.7	ISDN PRI	Input Return Loss for PRI	G.703, Cl. 11.3, ETSI TBR-4 Cl. 9.3.1		
I.8	ISDN PRI	Bit Rate Tolerance PRI	G.703, Cl. 11.1, ETSI TBR-4 Cl. 9.2.3		
I.9	ISDN PRI	Output Jitter for PRI	G.823, I.431, ETSI TBR-4		
I.10	ISDN PRI	Pulse Mask for PRI	G.703, Cl. 11.2, ETSI TBR-4 Cl. 9.2.1		
I.11	8Mbps-E2	Input Jitter Tolerance for 8 MBPS Int	G.823	Fig 14 , clause 7.1.3	
I.12	8Mbps-E2	Input Return Loss for 8 MBPS Int	G.703	211 to 422(KHz)-12dB 422 to 8448(KHz)-18dB 8448 to 12 672(KHZ)-14dB	
I.13	8Mbps-E2	Nominal Bit Rate with Tolerance 8 MBPS Int	G.703	8448 kbit/s	

S. No.	Interface Name	Parameter Name	Standard/ Parameter	Limits/ Values	Applicability/ Remarks
I.14	8Mbps-E2	Output Jitter for 8 MBPS Int	G.823	20 to 400 kHz -1.5(UIpp) 3 k to 400 kHz-0.2(UIpp)	
I.15	8Mbps-E2	Pulse Mask for 8 MBPS Int	G.703	Figure 12-1,clause-12.2	
I.16	34Mbps-E3	Input Jitter Tolerance for 34 Mbps Int	G.823	Fig 15 clause-7.1.4	
I.17	34Mbps-E3	Input Return Loss for 34 Mbps Int	G.703	860 to 1720(kHz)-12dB 1720 to 34 368(kHz)-18dB 34 368 to 51 550 (kHz)-14dB	
I.18	34Mbps-E3	N Nominal Bit Rate with Tolerance 34 Mbps Int	G.703	34 368 kbit/s	
I.19	34Mbps-E3	Output Jitter for 34 Mbps Int	G.823	100 to 800 kHz -1.5(UIpp) 10 k to 800 kHz-0.15(UIpp)	
I.20	34Mbps-E3	Pulse Mask for 34 Mbps Int	G.703	Figure 13-1,clause-13.2	
I.21	64 Kbps	Input Jitter Tolerance for 64 KBPS Int	G.823	Figure 12, clause-7.1.1	
I.22	64 Kbps	Input Return Loss for 64 KBPS Int	G.703	4 to 13(KHz)-12dB 13 to 256(KHz)-18dB 256 to 384(KHz)-14dB	
I.23	64 Kbps	Nominal Bit Rate with Tolerance 64 KBPS Int	G.703	64 kbit/s	
I.24	64 Kbps	Output Jitter for 64 KBPS Int	G.823	20 to 20 k -0.25(UIpp) 3 k to 20 kHz-0.05(UIpp)	
I.25	64 Kbps	Pulse Mask for 64 KBPS Int	G.703	Figure 6-5,clause-6.2.1.2	
I.26	N X 64 Kbps	Input Jitter Tolerance for NX64 KBPS Int	G.823, ETSI TBR-4 Cl. 9.3.3	Figure 12, clause-7.1.1	
I.27	N X 64 Kbps	Input Return Loss for NX64 KBPS Int	G.703	4 to 13(KHz)-12dB	

S. No.	Interface Name	Parameter Name	Standard/ Parameter	Limits/ Values	Applicability/ Remarks
				13 to 256(KHz)-18dB 256 to 384(KHz)-14dB	
I.28	N X 64 Kbps	Nominal Bit Rate with Tolerance NX64 KBPS Int	G.703	64 kbit/s	
I.29	N X 64 Kbps	Output Jitter for NX64 KBPS Int	G.823, I.431, ETSI TBR-4 Cl. 9.2.4	20 to 20 k -0.25(UIpp) 3 k to 20 kHz-0.05(UIpp)	
I.30	N X 64 Kbps	Pulse Mask for NX64 KBPS Int	G.703	Figure 6-5,clause-6.2.1.2	
I.31	45Mbps	Input Jitter Tolerance for 45 Mbps Int	G.824	Fig-9, clause—7.2.4	
I.32	45Mbps	-DC power	G.703	No DC power	
I.33	45Mbps	Nominal Bit Rate with Tolerance 45 Mbps Int	G.703	44 736 kbit/s	
I.34	45Mbps	Output Jitter for 45 Mbps Int	G.824	10 to 400kHz -5.0(UIpp) 30k to 400kHz -0.1(UIpp)	
I.35	45Mbps	Pulse Mask for 45 Mbps Int	G.703	Fig 10-1 , clause 10	
I.36	140Mbps-E4	Input Jitter Tolerance for 140 MBPS Int	G.703, ETSI TBR-4 Cl. 9.3.1	≥15 dB over frequency range 7 MHz to 210 MHz	
I.37	140Mbps-E4	Input Return Loss for 140 MBPS Int	G.703, ETSI TBR-4 Cl. 9.2.3	139264 kbit/s	
I.38	140Mbps-E4	Nominal Bit Rate with Tolerance 140 MBPS Int	G.823	200 to 3.5 MHz - 1.5(UIpp) 10 k to 3.5 MHz - 0.0755 (UIpp)	
I.39	140Mbps-E4	Output Jitter for 140 MBPS Int	G.703, ETSI TBR-4 Cl. 9.2.1	Fig 14.1,14.2 clause-14.2	
I.40	140Mbps-E4	Pulse Mask for 140 MBPS Int	G.703		
I.41	10 MBPS	Min Peak Voltage for 10 MHz Int	G.703		
I.42	10 MBPS	Max Peak Voltage for 10 MHz Int	G.823 , ETSI TBR-4	Fig 13,Clause No.-7.1.2	

Annexure-J1: xDSL Interface Parameters

Parameter Group: DSL Interface (INTDSL)

S. No.	Interface Name	Parameter Name	Standard	Limit/Value	Remarks
J1.1	ADSLx	Loop resistance for ADSLx	ETSI EN 300 001 Table 2.3		
J1.2	ADSLx	PSD for ADSLx Int	ITU G.992.2 Annex-II OR, G.992.1(anne- A) OR, G.992.3 OR, G.992.5.		
J1.3	ADSLx	Bit Rate for ADSLx Int	ANSI T1.413- Issue 2 OR, ITU G.992.2 OR, ITU G.992.1 OR, ITU G.992.1 Annex A OR, ITU G.992.1 Annex B OR, ITU G.992.3 Annex L OR, ITU G.992.3 OR, ITU G.992.4 OR, ITU G.992.5 OR, ITU G.992.5 Annex M.		
J1.4	ADSLx	Insulation Test for ADSLx Int	ETSI EN 300 001 Cl. 2.2 OR G.992.3		
J1.5	ADSLx	Impulse Noise Protection for ADSLx Int	G.992.3 Appendix V	Better than 2	
J1.6	ADSLx	Transmitted Power At ATU-C for ADSLxInt	G.992.3 Annexure-P		
J1.7	ADSLx	Line Port impedance for ADSLxInt	G.992.3		
J1.8	VDSLx	Insulation Test for VDSLx Int	ETSI EN 300 001		
J1.9	VDSLx	Loop resistance for VDSLx	ETSI EN 300 001		

J1.10	VDSLx	Profiles for VDSLx	G.993.1 OR G.993.2 Cl. 7.2		
J1.11	VDSLx	Return Loss for VDSLx	G.993.1 Cl. 6.5 OR G993.2		
J1.12	VDSLx	PSD for VDSLxInt	G.993.1 Cl. 6.2 OR G.993.2 Cl. 7.2		
J1.13	VDSLx	Line Port impedance for VDSLxInt	G.993.1 OR G993.2		
J1.14	VDSLx	Transmitted Power At ATU-C for VDSLxInt	G.993.1 OR G993.2		
J1.15	VDSLx	Bit Rate for VDSLxInt	G.993.1 OR G993.2		
J1.16	G.FAST	PPPoE for G.FAST Int	RFC 2516 Functional Test		Annex-P11
J1.17	G.FAST	PVC Support for G.FAST Int	G.9700		
J1.18	G.FAST	VPI-VCI Support for G.FAST Int	G.9700		
J1.19	G.FAST	Loop Resistance for G.FAST IntSLx	ETSI EN 300 001		
J1.20	G.FAST	Insulation Test for G.FAST Int	G.9700		
J1.21	G.FAST	Impulse Noise Protection for G.FAST Int	G.9700		
J1.22	G.FAST	Throughput Test for G.FAST Int	G.9700		
J1.23	G.FAST	Profiles for G.FAST Int	G.9700		
J1.24	G.HN	Profiles for G.HN Int	G.9960		
J1.25	G.HN	PSD for G.HN	G.9964		
J1.26	SHDSL	PSD for SHDSL Int	G.991.2 Annex B	<-30dBm	
J1.27	SHDSL	Return Loss for SHDSL	G.991.2 Annex B	Min 14dB over frequency band of 20KHz to 2MHz at input/output of interface	
J1.28	SHDSL	Transmitted Power for SHDSL Int	G.991.2 Annex B	+14.5+/-0.5dBm for data rate >2048kb/s +13.5+/-0.5dBm for data rate <2048kb/s	
J1.29	SHDSL	Insulation Resistance for SHDSL int	G.991.2	>5 M Ohm	
J1.30	SHDSL	Throughput for SHDSL Interface	G.991.2	64Kbps to 2048Kbps	
J1.31	SHDSL	LCL for SHDSL Interface	G.991.2	>40dB over frequency range	SHDSL interface

			Annex B	of 5KHz to 2MHz	having a metallic termination of 135 ohm and a longitudinal termination of 33.8ohm
J1.32	MG.FAST	Differential port impedance for MG.FAST Int	G.9711	Ratio at different interval satisfy <0.20	Clause 14.2
J1.33	MG.FAST	Longitudinal conversion loss for MG.FAST Int	G.9711	greater than or equal to 38 dB in the frequency band up to 12 MHz.	Clause 14.1.1
J1.34	MG.FAST	Loop Resistance for MG.FAST Int	EN 300 001.		
J1.35	MG.FAST	PSD for MG.FAST Int	G.9710.		
J1.36	MG.FAST	Profiles for MG.FAST Int	G.9711		Clause 6.0, Table-P1 of G.9711
J1.37	MG.FAST	Throughput Test for MG.FAST Int	G.9711	an aggregate (sum of upstream and downstream) data rate of up to 8 Gbit/s;	

Annexure-J2: PON Interface Parameters

Parameter Group: PON Interface (INTPON)

S. No.	Interface Name	Parameter Name	Standard/ Parameter	Limits/Values	Remarks
J2.1	GPON	Operating Wavelength in downstream direction for for GPON Int	G.984.2 Cl. 8.2.5.1	DS 1480-1500nm	
J2.2	GPON	Operating Wavelength in upstream direction for GPON Int	G.984.2 Cl. 8.2.5.2	US 1260-1360nm (Class B/B+) or 1290-1330nm (Class C/C+/D)	
J2.3	GPON	Opt Output Power for GPON Int at OLT	G.984.2	0 to +4dBm (A) +5.0 to +9.0 dBm (B) +1.5 to +5.0 dBm (B+) +3.0 to +7.0 dBm (C/C+) +6.0 to +10.0 dBm (D) A,B,B+,C,C+ and 'D' are classes of optical link budget for PON Measured at 1490nm at OLT 's PON port i.e. Rx or D/L mode. Refer following Tables of ITU-T G.984.2: (1) Table 2c & Table 2f1 for Class A, Class B, Class C (2) Table A.1 for Class B+ (3) Table V.1 for Class C+, (4) Table V.2 for Class D	**Note:** Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also.
J2.4	GPON	Opt Output Power for GPON Int at ONT	G.984.2	-3.0 to +2.0dBm (A) -2.0 to +3.0 dBm (B) +0.5 to +5.0 dBm (B+) +2.0 to +7.0 dBm (C) +0.5 to +5.0 dBm (C+) +0.5 to +5.0 dBm (D) A,B,B+,C,C+ and 'D' are classes of optical link budget for PON Measured at 1490nm at OLT 's PON port	

				i.e. Rx or D/L mode. Refer following Tables of ITU-T G.984.2: (1) Table 2c & Table 2f1 for Class A, Class B, Class C (2) Table A.1 for Class B+ (3) Table V.1 for Class C+, (4) Table V.2 for Class D	
J2.5	GPON	Receiver Sensitivity for GPON Int at OLT	G.984.2	-24dBm(minimum) (A) -28 dBm(minimum) (B/B+) -29 dBm(minimum) (C) -32 dBm(minimum) (C+) -35 dBm(minimum) (D) A,B,B+,C,C+ and 'D' are classes of optical link budget for PON Measured at 1490nm at OLT 's PON port i.e. Rx or D/L mode. Refer following Tables of ITU-T G.984.2: (1) Table 2c & Table 2f1 for Class A, Class B, Class C (2) Table A.1 for Class B+ (3) Table V.1 for Class C+, (4) Table V.2 for Class D	**Note:** Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also.

J2.6	GPON	Receiver Sensitivity for GPON Int at ONT	G.984.2	-21dBm(minimum) (A) -21 dBm(minimum) (B) -27 dBm(minimum) (B+) -28 dBm(minimum) (C) -30 dBm(minimum) (C+) -30 dBm(minimum) (D) A,B,B+,C,C+ and 'D' are classes of optical link budget for PON Measured at 1490nm at OLT 's PON port i.e. Rx or D/L mode. Refer following Tables of ITU-T G.984.2: (1) Table 2c & Table 2f1 for Class A, Class B, Class C (2) Table A.1 for Class B+ (3) Table V.1 for Class C+, (4) Table V.2 for Class D	
J2.7	GPON	Protocol Test for GPON Int	G.984.x	Refer List-1	
J2.8	EPON	Operating Wavelength in downstream direction for EPON Int	IEEE 802.3ah	DS 1480 -1500 nm Refer TEC GR on EPON(2019)	
J2.9	EPON	Operating Wavelength in upstream direction for EPON Int	IEEE 802.3ah	US 1260-1360 nm Refer TEC GR on EPON(2019)	
J2.10	EPON	Opt Output Power for EPON Int at OLT	IEEE 802.3ah	+2 dbm to +7dbm Refer TEC GR on EPON(2019)	**Note:** Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also.
J2.11	EPON	Opt Output Power for EPON Int at ONT	IEEE 802.3ah	-1 dbm to +4dbm Refer TEC GR on EPON(2019)	
J2.12	EPON	Receiver Sensitivity for EPON Int at OLT	IEEE 802.3ah	-27dbm(minimum)(for 1000Base-PX20-D) -30dbm(minimum)(1000Base-PX20E- D) Refer TEC GR on EPON(2019)	

J2.13	EPON	Receiver Sensitivity for EPON Int at ONT	IEEE 802.3ah	-24dbm(minimum)(for 1000Base-PX20-U) -27dbm(minimum)(1000Base-PX20E- U) Refer TEC GR on EPON(2019)	
J2.14	EPON	Protocol Test for EPON Int	IEEE 802.3ah. BBF-TR-201. Annex-J2	Refer List-5 Clause number 5.4, 5.5 and 8.2 of BBF-TR-201 (Using EPON in the Context of TR-101 Issue: 1 Corrigendum 1 Issue Date: July 2011)	
J2.15	XGPON	Operating Wavelength in downstream direction for XGPON Int	G.987.2	DS 1575 – 1580 nm	
J2.16	XGPON	Operating Wavelength in upstream direction for XGPON Int	G.987.2	US 1260 – 1280 nm	
J2.17	XGPON	Opt Output Power XGPON Int at OLT	G.987.2	+2.0 to +6.0 dBm (N1) +4.0 to +8.0 dBm (N2a) +10.0 to +12.5 dBm (N2b) +6.0 to +10.0 dBm (E1) +8.0 to +12.0 dBm (E2a) +14.5.0 to +16.5 dBm (E2b) N1, N2, E1 and E2 are classes of optical path loss. Refer following Table 9.3 of ITU-T G.987.2	**Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on**
J2.18	XGPON	Opt Output Power XGPON Int at ONT	G.987.2	+2.0 to +7.0 dBm (N1,N2,E1, E2) Refer following Table 9.4 of ITU-T G.987.2	

J2.19	XGPON	Receiver Sensitivity XGPON Int at OLT	G.987.2	-27.5dBm for (N1) -29.5dBm for (N2) -31.5dBm for (E1) -33.5dBm for (E2) Refer following Table 9.4 of ITU-T G.987.2	**MTCTE Certificate also**.
J2.20	XGPON	Receiver Sensitivity XGPON Int at ONT	G.987.2	-28.0dBm for (N1) -28.0dBm for (N2a) -21.5dBm for (N2b) -28.0dBm for (E1) -28.0dBm for (E2a) -21.5dBm for (E2b) Refer following Table 9.3 of ITU-T G.987.2	
J2.21	XGPON	Protocol test for XGPON Int	G.987.x	Refer List-2	
J2.22	XGSPON	Operating Wavelength in downstream direction XGSPON Int	G.9807.1	"DS i. 1575 – 1580 nm (Basic wavelength) ii. 1480 to 1500 nm (optional wavelength) XGS-PON systems come with two operating wavelength options Basic wavelength set: consists of XG-PON wavelength reuse, in which case the system has to accommodate both XGS-PON ONUs and legacy XG- PON ONUs Optional wavelength set: consists of G-PON wavelength reuse, for the operators having no legacy Gigabit PON in the deployment area Refer ITU-T G.9807.1"	

J2.23	XGSPON	Operating Wavelength in upstream direction XGSPON Int	G.9807.1	"US i. 1260 – 1280 nm (Basic wavelength) ii. 1300 to 1320 nm (optional wavelength) XGS-PON systems come with two operating wavelength options Basic wavelength set: consists of XG-PON wavelength reuse, in which case the system has to accommodate both XGS-PON ONUs and legacy XG- PON ONUs Optional wavelength set: consists of G-PON wavelength reuse, for the operators having no legacy Gigabit PON in the deployment area Refer ITU-T G.9807.1"	
J2.24	XGSPON	Opt Output Power XGSPON Int at OLT	G.9807.1	+2.0 to +5.0 dBm (N1) +4.0 to +7.0 dBm (N2) +6.0 to +9.0 dBm (E1) N1, N2 and E1 are classes of optical link budget for PON. Refer Table B.9.3 of standard ITU-T G.9807.1	**Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.25	XGSPON	Opt Output Power XGSPON Int at ONT	G.9807.1	+4.0 to +9.0 dBm (N1,N2,E1) Refer Table B.9.4 of standard ITU-T G.9807.1	
J2.26	XGSPON	Receiver Sensitivity XGSPON Int at OLT	G.9807.1	-26.0 dBm (N1) -28.0 dBm (N2) -30.0 dBm (E1) Refer Table B.9.4 of standard ITU-T G.9807.1	
J2.27	XGSPON	Receiver Sensitivity XGSPON Int at ONT	G.9807.1	-28dBm (N1, N2 and E1) Refer Table B.9.3 of standard ITU-T G.9807.1	

J2.28	XGSPON	Protocol Test for XGSPON Int	G.9807.x	Refer List-3	
J2.29	WDMPON	Operating Wavelength in upstream direction WDMPON Int	G.694.1 (G.989.2/p2p WDM)	US 1530nm-1560nm C-Band Refer TEC GR on WDM-PON(2017)	These are proprietary implementation
J2.30	WDMPON	Operating Wavelength in downstream direction WDMPON Int	G.694.1 (G.989.2/p2p WDM)	DS 1530nm-1560nm C-Band Refer TEC GR on WDM-PON(2017)	These are proprietary implementation
J2.31	WDMPON	Opt Output Power WDMPON Int at OLT	G.694.1 (G.989.2/p2p WDM)	+2.0 to +7.0 dBm Refer TEC GR on WDM-PON(2017)	These are proprietary implementation **Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.32	WDMPON	Opt Output Power WDMPON Int at ONT	G.694.1 (G.989.2/p2p WDM)	-2.0 to +2.0 dBm Refer TEC GR on WDM-PON(2017)	
J2.33	WDMPON	Receiver Sensitivity WDMPON Int at OLT	G.694.1 (G.989.2/p2p WDM)	-24.0 dBm Refer TEC GR on WDM-PON(2017)	
J2.34	WDMPON	Receiver Sensitivity WDMPON Int at ONT	G.694.1 (G.989.2/p2p WDM)	-17.0 dBm Refer TEC GR on WDM-PON(2017)	
J2.35	WDMPON	Throughput for WDMPON Int	RFC2544		These are proprietary implementation
J2.36	WDMPON	Protocol test for WDMPON Int	G.694.1 (G.989.x/p2p WDM)	Refer List -2	These are proprietary implementation

J2.37	NGNPON2	Operating Wavelength in downstream direction NGPON2Int	G.989.2	DS 1596 -1603 nm Refer ITU-T G.989.2	
J2.38	NGNPON2	Operating Wavelength in upstream direction NGPON2Int	G.989.2	US For TWDM PON 1524-1544nm for Wideband 1528-1540nm for Reduced band 1532-1540nm for Narrow band For PtP WDM PON 1524-1625nm for Expanded Spectrum 1603-1625nm for Shared spectrum Refer ITU-T G.989.2	
J2.39	NGNPON2	Opt Output Power NGPON2Int at OLT	G.989.2	For 2.48832 Gbit/s downstream Direction 0.0 to +4.0 dBm (N1) +2.0 to +6.0 dBm (N2) +4.0 to +8.0 dBm (E1) +6.0 to +10.0 dBm (E2) For 9.95328 Gbit/s downstream Direction +3.0 to +7.0 dBm (N1) +5.0 to +9.0 dBm (N2) +7.0 to +11.0 dBm (E1) +9.0 to +11.0 dBm (E2) N1, N2, E1 and E2 are classes of optical link budget for PON Refer following Table 11.4 & Table 11.5 of ITU-T G.989.2	**Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.

J2.40	NGNPON2	Opt Output Power NGPON2Int at ONT	G.989.2	For 2.48832 Gbit/s upstream Direction Type A link +4.0 to +9.0 dBm (N1,N2, E1, E2) Type B link 0 to +5.0 dBm (N1, N2, E1, E2) For 9.95328 Gbit/s upstream Direction Type A link +4.0 to +9.0 dBm (N1) +4.0 to +9.0 dBm (N2) +4.0 to +9.0 dBm (E1) NA (E2) Type B link +2.0 to +7.0 dBm (N1) +2.0 to +7.0 dBm (N2) +2.0 to +7.0 dBm (E1) +4.0 to +9.0 dBm (E2 Type A link values assume an unamplified OLT receiver Type B link values assume an amplified OLT receiver with the amplifier at the S/R-CG reference point Refer following Table 11.6 & Table 11.7 of ITU-T G.989.2	**Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.41	NGNPON2	Receiver Sensitivity NGPON2Int at OLT	G.989.2	For 2.48832 Gbit/s Type A link - 26.0 dBm (N1) -28.0 dBm (N2) -30.5 dBm (E1) -32.5 dBm(E2) Type B link	

S. No.	Interface Name	Parameter Name	Standard/ Parameter	Limits/Values	Remarks
				-30.0 dBm (N1) -32.0 dBm (N2) -34.5 dBm (E1) -36.5 dBm (E2) For 9.95328 Gbit/s Type A link - 26.0 dBm (N1) -28.0 dBm (N2) -30.5 dBm (E1) Type B link - 28.0 dBm (N1) -30.0 dBm (N2) -32.5 dBm (E1) -32.5 dBm (E2) Refer following Table 11.6 & Table 11.7 of ITU-T G.989.2	**Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.42	NGNPON2	Receiver Sensitivity NGPON2Int at ONT	G.989.2	For 2.48832 Gbit/s - 30.0 dBm (N1,N2, E1, E2) For 9.95328 Gbit/s - 28.0 dBm (N1,N2, E1, E2) Refer following Table 11.4 & Table 11.5 of ITU-T G.989.2	
J2.43	NGNPON2	Protocol Test for NGPON2Int	G.989.x	Refer list -4	

J2.44	RF Video	RF Video Output Bandwidth and Level		52-870 MHz, 14 dBmV	RF video interface over coaxial F connector
J2.45	10G- EPON	Operating Wavelength in downstream direction for 10G-EPON Int	IEEE 802.3av.	DS 1577nm, -2,+3nm	Refer Table Number 75-1 of IEEE 802.3 (2018).
J2.46	10G- EPON	Operating Wavelength in upstream direction for 10G-EPON Int	IEEE 802.3av.	1310± 50 nm(for PRX10/PRX20/PRX30 1Gbps US) ; or 1270± 10 nm(for 10Gbps US) Or 1310± 20 nm(for PRX40 1Gbps US)	Refer Table Number 75-1 of IEEE 802.3 (2018).
J2.47	10G- EPON	Opt Output Power for 10G-EPON Int at OLT	IEEE 802.3av.	+2.0 to +5.0 dBm (Power Class PR10/PRX10/PR30/PRX30) OR +5.0 to +9.0 dBm (Power Class PR20/PRX20/PR40/PRX40)	**Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**. Refer Table Number 75-5 of IEEE 802.3 (2018).
J2.48	10G- EPON	Opt Output Power for 10G-EPON Int at ONT	IEEE 802.3av.	-1.0 to +4.0 dBm (PR10/PR20) OR +4.0 to +9.0 dBm (PR30) OR +6.0 to +9.0 dBm (PR40) OR -1.0 to +4.0 dBm (PRX10/PRX20) OR +0.6 to +5.6 dBm (PRX30)	Refer Table Number 75-8 to 75-9 of IEEE 802.3 (2018).

				OR +2.0 to +6.0 dBm (PRX40).	
J2.49	10G- EPON	Receiver Sensitivity for 10G-EPON Int at OLT	IEEE 802.3av.	-24dBm (PR10/PRX10), OR -28dBm (PR20/PR30), OR -27dBm (PRX20), OR -29.8dBm (PRX30), OR -29dBm (PR40), OR -32dBm (PRX40),	Refer Table Number 75-6 to 75-7 of IEEE 802.3 (2018). **Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.50	10G- EPON	Receiver Sensitivity for 10G-EPON Int at ONT	IEEE 802.3av.	-20.5 dBm (Power Class PR10/PRX10/PR20/PRX20) OR -28.5 dBm (Power Class PR30/PRX30) OR -29.5 dBm (Power Class PR40/PX40)	Refer Table Number 75-10 of IEEE 802.3 (2018). **Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.51	10G-EPON Int	Protocol test for 10G-EPON Int	IEEE 802.3av. BBF-TR-201	Refer List 5 Clause number 5.4, 5.5 and 8.2 of BBF-TR-201 (Using EPON in the Context of TR-101 Issue: 1 Corrigendum 1 Issue Date: July 2011)	All the "Mandatory' parameters under Clause number 142.5, Cl 143.5 and Cl 144.5 of IEEE 802.3 (2018)
J2.52	Nx25G- EPON	Operating Wavelength in downstream direction for Nx25G-EPON Int	IEEE 802.3ca.	DS 1358 ± 2 nm, 1342 ± 2 nm. Note: one wavelength for 25Gbps and two wavelength for 50Gbps.	Note: OEM will support either 25Gbps or 50Gbps. Refer Table Number 141-2 to 141-5 of IEEE 802.3ca.

J2.53	Nx25G- EPON	Operating Wavelength in upstream direction for Nx25G-EPON Int	IEEE 802.3ca.	US 1270± 10 nm, 1300± 10 nm, 1320 ± 2. Note: one wavelength for 10/25Gbps and two wavelength for 50Gbps.	Note: OEM will support either 25Gbps or 50Gbps. Refer Table Number 141-2 to 141-5 of IEEE 802.3ca.
J2.54	Nx25G- EPON	Opt Output Power for Nx25G-EPON Int at OLT	IEEE 802.3ca.	Medium Power Class: +5.0 dBm (max) (for 25Gbps DS) OR +8.0 dBm (max) (for 50Gbps DS, +5.0 dBm(max) per channel); OR High Power Class: +7.8 dBm (max) (for 25Gbps DS) OR +10.8 dBm (max) (for 50Gbps DS; +7.8 dBm(max) per channel);	**Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**. Refer Table Number 141-15 to 141-16 of IEEE 802.3ca.
J2.55	Nx25G- EPON	Opt Output Power for Nx25G-EPON Int at ONT	IEEE 802.3ca.	Medium Power Class: +9.0 dBm (max) (for 10Gbps US) OR +7.0 dBm (max) (for 25Gbps US) OR +10.0 dBm (max) (for 50Gbps US; +7.0dBm (max) per channel); OR High Power Class: +9.0 dBm (max) (for 25Gbps US) OR +12.0 dBm (max) (for 50Gbps US; +9.0dBm (max) per channel);	**Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**. Refer Table Number 141-19 to 141-20 of IEEE 802.3ca.
J2.56	Nx25G- EPON	Receiver Sensitivity for Nx25G-EPON Int at OLT	IEEE 802.3ca.	Medium Power Class: -28.0 dBm (for 10Gbps US) OR -22.7 dBm per channel; OR	Refer Table Number 141-17 to 141-18 of IEEE 802.3ca. **Note: Testing of optical**

				High Power Class: -28.0 dBm (for 10Gbps US) OR -24.3 dBm per channel;	**class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.57	Nx25G- EPON	Receiver Sensitivity for Nx25G-EPON Int at ONT	IEEE 802.3ca.	Medium Power Class: -21.4 dBm per channel; OR High Power Class: -24.1 dBm per channel;	Refer Table Number 141-21 to 141-22 of IEEE 802.3ca. **Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.58	Nx25G-EPON Int	Protocol test for Nx25G-EPON Int	IEEE 802.3ca.	To be added	All the “Mandatory’ parameters under Clause number 76.5 and Cl 77.5 of IEEE 802.3(2018)
J2.59	MPX (GPON & XGPON)	Operating Wavelength in upstream direction	G.984.5. amendment-2. Annex-J2	Supports corresponding standard for GPON and XGPON.	
J2.60	MPX (GPON & XGPON)	Operating Wavelength in downstream direction MPX Int	G.984.5. amendment-2. Annex-J2	Supports corresponding standard for GPON and XGPON.	
J2.61	MPX (GPON & XGPON)	Opt Output Power MPX Int at OLT	G.984.5. amendment-2. Annex-J2	For GPON: +1.5 to +5.0 dBm (B+) OR +3.0 to +7.0 dBm (C+) OR +6.0 to +10.0 dBm (D). AND	Refer Table Number IV.2 of ITU-T G.984.5 (amendment 2). **Note: Testing of optical**

				For XGPON: +1.0 to +5.0 dBm (B+) OR +5.0 to +9.0 dBm (C+) OR +8.0 to +12.0 dBm (D)	**class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.62	MPX (GPON & XGPON)	Opt Output Power MPX Int at ONT	G.984.5. amendment-2. Annex-J2	Supports corresponding standard for GPON and XGPON.	
J2.63	MPX (GPON & XGPON)	Protocol test for MPX int	**ITU-T G.984.x. Annex-J2 and ITU-T G.987.x. Annex-J2**	Comply List-1 (GPON) and List-2(XGPON)	
S. No.	**Interface Name**	**Parameter Name**	**Standard/ Parameter**	**Limits/Values**	**Remarks**
J2.64	MPX (GPON & XGPON)	Receiver Sensitivity MPX Int at OLT	G.984.5. amendment-2. Annex-J2	For GPON: -28 dBm (Class B+) OR -32dBm (Class C+) OR -35dBm (Class D) AND For XGPON: -26.5 dBm (Class B+) OR -30.5 dBm (Class C+) OR -33.5 dBm (Class D)	Refer Table Number IV.2 of ITU-T G.984.5 (amendment 2). **Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.65	MPX (GPON & XGPON)	Receiver Sensitivity MPX Int at ONT	G.984.5. amendment-2. Annex-J2	Supports corresponding standard for GPON and XGPON.	

J2.66	MPS (GPON & XGS PON)	Operating Wavelength in Upstream direction MPS Int	G.984.5. amendment-2. Annex-J2	Supports corresponding standard for GPON and XGSPON.	
J2.67	MPS (GPON & XGS PON)	Operating Wavelength in Downstream direction MPS Int	G.984.5. amendment-2. Annex-J2	Supports corresponding standard for GPON and XGSPON.	
J2.68	MPS (GPON & XGS PON)	Opt Output Power MPS Int at OLT	G.984.5. amendment-2. Annex-J2	For GPON: +1.5 to +5.0 dBm (B+) OR +3.0 to +7.0 dBm (C+) OR +6.0 to +10.0 dBm (D). AND For XGSPON: +1.0 to +4.0 dBm (B+) OR +5.0 to +8.0 dBm (C+) OR +8.0 to +11.0 dBm (D)	Refer Table Number IV.2 of ITU-T G.984.5 (amendment 2). **Note: Testing of optical class (module) shall be limited to the one offered in the bill of material (BOM). And tested optical class shall be mentioned on MTCTE Certificate also**.
J2.69	MPS (GPON & XGS PON)	Opt Output Power MPS Int at ONT	G.984.5. amendment-2. Annex-J2	Supports corresponding standard for GPON and XGSPON.	
J2.70	MPS (GPON & XGS PON)	Protocol test for MPS int	**ITU-T G.984.x. Annex-J2 and ITU-T G.9807.x. Annex-J2**	Comply List-1(GPON) and List-3(XGSPON)	
J2.71	MPS (GPON & XGS PON)	Receiver Sensitivity MPS Int at OLT	G.984.5. amendment-2. Annex-J2	For GPON: -28 dBm (Class B+) OR -32dBm (Class C+) OR -35dBm (Class D) AND For XGSPON: -25 dBm (Class B+) OR -29 dBm (Class C+) OR -32 dBm (Class D)	Refer Table Number IV.2 of ITU-T G.984.5 (amendment 2). **Note: Testing of optical class (module) shall be limited to the one offered in the bill of material**

					(BOM). And tested optical class shall be mentioned on MTCTE Certificate also.
J2.72	MPS (GPON & XGS PON)	Receiver Sensitivity MPS Int at ONT	G.984.5. amendment-2. Annex-J2	Supports corresponding standard for GPON and XGSPON.	

Annexure-J3: PON Common Parameters

Parameter Group: PON Common (CONFPON)

S. No.	Parameter Name	Standard	Remarks
J3.1	DOS Prevention, SSH v1-2 for CLI in PON	ITU-T G.984.3 section V.2, IEEE 802.3ah (FOR EPON, 10FEPON, Nx25G EPON), G.987.2 (FOR XGPON), G.9807.1 (FOR XGSPON), G.694.1 (FOR WDMPON), G.989.2 (FOR NGPON2),SSH v2 RFC 4251.	The denied Traffic streams should not pass through the OLT.
J3.2	Frameloss of PON	RFC 2544.	Support a BER of better than or equal to 10^{-10} at the MAC service interface (or the frame loss ratio equivalent)
J3.3	Latency of PON	RFC 2544.	<1.5 ms one way for 20Km of distance. refer Table I.1/G.984.1
J3.4	MAC Address Learning and Aging Control OLT	G.984.1. (For GPON OLT), IEEE 802.3ah (FOR EPON OLT), G.987.2 (FOR XGPON OLT), G.9807.1 (FOR XGSPON OLT), G.694.1 (FOR WDMPON OLT), G.989.2 (FOR NGPON2 OLT) IEEE 802.3av (For 10G EPON OLT), IEEE 802.3ca (For Nx25G EPON) , IEEE 802.1Q (Testing Procedure) & 802.3	Yes/No
J3.5	MAC Address Limitation in PON	IEEE 802.3.	The data stream is received from only the number of streams specified.
J3.6	Inbuilt port/ MAC Based 802.1x Authentication in PON	IEEE 802.1x.	Authentication based on IEEE 802.1x shall be supported.
J3.7	MAC Learning Support at OLT	IEEE 802.3.	Yes/No

S. No.	Parameter Name	Standard	Remarks
J3.8	Maximum Bandwidth Limiting in PON	G.984.3 Section 7.5 (For GPON OLT), IEEE 802.3ah (FOR EPON OLT), G.987.2 (FOR XGPON OLT), G.9807.1 (FOR XGSPON OLT), G.694.1 (FOR WDMPON OLT), G.989.2 (FOR NGPON2 OLT) IEEE 802.3av (For 10G EPON OLT), IEEE 802.3ca (For Nx25G EPON)	max. 1Gbps (GPON)
J3.9	Minimum Guaranteed Bandwidth in PON	G.984.3 Section 7.5. (For GPON OLT), IEEE 802.3ah (FOR EPON OLT), G.987.2 (FOR XGPON OLT), G.9807.1 (FOR XGSPON OLT), G.694.1 (FOR WDMPON OLT), G.989.2 (FOR NGPON2 OLT) IEEE 802.3av (For 10G EPON OLT), IEEE 802.3ca (For Nx25G EPON)	minimum 512Kbps
J3.10	Minimum two classes of Classification in PON	G.984.3 Section 7.5. (For GPON OLT), IEEE 802.3ah (FOR EPON OLT), G.987.2 (FOR XGPON OLT), G.9807.1 (FOR XGSPON OLT), G.694.1 (FOR WDMPON OLT), G.989.2 (FOR NGPON2 OLT) IEEE 802.3av (For 10G EPON OLT), IEEE 802.3ca (For Nx25G EPON)	support of all TCONT-1, 2 ,3, 4 types.
J3.11	Password Based Authentication in PON	ITU-T G. 988, IEEE 802.3. Annex-J3	Password based authentication should be supported.
J3.12	Port-id Based VLAN Support at OLT	G.984.1 (For GPON OLT), IEEE 802.3ah (FOR EPON OLT), G.987.2 (FOR XGPON OLT), G.9807.1 (FOR XGSPON OLT), G.694.1 (FOR WDMPON OLT), G.989.2 (FOR NGPON2 OLT) IEEE 802.3av (For 10G EPON OLT), IEEE 802.3ca (For Nx25G EPON) & IEEE 802.1Q (Testing Procedure)	Yes/No Provision of creating multiple port-id based multiple VLAN shall exist.

S. No.	Parameter Name	Standard	Remarks
J3.13	Switch Fabric Throughput Capability OLT	G.984.1 (For GPON OLT), IEEE 802.3ah (FOR EPON OLT), G.987.2 (FOR XGPON OLT), G.9807.1 (FOR XGSPON OLT), G.694.1 (FOR WDMPON OLT), G.989.2 (FOR NGPON2 OLT), IEEE 802.3av (For 10G EPON OLT), IEEE 802.3ca (For Nx25G EPON)	Demonstrate support for full wired speed throughput by testing traffic through one randomly chosen port of switch fabric then using this value corroborate with datasheet provided by chipset vendor.
J3.14	Throughput of PON	RFC 2544 and respective standard i.e. 1)GPON-G.984.2/cl8.2.1, (2)XGPON- G.987.2/Cl 9.2.1,(3) NGPON2-G.989.2/Cl 11.1.1,(4) XGSPON- G.9807.1/Cl B.9.2.1, (5) EPON-IEEE 802.3ah (6) 10G-EPON- Table Number 75-1 of IEEE 802.3 (2018). (7) Nx25G EPON-Table Number 141-2 to 141-5 of IEEE 802.3ca.	Note: For Multi PON module interfaces i.e. MPX and MPS, throughput of corresponding standard for GPON and XGPON/XGSPON should be supported. **Note: In order to verify non-blocking of IPv4 and IPv6 traffic, Throughput test shall be carried out with IPv4 and IPv6 traffic. Refer test case number 43 for test seup**
J3.15	VLAN Stacking to Network Support at OLT	IEEE 802.1ad & IEEE 802.1Q(testing procedure).	Yes/No To test the double tagging support between ONT and OLT.

Annexure J4 – DSLAM Functional Test

Applicable to→ **Test Parameter↓**	**Standard**	**IP-DSLAM**	**IP-DSLAM** **With splitter**	**Remarks**
POTS SPLITTERS The broad specifications for splitter shall be: a. 600-ohm impedance b. ETSI harmonized impedance splitter (ETSI TR 101 728).			Y	
VLAN Aggregation: The DSLAM shall terminate PVCs on DSL line and aggregate them over a single or multiple Customer-VLANs, Service-VLANs as well as a combination of them, at the uplink interface. It shall also implement 802.1p priority on the Ethernet flows.	IEEE 802.1p	Y	Y	To check if more than 1 vlan can be passed over the same port in DSLAM
Protocol *Support* DSLAM shall support DHCP based IP access with DHCP relay and DHCP option 82 for direct IP over Ethernet based access for video/gaming and other entertainment services.	RFC 2131 RFC 3046	Y	Y	
PPPoE over ATM (U-interface): Figure 1 depicts the end-to-end protocol stacks associated with PPPoE access method		Y	Y	To check PPPoE session is established on the ADSL or VDSL system. Methodology is mentioned in DSL forum technical report TR-045. **Annexure-E: group 3.3_test 1 & Test 2 may be carried out to cater this clause.** It is tested through protocol simulator.

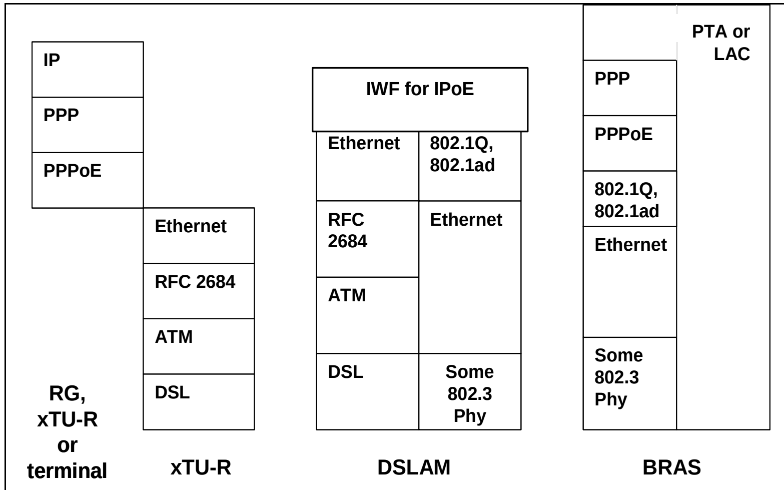
<table>
<tr><td>

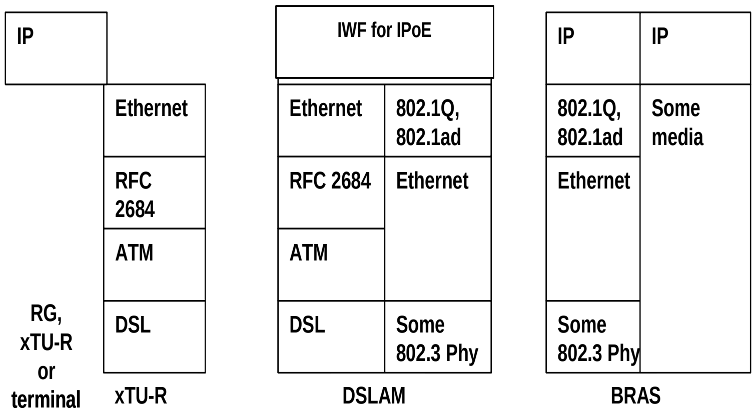
Figure 1-</td><td></td><td></td><td></td><td></td></tr>
<tr><td>IPoE <u>over ATM (U-interface):</u> Figure 2 depicts the end-to-end protocol stacks associated with IPoE access method.


Figure 2</td><td></td><td>Y</td><td>Y</td><td>To check if IPOE is established on the ADSL or VDSL system. Methodology is mentioned in DSL forum technical report TR-045. Annexure-E: group 3.3_test 1 & Test 2 may be carried out to cater this clause. It is tested through protocol simulator.</td></tr>
</table>

Ethernet Scalability **1.** The device shall provide a means to limit the number of MAC addresses learned on any given port. **2.** The device shall support placing all subscriber traffic into a single or multiple VLANs on an uplink.		Y	Y	1. Limit the port on DSLAM to 1 mac and send two mac traffic only one mac traffic which is defined will run. 2. Check more than 1 vlan can pass through the port
Video application protocol support • IGMP Proxy • IGMPv2/v3 snooping Further- 1. IGMP proxy shall handle multicast and control where the packets has to be replicated (in terms of specific customer VLANs or ports). 2. In upstream direction, IGMP proxy function shall forward IGMP messages from subscriber to multicast VLAN. 3. In downstream direction, multicast streams shall be multiplexed in to subscriber's connection based on 'Join' messages received.	RFC 2236 RFC3376	Y	Y	Capability to be demonstrated as describes in clause. Enable IGMP proxy and snooping and check if multicast channel is learnt once the channel is joint
Filtering : The DSLAM shall allow the following filters to be defined: • List of acceptable MAC destination addresses applicable to frames received at the upstream direction on bridged ports. • When attached to a bridged port, any frame received with a destination MAC not specified in the list shall be discarded.		Y	Y	Capability to be demonstrated as describes in clause. Set the MAC address to be allowed per port, send traffic of that mac and see it is going through. Send traffic of other mac and see that traffic is not going

The DSLAM shall be capable of filtering L2 traffic configurable per Port/PVC/Service basis at least for the following parameters- **a. Source IP and MAC Address per port, per PVC, per VLAN** **b. Destination IP and MAC Address per port, per PVC, per VLAN.**				
Broadcast Handling: As far as Ethernet broadcast traffic is concerned, all downstream broadcast traffic shall be discarded with the exception cases called for by DHCP Relay Agent, PPPoE Intermediate Agent, and IGMP Snooping/ IGMP Snooping and Proxy functions.		Y	Y	Capability to be demonstrated as describes in clause.
Protection from ARP spoofing attacks • ***Source MAC Flooding*** • ***Broadcast control*** • ***L2 Peer to Peer ("hair-pin") Forwarding*** • ***Source MAC Spoofing***		Y	Y	1. To check if DSLAM can block certain MAC. 2. To check if broadcast mac can be controlled 3. Communication on same vlan can be done or blocked. 4. To check if mac is learnt on the DSLAM

Note: Wherever RFC are referred, only 'shall' clauses given in the RFCs should be tested against the parameter referred in this ER.

Annexure J5: Interpoerability Test

S. No.	Interface Name	Test Case	Standard	Limit/Value (Yes: Test Pass, No: Test failed)	Remarks
J5.1	OLT & ONU	ONT must discover automatically on the OLT after connecting fiber having -9 dBm to -28 dBm optical power	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.2	OLT	ONT SN can be added manually without connecting fiber.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.3	OLT	ONT can be added and removed from the OLT.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.4	OLT	ONT can be activated and deactivated from the OLT/EMS / Third Party Database	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.5	OLT & ONU	Update of OMCI config for ONT	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.6	OLT & ONU	ONT configuration via OMCI (All Standard ME Support)	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.7	OLT & ONU	MIB reset functionality to be incorporated for any changes performed through OMCI	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.8	OLT & ONU	ONT PON Tx power can be seen on the OLT after successful registration.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.9	OLT & ONU	ONT PON Rx power can be seen on the OLT after successful registration.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.10	OLT & ONU	ONT must report interface statistics related POTS. VEIP, Ethernet, FE /GE (number and type of Ethernet port	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.11	OLT & ONU	Multi-Services with a Combination of TC-1, TC-2, TC-4. TC-3 and TC-5(All kind of TCONT to be supported)	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.12	OLT & ONU	Single UNI Port. Uni-VLAN based (No Translation).	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	

J5.13	OLT & ONU	Multiport. Uni-VLAN Based (without translation).	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.14	OLT & ONU	Multiport. No Uni-VLAN. One service per UNI port. C	ITU-T Rec G.984.x G.988 and TR-255;	Yes / No	
J5.15	OLT & ONU	Voice service and IP host configuration using OMCI and verify E2E phone call using Pots ports	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.16	OLT & ONU	Verify the configurability and support of Forward Error Correction for each type of ONT.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.17	OLT & ONU	Verify the configurability and support of ONT operations for each type of ONT. (Supports all standard ME's for ONT management)	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.18	OLT & ONU	Verify the configurability and support of ONT UNI port operations for each type of ONT.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.19	OLT & ONU	Verify the support of various Frame sizes 64-1500 to Jumbo frame support using RFC-2544	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.20	OLT & ONU	Verify the support of configuration and working of AES on ONT	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.21	OLT & ONU	Configure PPPoE service and verify bidirectional traffic of end-to-end PPPoE(with single TAG and Double TAG)	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.22	OLT & ONU	Configure IPoE service and verify bidirectional traffic of end-to-end IPoE	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.23	OLT & ONU	Multiservice on the Different UNI port (one untagged and many tagged services on each port)	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.24	OLT & ONU	Verify Port Optical Characteristics on EMS	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.25	OLT & ONU	Creation of Voice interfaces of ONT over OMCI	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	

J5.26	OLT & ONU	Voice Sip Configuration profile, User Profile Creation, IP Host and POTS association to voice service.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.27	OLT & ONU	Voice Service Activation	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.28	OLT & ONU	Voice Service Verification	ITU-T Rec G.984.x G.988 and TR-255 ;	Yes / No	
J5.29	OLT & ONU	Deactivation of Voice service and IP host Modification/Update restrictions as applicable	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.30	OLT & ONU	Sip profile Modification/Update	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.31	OLT & ONU	Voice port and profiles deletion	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.32	OLT & ONU	Configuration and update of static IP on IP Host Interface of ONT	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.33	OLT & ONU	Basic 2-way call	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.34	OLT & ONU	Verify Call Disconnect by calling and called party	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.35	OLT & ONU	Verify No Answer	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.36	OLT & ONU	Verify short and long 2-way call	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.37	OLT & ONU	LOAa_06: PON cable Plug IN/OUT and SFP removal should initiate the message Transmission b/w OLT and ONU and ONU is not sending back to OLT and alarm is generated.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.38	ONT/ONU	Verify the configurability and support of ONU Single Homing on Type-B	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	

J5.39	ONT/ONU	Verify the configurability and support of ONU IPv4 Traffic (Bridging or Routing) IPv4 Address allocation through DHCP Discover	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.40	OLT & ONU	Verify the stability of All services (VoIP, Internet, IPTV) application service & SIP user data features in OLT/ONT activate/deactivate, reboot and power cycle	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.41	OLT & ONU	EMS /OLT should support One-to-one firmware upgrade for own & third party ONT's. Any S/W upgradation performed on ONT should not impact the existing configuration of ONT including services.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.42	OLT	All type of ONT which includes own manufactured along with the third party manufactured should be configured and operated through common EMS system	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
RG (Residential Gateway) Mode Test Case					
J5.43	OLT & ONU	Multi-Services with a Combination of (Committed, Assured and Non-assured components) and Triple play service with TCONT type of services.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.44	OLT & ONU	Verify Port Optical Characteristics on EMS (with ONT Monitor)	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.45	OLT & ONU	Verify ONT Alarms at EMS like ONT LOS, Dying Gasp.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.46	OLT & ONU	Verify ONT events on EMS for every operation performed on ONT (Reboot, deactivate, delete, re-add, reactivate)	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	

J5.47	OLT & ONU	Verify the configurability and support of Forward Error Correction for each type of ONT. (upstream and downstream enable and disable)	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.48	OLT & ONU	Verify the configurability and support of ONT operations for each type of ONT.	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.49	OLT & ONU	Verify the configurability and support of ONU IPv4 Traffic (Routing) IPv4 Address allocation through Dhcp	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.50	OLT & ONU	Verify the support of various Frame sizes 64-1500 or till 9k to Jumbo frame support using RFC-2544	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.51	OLT & ONU	Verify the support of configuration and working of AES on ONT	ITU-T Rec G.984.x; G.988 and TR-255	Yes / No	
J5.52	OLT & ONU	Demonstrate Configuration of IPoE and verify IPoE capabilities	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.53	OLT & ONU	Verify the configurability and support of ONT operations of ONT. (Add, Activate, Edit, Reboot, Deactivate, Delete) based on serial number and registration ID	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.54	OLT & ONU	Verify the configurability and support of ONT port operations of ONT. (Activate, Edit, Deactivate) based on serial number and registration ID	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	
J5.55	OLT & ONU	Verify Bi-directional traffic by assigning following WAN connection types: IPv4/IPv6/Static IP add and vlan	ITU-T Rec G.984.x ; G.988 and TR-255	Yes / No	

Note: a) For interoperability testing of OLT: - (i) In case the prescribed tests be done through OLT emulator, it shall be performed with three different make MTCTE certified ONUs / ONTs and / or BBF TR-247 certified ONUs / ONTs (including own make, if any), and (ii) In case the prescribed tests be done without OLT emulator, it shall be performed with five different make MTCTE certified ONUs / ONTs and / or BBF TR-247 certified ONUs / ONTs (including own make, if any); b) For interoperability testing of ONU/ ONT:- (i) In

case the prescribed tests be done through OLT emulator, it shall be performed with three different make OLTs (including own make, if any), and (ii) In case the prescribed tests be done without OLT emulator, it shall be performed with five different make OLTs (including own make, if any). Further, device manufacturer /OEM of OLT and ONT/ONU shall give an undertaking that their respective OLT and ONT/ONU are interoperable with all makes of equipments and in case of any problems / issues, the concerned device manufacturer will help in solving the problems / issues.

Annexure-K: SDH Interface Parameters

Parameter Group: SDH Interface (INTSDH).

No.	Interface Name	Parameter Name	Standard/ Parameter	Limits/Values	Applicability/ Remarks
K.1	STM-1 Electrical	Input Jitter Tolerance STM-1 Electrical	G.825	Table 4, Fig-1 clause-6.1.2.1	
K.2	STM-1 Electrical	Input Return Loss for STM-1 Electrical	G.703	≥15 dB over frequency range 8 MHz to 240 MHz	
K.3	STM-1 Electrical	Nominal Bit Rate with Tolerance STM-1 Electrical Int	G.703	155520 Kbps	
K.4	STM-1 Electrical	Output Jitter for STM-1 Electrical Int	G.825	500 to 1.3 MHz - 1.5(UIpp) 65 k to 1.3 MHz- 0.075 (UIpp)	
K.5	STM-1 Electrical	Pulse Mask for STM-1 Electrical Int	G.703	Fig 17-1 & 17-2 clause-17.4	

<table>
<tr>
<td>K.6</td>
<td>STM-1 Optical</td>
<td>Input Jitter Tolerance for STM-1 Opt</td>
<td>G.825</td>
<td>
Table 3/G.825 − STM-1 input jitter tolerance limit
<table>
<tr><td colspan="2">Frequency
f(Hz)</td><td>Requirement
(Peak-Peak)</td></tr>
<tr><td>2048 kbit/s networks</td><td>1544 kbit/s networks</td><td></td></tr>
<tr><td>-</td><td>10 < f ≤ 68.7</td><td>10.9 UI</td></tr>
<tr><td>10 < f ≤ 19.3</td><td>-</td><td>38.9 UI (0.25 μs)</td></tr>
<tr><td>19.3 < f ≤ 68.7</td><td>-</td><td>750 f^{-1} UI</td></tr>
<tr><td colspan="2">68.7 < f ≤ 500</td><td>750 f^{-1} UI</td></tr>
<tr><td colspan="2">500 < f ≤ 6.5 k</td><td>1.5 UI</td></tr>
<tr><td colspan="2">6.5 k < f ≤ 65 k</td><td>$9.8 \times 10^3 f^{-1}$ UI</td></tr>
<tr><td colspan="2">65 k < f ≤ 1.3 M</td><td>0.15 UI</td></tr>
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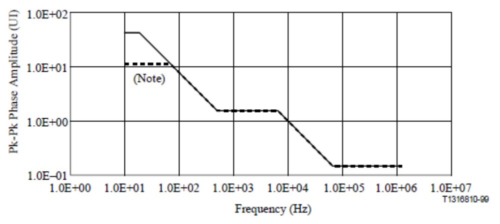

NOTE – The dashed curve is the requirement for 1544 kbit/s networks for frequencies less than 68.7 Hz.
Figure 1/G.825 – STM-1 jitter tolerance
</td>
<td>Refer Table 3 and Fig. 1, clause-6.1.2.1 of ITU-T G.825</td>
</tr>
</table>

<table>
<tr><td>K.7</td><td>STM-1 Optical</td><td>Mean Launched Power for STM-1 Opt Int</td><td>G.957</td><td>
<table>
<tr><td></td><td>Unit</td><td colspan="6">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-1</td><td>S - 1.1</td><td>S - 1.2</td><td>L - 1.1</td><td>L-1.2</td><td>L-1.3</td></tr>
<tr><td>Mean launched power: maximum & minimum</td><td>dBm</td><td>-8 & -15</td><td>-8 & -15</td><td>-8 & -15</td><td>0 & -5</td><td>0 & -5</td><td>0 & -5</td></tr>
</table>
</td><td>For values, refer Table 2 of ITU-T G.957. For different Application Codes, refer Table 1 of ITU-T G.957.</td></tr>
<tr><td>K.8</td><td>STM-1 Optical</td><td>Nominal Bit Rate with Tolerance STM-1 Opt Int</td><td>G.957</td><td>155520 Kbps</td><td></td></tr>
</table>

<table>
<tr>
<td>K.9</td>
<td>STM-1 Optical</td>
<td>Operating Wavelength Range for STM-1 Opt Int</td>
<td>G.957</td>
<td>
<table>
<tr><td></td><td>Unit</td><td colspan="8">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-1</td><td>S-1.1</td><td colspan="2">S -1.2</td><td>L - 1.1</td><td>L-1.2</td><td colspan="2">L-1.3</td></tr>
<tr><td>Operating Wavelength Range</td><td>nm</td><td>1260[a)] - 1360</td><td>1261[a)]- 1360</td><td>1430 - 1576</td><td>1430 - 1580</td><td>1263[a)] - 1360</td><td>1480- 1580</td><td>1534 - 1566/ 1523 - 1577</td><td>1480 - 1580</td></tr>
<tr><td colspan="10">[a)] Some Administrations may require a limit of 1270 nm.</td></tr>
</table>
</td>
<td>For values, refer Table 2 of ITU-T G.957. For different Application Codes, refer Table 1 of ITU-T G.957.</td>
</tr>
<tr>
<td>K.10</td>
<td>STM-1 Optical</td>
<td>Output Jitter for STM-1 Opt Int</td>
<td>G.783</td>
<td>0.5k to 1.3 MHz - 0.30(UI)
65 k to 1.3MHz – 0.10 (UI)
(1UI=6.43ns)</td>
<td></td>
</tr>
</table>

<table>
<tr>
<td>K.11</td>
<td>STM-1 Optical</td>
<td>Receiver Overload for STM-1 Opt Int</td>
<td>G.957</td>
<td>
<table>
<tr><td></td><td>Unit</td><td colspan="6">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-1</td><td>S - 1.1</td><td>S - 1.2</td><td>L - 1.1</td><td>L- 1.2</td><td>L- 1.3</td></tr>
<tr><td>Minimum Overload</td><td>dBm</td><td>-8</td><td>-8</td><td>-8</td><td>-10</td><td>-10</td><td>-10</td></tr>
</table>
</td>
<td>For values refer Table 2 of ITU-T G. 957. For different Application Codes, refer Table 1 of ITU-T G.957.</td>
</tr>
<tr>
<td>K.12</td>
<td>STM-1 Optical</td>
<td>Receiver Sensitivity for STM-1 Opt Int</td>
<td>G.957</td>
<td>
<table>
<tr><td></td><td>Unit</td><td colspan="6">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-1</td><td>S- 1.1</td><td>S-1.2</td><td>L - 1.1</td><td>L- 1.2</td><td>L- 1.3</td></tr>
<tr><td>Minimum Sensitivity[b)]</td><td>dBm</td><td>-23</td><td>-28</td><td>-28</td><td>-34</td><td>-34</td><td>-34</td></tr>
<tr><td colspan="8">[b)] See clause 6 of ITU-T G.957</td></tr>
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</td>
<td>For values refer Table 2 of ITU-T G.957. For different Application Codes, refer Table 1 of ITU-T G.957.</td>
</tr>
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<table>
<tr>
<td>K.13</td>
<td>STM-4 Optical</td>
<td>Input Jitter Tolerance for STM-4 Opt</td>
<td>G.825</td>
<td>
<table>
<tr><td colspan="3">Table 5/G.825 − STM-4 input jitter tolerance limit</td></tr>
<tr><td colspan="2">Frequency
f(Hz)</td><td>Requirement (Peak-Peak)</td></tr>
<tr><td>2048 kbit/s networks</td><td>1544 kbit/s networks</td><td></td></tr>
<tr><td>-</td><td>$10 < f \leq 18.5$</td><td>$277.5\ f^{-1}$ UI</td></tr>
<tr><td>-</td><td>$18.5 < f \leq 100$</td><td>15 UI</td></tr>
<tr><td>$9.65 < f \leq 100$</td><td>-</td><td>$1500\ f^{-1}$ UI</td></tr>
<tr><td colspan="2">$100 < f \leq 1000$</td><td>$1500\ f^{-1}$ UI</td></tr>
<tr><td colspan="2">$1\ k < f \leq 25\ k$</td><td>1.5 UI</td></tr>
<tr><td colspan="2">$25\ k < f \leq 250\ k$</td><td>$3.8 \times 10^{4}\ f^{-1}$ UI</td></tr>
<tr><td colspan="2">$250\ k < f \leq 5\ M$</td><td>0.15 UI</td></tr>
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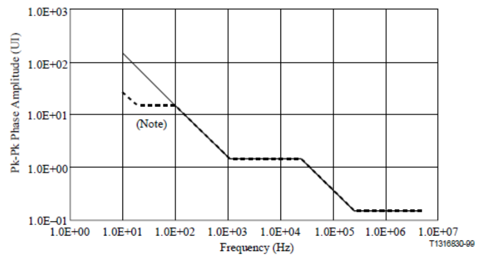

NOTE – The dashed curve is the requirement for 1544 kbit/s networks for frequencies less than 100 Hz.
Figure 3/G.825–STM-4 jitter tolerance
</td>
<td>Refer Table 5 and Fig. 3, clause-6.1.2.2 of ITU-T G.825</td>
</tr>
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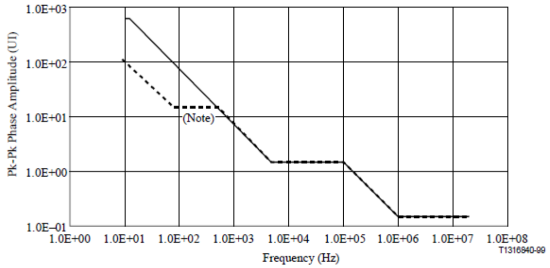
<table>
<tr><td>K.14</td><td>STM-4 Optical</td><td>Mean Launched Power for STM-4 Opt Int</td><td>G.957,G.691</td><td><table><tr><td></td><td>Unit</td><td colspan="2">Values</td></tr><tr><td>Application code</td><td></td><td>I-4</td><td>S -4.1</td></tr><tr><td>Mean launched power: maximum & minimum</td><td>dBm</td><td>-8 & -15</td><td>-8 & -15</td></tr></table></td><td>For values, refer Table 3 of ITU-T G. 957. For different Application Codes, refer Table 1 of ITU-T G.957.</td></tr>
<tr><td>K.15</td><td>STM-4 Optical</td><td>Nominal Bit Rate with Tolerance STM-4 Opt Int</td><td>G.957</td><td>622080Kbps</td><td></td></tr>
</table>

<table>
<tr>
<td>K.16</td>
<td>STM-4 Optical</td>
<td>Operating Wavelength Range for STM-4 Opt Int</td>
<td>G.957</td>
<td>
<table>
<tr><td></td><td>Unit</td><td colspan="7">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-4</td><td>S -4.1</td><td>S -4.2</td><td colspan="2">L -4.1</td><td>L-4.2</td><td>L-4.3</td></tr>
<tr><td>Operating Wavelength Range</td><td>nm</td><td>1261 [a] - 1360</td><td>1293 - 1334/
1274 - 1356</td><td>1430 – 1580</td><td>1300 - 1325/
1296 - 1330</td><td>1280 - 1335</td><td>1480 - 1580</td><td>1480 - 1580</td></tr>
<tr><td colspan="9">[a] Some Administrations may require a limit of 1270 nm.</td></tr>
</table>
</td>
<td>For values, refer Table 3 of ITU-T G. 957. For different Application Codes, refer Table 1 of ITU-T G.957.</td>
</tr>
<tr>
<td>K.17</td>
<td>STM-4 Optical</td>
<td>Output Jitter for STM-4 Opt Int</td>
<td>G.783</td>
<td>1k to 5 MHz - 0.30(UI)

250 k to 5 MHz – 0.10 (UI)

(1UI=1.61ns)</td>
<td></td>
</tr>
</table>

<table>
<tr><td>K.18</td><td>STM-4 Optical</td><td>Receiver Overload for STM-4 Opt Int</td><td>G.957</td><td><table><tr><td></td><td>unit</td><td colspan="4">Values</td></tr><tr><td>Application code</td><td></td><td>I-4</td><td>S -4.1</td><td>S -4.2</td><td>L</td></tr><tr><td>Minimum overload</td><td>dBm</td><td>-8</td><td>-8</td><td>-8</td><td>-8</td></tr></table></td><td>For values, refer Table 3 of ITU-T G. 957. For different Application Codes, refer Table 1 of ITU-T G.957.</td></tr>
<tr><td>K.19</td><td>STM-4 Optical</td><td>Receiver Sensitivity for STM-4 Opt Int</td><td>G.957</td><td><table><tr><td></td><td>unit</td><td colspan="3">Values</td></tr><tr><td>Application code</td><td></td><td>I-4</td><td>S -4.1</td><td>S -</td></tr><tr><td>Minimum sensitivity[b)]</td><td>dBm</td><td>-23</td><td>-28</td><td>-2</td></tr><tr><td colspan="5">[b)] See clause 6 of ITU-T G.957</td></tr></table></td><td>For values, refer Table 3 of ITU-T G. 957. For different Application Codes, refer Table 1 of ITU-T G.957.</td></tr>
</table>

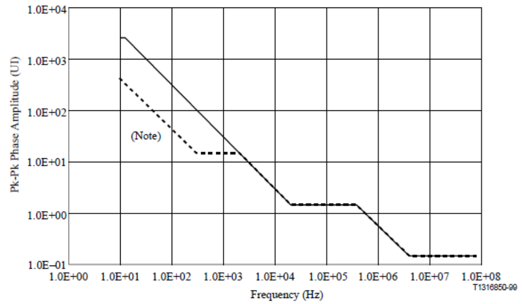
<table>
<tr>
<td>K.20</td>
<td>STM-16 Optical</td>
<td>Input Jitter Tolerance for STM-16 Opt</td>
<td>G.825</td>
<td>
Table 6/G.825 − STM- 16 input jitter tolerance
<table>
<tr><td colspan="2">Frequency
f (Hz)</td></tr>
<tr><td>2048 kbit/s networks</td><td>1544 kbit/s networks</td></tr>
<tr><td>-</td><td>10 < f ≤ 70.9</td></tr>
<tr><td>-</td><td>70.9 < f ≤ 500</td></tr>
<tr><td>10 < f ≤ 12.1</td><td>-</td></tr>
<tr><td>12.1 < f ≤ 500</td><td>-</td></tr>
<tr><td colspan="2">500 < f ≤ 5 k</td></tr>
<tr><td colspan="2">5 k < f ≤ 100 k</td></tr>
<tr><td colspan="2">100 k < f ≤ 1 M</td></tr>
<tr><td colspan="2">1 M < f ≤ 20 M</td></tr>
</table>


NOTE – The dashed curve is the requirement for 1544 kbit/s networks for frequencies less than 500 Hz.
Figure 4/G.825–STM-16 jitter tolerance
</td>
<td>Refer Table 6 and Fig. 4, clause-6.1.2.3 of ITU-T G.825</td>
</tr>
</table>

<table>
<tr><td>K.21</td><td>STM-16 Optical</td><td>Mean Launched Power for STM-16 Opt Int</td><td>G.957</td><td>
<table>
<tr><td></td><td>Unit</td><td colspan="6">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-16</td><td>S - 16.1</td><td>S - 16.2</td><td>L - 16.1</td><td>L-16.2</td><td>L-16.3</td></tr>
<tr><td>Mean launched power:
maximum &
minimum</td><td>dBm</td><td>-3 & -10</td><td>0 & -5</td><td>0 & -5</td><td>+3 & -2</td><td>+3 & -2</td><td>+3 & -2</td></tr>
</table>
</td><td>For values, refer Table 4 of ITU-T Rec. G.957. For different Application Codes, refer Table 1 of ITU-T G.957.</td></tr>
<tr><td>K.22</td><td>STM-16 Optical</td><td>Nominal Bit Rate with Tolerance STM-16 Opt Int</td><td>G.957</td><td>2488320 kbps</td><td></td></tr>
</table>

<table>
<tr><td>K.23</td><td>STM-16 Optical</td><td>Operating Wavelength Range for STM-16 Opt Int</td><td>G.957</td><td>
<table>
<tr><td></td><td>unit</td><td colspan="6">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-16</td><td>S - 16.1</td><td>S - 16.2</td><td>L -16.1</td><td>L-16.2</td><td>L-16.3</td></tr>
<tr><td>Operating Wavelength Range</td><td>nm</td><td>1266[a)] - 1360</td><td>1260[a)] - 1360</td><td>1430 - 1580</td><td>1280 - 1335</td><td>1500 - 1580</td><td>1500 - 1580</td></tr>
<tr><td colspan="8">[a)] Some Administrations may require a limit of 1270 nm.</td></tr>
</table>
</td><td>For values, refer Table 4 of ITU-T G.957. For different Application Codes, refer Table 1 of ITU-T G.957.</td></tr>
<tr><td>K.24</td><td>STM-16 Optical</td><td>Output Jitter for STM-16 Opt Int</td><td>G.783</td><td>5k to 20 MHz - 0.30(UI)
1000 k to 20 MHz – 0.10 (UI)
(1UI=0.40ns)</td><td></td></tr>
<tr><td>K.25</td><td>STM-16 Optical</td><td>Receiver Overload for STM-16 Opt Int</td><td>G.957</td><td>
<table>
<tr><td></td><td>Unit</td><td colspan="6">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-16</td><td>S - 16.1</td><td>S - 16.2</td><td>L - 16.1</td><td>L-16.2</td><td>L-16.3</td></tr>
<tr><td>Minimum overload</td><td>dBm</td><td>-3</td><td>0</td><td>0</td><td>-9</td><td>-9</td><td>-9</td></tr>
</table>
</td><td>For values, refer Table 4 of ITU-T G.957. For different Application Codes, refer Table 1 of ITU-T G.957.</td></tr>
</table>

<table>
<tr>
<td>K.26</td>
<td>STM-16 Optical</td>
<td>Receiver Sensitivity for STM-16 Opt Int</td>
<td>G.957</td>
<td>
<table>
<tr><td></td><td>Unit</td><td colspan="6">Values</td></tr>
<tr><td>Application code</td><td></td><td>I-16</td><td>S-16.1</td><td>S-16.2</td><td>L-16.1</td><td>L-16.2</td><td>L-16.3</td></tr>
<tr><td>Minimum sensitivity[b)]</td><td>dBm</td><td>-18</td><td>-18</td><td>-18</td><td>-27</td><td>-28</td><td>-27</td></tr>
<tr><td colspan="8">b) See clause 6 of ITU-T G.957</td></tr>
</table>
</td>
<td>For values, refer Table 4 of ITU-T G.957. For different Application Codes, refer Table 1 of ITU-T G.957.</td>
</tr>
</table>

<table>
<tr>
<td>K.27</td>
<td>STM-64 Optical</td>
<td>Input Jitter Tolerance for STM64 Opt</td>
<td>G.825</td>
<td>
Table 7/G.825 − STM- 64 input jitter tolerance limit
<table>
<tr><td colspan="2">Frequency
f(Hz)</td><td>Requirement
(Peak - Peak)</td></tr>
<tr><td>2048 kbit/s networks</td><td>1544 kbit/s networks</td><td></td></tr>
<tr><td>-</td><td>$10 < f \leq 296$</td><td>$4446f^{-1}$ UI</td></tr>
<tr><td>-</td><td>$296 < f \leq 2000$</td><td>15 UI</td></tr>
<tr><td>$10 < f \leq 12.1$</td><td>-</td><td>2490 UI (0.25 μs)</td></tr>
<tr><td>$12.1 < f \leq 2000$</td><td>-</td><td>$3.0 \times 10^4 f^{-1}$</td></tr>
<tr><td colspan="2">$2000 < f \leq 20$ k</td><td>$3.0 \times 10^4 f^{-1}$</td></tr>
<tr><td colspan="2">$20k < f \leq 400$ k</td><td>1.5 UI</td></tr>
<tr><td colspan="2">400 k $< f \leq 4$ M</td><td>$6.0 \times 10^5 f^{-1}$ UI</td></tr>
<tr><td colspan="2">4 M $< f \leq 80$ M</td><td>0.15 UI</td></tr>
</table>


NOTE – The dashed curve is the requirement for 1544 kbit/s networks for frequencies less than 2 kHz.
Figure 5/G.825 – STM-64 jitter tolerance
</td>
<td>Table 7 and Fig. 5, clause-6.1.2.4 of ITU-T G.825</td>
</tr>
</table>

K.28	**STM-64 Optical**	**Mean Launched Power for STM-64 Opt Int**	**G.691**	**Refer Tables 5a, 5b, 5c and 5d of ITU-T G.691(attached)**	**For different Application Codes, refer Clause 5 and Table 1 of ITU-T G.691.**
K.29	**STM-64 Optical**	**Nominal Bit Rate with Tolerance STM-64 Opt Int**	**G.707**	**9953280 Kbps**	
K.30	**STM-64 Optical**	**Operating Wavelength Range for STM-64 Opt Int**	**G.691**	**Refer Tables 5a, 5b, 5c and 5d of ITU-T G.691(attached)**	**For different Application Codes, refer Clause 5 and Table 1 of ITU-T G.691.**
K.31	**STM-64 Optical**	**Output Jitter for STM-64 Opt Int**	**G.783**	**20k to 80 MHz - 0.30(UI)** **4000 k to 80 MHz – 0.10 (UI)** **(1UI=0.10ns)**	
K.32	**STM-64 Optical**	**Receiver Overload for STM-64 Opt Int**	**G.691**	**Refer Tables 5a, 5b, 5c and 5d of ITU-T G.691(attached)**	**For different Application Codes, refer Clause 5 and Table 1 of ITU-T G.691.**
K.33	**STM-64 Optical**	**Receiver Sensitivity for STM-64 Opt Int**	**G.691**	**Refer Tables 5a, 5b, 5c and 5d of ITU-T G.691(attached)**	**For different Application Codes, refer Clause 5 and Table 1 of ITU-T G.691.**

K.34	**STM-256 Optical**	**Input Jitter Tolerance for STM-256 Opt**	**G.825**	**Table 8 Fig 6 Amd.1**	
K.35	**STM-256 Optical**	**Mean Launched Power for STM-256 Opt Int**	**G.693**	**Table 4 & 6**	
K.36	**STM-256 Optical**	**Nominal Bit Rate with Tolerance STM-256 Opt Int**	**G.693**	**NRZ 40G**	
K.37	**STM-256 Optical**	**Operating Wavelength Range for STM-256 Opt Int**	**G.693**	**Table 4 & 6**	
K.38	**STM-256 Optical**	**Output Jitter for STM-256 Opt Int**	**G.783**	**FFS to FFS -FFS** **16000 k to 320 MHz – 0.10 (UI)** **(1UI=0.025ns)**	
K.39	**STM-256 Optical**	**Receiver Overload for STM-256 Opt Int**	**G.693**	**Table 4 & 6**	
K.40	**STM-256 Optical**	**Receiver Sensitivity for STM-256 Opt Int**	**G.693**	**Table 4, Fig-1 clause-6.1.2.1**	

Note: - Attachment to Annexure-K is placed at the end of document

Annexure-L: OTN Interface Parameters

Parameter Group: OTN Interface (INTOTN)

S.No.	Interface Name	Parameter Name	Standard/Parameter	Limits/Values	Applicability/Remarks
L.1	OTU-1	Central Frequency for OTU-1 Int	G.959.1, G.693	Refer Tables 8-1, 8-4, 8-7,8-8, 8-9 of ITU-T G.959.1 (attached)	For different Application codes*, refer to Clause 5 of ITU-T G.959.1.
L.2	OTU-1	Input Jitter Tolerance for OTU-1 Int	G.8251	Table 7.1-1,Figure 7.1-1	
L.3	OTU-1	Mean total Input Power for OTU-1 Int	G.959.1, G.693	Refer Tables 8-1, 8-4, 8-7,8-8, 8-9 of ITU-T G.959.1 (attached)	For different Application codes*, refer to Clause 5 of ITU-T G.959.1.
L.4	OTU-1	Mean total Output Power for OTU-1 Int	G.959.1, G.693	Refer Tables 8-1, 8-4, 8-7,8-8, 8-9 of ITU-T G.959.1(attached)	For different Application codes*, refer to Clause 5 of ITU-T G.959.1.
L.5	OTU-1	Minimum Receiver Overload for OTU-1	G.959.1,G.693		
L.6	OTU-1	Nominal Bit Rate with Tolerance OTU-1 Int	G.709	255/238 × 2 488 320kbit/s ± 20 ppm (2666057.143 kbit/s ± 20 ppm)	Refer Table 7-1 of ITU-T G.709
L.7	OTU-1	Output Jitter for OTU-1 Int	G.8251	5k to 20 M:1.5(UIpp) 1M to 20 M:0.15 (UIpp)	
L.8	OTU-1	Receiver Sensitivity for OTU-1 Int	G.959.1, G.693	Refer Tables 8-1, 8-4, 8-7,8-8, 8-9 of ITU-T G.959.1 (attached).	For different Application codes*, refer to Clause 5 of ITU-T G.959.1
L.9	OTU-2	Central Frequency for OTU-2 Int	G.959.1, G.693	Refer Tables 8-2, 8-3, 8-4, 8-10, 8-11, 8-12,8-13,8-14, 8-15 of ITU-T G.959.1 (attached). Refer Clause 7 of ITU-T G.693 (attached).	For different Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.693
L.10	OTU-2	Input Jitter Tolerance for OTU-2 Int	G.8251	Table 7.1-2, Figure 7.1-2	

L.11	OTU-2	Mean total Input Power for OTU-2 Int	G.959.1, G.693	Refer Tables 8-2, 8-3, 8-4,8-10, 8-11, 8-12,8-13,8-14, 8-15 of ITU-T G.959.1 (attached).	For different Application codes*, refer to Clause 5 of ITU-T G.959.1.
L.12	OTU-2	Mean total Output Power for OTU-2 Int	G.959.1, G.693	Refer Tables 8-2, 8-3, 8-4,8-10, 8-11, 8-12,8-13,8-14, 8-15 of ITU-T G.959.1 (attached). Refer Clause 7 of ITU-T G.693 (attached).	For Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.693
L.13	OTU-2	Minimum Receiver Overload for OTU-2 Int	G.959.1, G.693	-1dBm	
L.14	OTU-2	Nominal Bit Rate with Tolerance OTU-2 Int	G.709	255/237 × 9 953 280kbit/s ± 20 ppm (10709225.316 kbit/s ± 20 ppm)	Refer Table 7-1 of ITU-T G.709
L.15	OTU-2	Output Jitter for OTU-2 Int	G.8251	20k to 80 M :1.5(UIpp) 4M to 20 M: 0.15 (UIpp)	
L.16	OTU-2	Receiver Sensitivity for OTU-2 Int	G.959.1 Cl. 7, 8, G.693 Cl. 6, 7	Refer Tables 8-2, 8-3, 8-4,8-10, 8-11, 8-12,8-13,8-14, 8-15 of ITU-T G.959.1 (attached). Refer Clause 7 of ITU-T G.693 (attached).	For different Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.693.
L.17	OTU-3	Central Frequency for OTU-3 Int	G.959.1, G.693	Refer Tables 8-16, 8-17, 8-18 of ITU-T G.959.1(attached). Refer Clause 7 of ITU-T G.693(attached).	For different Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.693.

L.18	OTU-3	Mean total Input Power for OTU-3 Int	G.959.1, G.693	Refer Tables 8-16, 8-17, 8-18 of ITU-T G.959.1(attached).	For different Application codes*, refer to Clause 5 of ITU-T G.959.1.
L.19	OTU-3	Mean total Output Power for OTU-3 Int	G.959.1, G.693	Refer Tables 8-16, 8-17, 8-18 of ITU-T G.959.1 (attached). Refer Clause 7 of ITU-T G.693(attached).	For different Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.693.
L.20	OTU-3	Minimum Receiver Overload for OTU-3 Int	G.959.1, G.693	+3dBm	
L.21	OTU-3	Nominal Bit Rate with Tolerance OTU-3 Int	G.709	255/236 × 39 813 120 kbit/s ± 20 ppm (43018413.559 kbit/s ± 20 ppm)	Refer Table 7-1 of ITU-T G.709
L.22	OTU-3	Receiver Sensitivity for OTU-3 Int	G.959.1, G.693	Refer Tables 8-16, 8-17, 8-18 of ITU-T G.959.1(attached). Refer Clause 7 of ITU-T G.693(attached).	For different Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.693. .
L.23	OTU-4	Central Frequency for OTU-4 Int	G.959.1, G.695	229.0 + 0.8 m, m = 0 to 3 (THz)	
L.24	OTU-4	Mean total input Power for OTU-4 Int	G.959.1, G.695	Table 8-5, 8-6 G.959.1/Table 8-23 G.695(attached)	For different Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.695
L.25	OTU-4	Mean Total Output Power for OTU-4int	G.959.1, G.695	Table 8-5, 8-6 G.959.1/Table 8-23 G.695(attached)	For different Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.695
L.26	OTU-4	Minimum receiver overload for OTU-4	G.959.1, G.695		

		Int			
L.27	OTU-4	Nominal Bit Rate with Tolerance OTU-4 Int	G.709	255/227 × 99 532 800 kbit/s ± 20 ppm (111809973.568 kbit/s ± 20 ppm)	Refer Table 7-1 of ITU-T G.709
L.28	OTU-4	Receiver Sensitivity for OTU-4 Int	G.959.1, G.695	Table 8-5, 8-6 G.959.1/Table 8-23 G.695(attached)	For different Application codes*, refer to Clause 5 of ITU-T G.959.1 and G.695

***Application codes differ based on the fibre, no of channels, span distance/attenuation etc., so the respective tables may be referred for the value.**

Note:- Attachment to Annexure-L is placed at the end of document

Annexure-M: Mobile Handset and Tablet Test Parameters

Parameter Group: Mobile Functional (MOBFUNC)

S. No.	Applicability	Parameter Name	Standard	Test Procedure
M.1	Mobile Handset and Tablet	Mobile device - Non-Zero IMEI/MEID/ESN	GSMA official document IMEI Allocation & Approval Process	Appendix-II, Test-30
M.2	Mobile Handset – Feature Phone	Mobile Emergency Support - Panic Button	G.S.R. No. 436 (E) dated 22-04-2016, 3GPP TS 22.101 for GSM/ UMTS/ LTE, 3GPP2 C.S0023 for CDMA.	Appendix-II, Test-31
M.3	Mobile Handset – Smart Phone	Mobile Emergency Support - Panic Button	G.S.R. No. 436 (E) dated 22-04-2016, 3GPP TS 22.101 for GSM/ UMTS/ LTE, 3GPP2 C.S0023 for CDMA.	Appendix-II, Test-32
M.4	Mobile Handset – Smart Phone	Mobile Emergency Support - GPS Location	G.S.R. No. 1441 (E) dated 23-11-2017.	Appendix-II, Test-33
M.5	Mobile Handset	Mobile Emergency Support - Call on 112	DoT 16-04/2015-AS-III/NP/67/120 dt 4.5.16, 3GPP2 C.S0023 for CDMA 2000, 3GPP TS 22.101 and TS 24.008 for GSM/ UMTS/ LTE.	Appendix-II, Test-34
M.6	Mobile Handset	Mobile Device Indian Language Support	IS 16333 (Part 3).	Appendix-II, Test-37
M.7	Mobile Handset	SAR Display for Mobile Handset	TEC/GR/SAR/001/01.MAR.09 or IEC Standard 62209-1	Appendix-II, Test-35
M.8	Mobile Handset	SAR Value for Mobile Handset	IEC 62209-1:2005 TEC/GR/SAR/001/01.MAR.09	62209-1: 2005 or later version
M.9	IoT Devices	IoT Dev - Non-0 IMEI or MEID or Unique MAC	GSMA official document IMEI Allocation & Approval Process (for IMEI / MEID)	Device manufacturer shall mention the suitable procedure for testing IMEI/ MEID/ MAC address/ any other unique ID by

				connecting device to smart phone/ tablet/ PC and without using any specialised test equipment
M.10	(i) SAR values for IoT devices expected to be worn on the body.	Parameters given in section 4.2.1, table- iv of STANDARD No.: TEC13016:2023	STANDARD No.: TEC 13016:2023 , Section 4.2.1 Table -iv	As per STANDARD No.: TEC 13016:2023
	(ii) SAR values for IoT devices expected to be worn on the body near the head.	Parameters given in section 4.2.1, table- v of STANDARD No.: TEC 13016:2023	STANDARD No.: TEC 13016:2023 , Section 4.2.1 Table -v	As per STANDARD No.: TEC 13016:2023
	(iii) SAR values for IoT devices expected to be used in close proximity of 20 cm or less to the body	Parameters given in section 4.2.1, table- vi of STANDARD No.: TEC13016:2023	STANDARD No.: TEC 13016:2023 , Section 4.2.1 Table -vi	As per STANDARD No.: TEC 13016:2023
M.11	Fixed Wireless Phone (FWP)	FWP Emergency Support - Call on112	DoT 16-04/2015-AS-III/NP/67/120 dt 4.5.16, 3GPP2 C.S0023 for CDMA 2000, 3GPP TS 22.101 and TS 24.008 for GSM/ UMTS/ LTE.	Appendix-II, Test-45

Annexure-P1: IP Conformance Parameters – SIP and SIPI – RFC 3261 and Q.1912.5

Parameter Group: IP Conformance

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P1.1	SIP Parameters Set-A	SIP Header : Message Body Type	RFC 3261	Clause 7.4.1	SIP Terminal, PABX
P1.2	SIP Parameters Set-A	Generating SIP request (To, R-URI, From, Call-ID, CSeq, Max-Forwards, Via)	RFC 3261	Clause 8.1.1, 8.1.1.2 to 8.1.1.7	SIP Terminal, PABX
P1.3	SIP Parameters Set-A	SIP Dialog and Transaction	RFC 3261	Clause 12, 12.1.1, 12.1.2	SIP Terminal, PABX
P1.4	SIP Parameters Set-A	SIP Terminating a Session with a BYE request.	RFC 3261	Clause 15	SIP Terminal, PABX
P1.5	SIP Parameters Set-A	SIP Creating the initial invite	RFC 3261	Clause 13.2.1	SIP Terminal, PABX
P1.6	SIP Parameters Set-A	User Authentication	RFC 3261	Clause 21	SIP Terminal, PABX
P1.7	SIP Parameters Set-B	SIP - Call Flow	RFC 3261	Clause 4	LMGW
P1.8	SIP Parameters Set-B	SIP Header : Message Body Type	RFC 3261	Clause 7.4.1	LMGW
P1.9	SIP Parameters Set-B	Generating SIP request (To, R-URI, From, Call-ID, CSeq, Max-Forwards, Via)	RFC 3261	Clause 8.1.1, 8.1.1.2 to 8.1.1.7	LMGW
P1.10	SIP Parameters Set-B	SIP Dialog and Transaction	RFC 3261	Clause 12, 12.1.1, 12.1.2	LMGW
P1.11	SIP Parameters Set-B	SIP Terminating a Session with a BYE request.	RFC 3261	Clause 15	LMGW

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P1.12	SIP Parameters Set-B	SIP Creating the initial invite	RFC 3261	Clause 13.2.1	LMGW
P1.13	SIP Parameters Set-B	User Authentication	RFC 3261	Clause 21	LMGW
P1.14	SIP Parameters Set-C	SIP - Max Forwards (Not for SIPS URI)	RFC 3261	Clause 8.1.1.6	SBC
P1.15	SIP Parameters Set-C	SIP - Message Body length (Not for SIPS URI)	RFC 3261	Clause 7.4.2	SBC
P1.16	SIP Parameters Set-C	SIP - Responses (Not for SIPS URI)	RFC 3261	Clause 7.2	SBC
P1.17	SIP Parameters Set-D	SIP - Max Forwards (Not for SIPS URI)	RFC 3261	Clause 8.1.1.6	SOFT SWITCH
P1.18	SIP Parameters Set-D	SIP - Message Body length (Not for SIPS URI)	RFC 3261	Clause 7.4.2	SOFT SWITCH
P1.19	SIP Parameters Set-D	SIP - Responses (Not for SIPS URI)	RFC 3261	Clause 7.2	SOFT SWITCH
P1.20	SIP Parameters Set-D	SIP - Cancelling a Request	RFC 3261	Clause 9	SOFT SWITCH
P1.21	SIP Parameters Set-D	SIP - Client Behaviour (Not for SIPS URI)	RFC 3261	Clause 9.1	SOFT SWITCH
P1.22	SIPI Parameters	SIPI - Conventions for representation of ISUP PDU	Q 1912.5	Clause 5.1	SOFT SWITCH
P1.23	SIPI Parameters	SIPI - Conventions for representation of SIP/SDP information	Q 1912.5	Clause 5.2	SOFT SWITCH
P1.24	SIPI Parameters	SIPI - IAM parameters	Q 1912.5	Clause 6.1.3	SOFT SWITCH

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P1.25	SIPI Parameters	SIPI - INVITE received with an SDP offer	Q 1912.5	Clause 6.1.2	SOFT SWITCH
P1.26	SIPI Parameters	SIPI - INVITE received without an SDP offer	Q 1912.5	Clause 6.1.1	SOFT SWITCH
P1.27	SIPI Parameters	SIPI - ISUP encapsulation – detailed procedures	Q 1912.5	Clause 5.4	SOFT SWITCH
P1.28	SIPI Parameters	SIPI - Sending of Initial Address Message (IAM)	Q 1912.5	Clause 6.1	SOFT SWITCH

Annexure-P2: IP Conformance Parameters – RTP – RFC 3550

Parameter Group: IP Conformance (CONFIP)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P2.1	RTP Parameters Set-A	RTP: Sender report RTCP packet version	RFC 3550	Clause 6.4.1	SIP Terminal, PABX
P2.2	RTP Parameters Set-A	RTP: Sequence number	RFC 3550	Clause 5.1	SIP Terminal, PABX
P2.3	RTP Parameters Set-A	RTP: Version and Port	RFC 3550	Clause 5.1	SIP Terminal, PABX
P2.4	RTP Parameters Set-A	RTP: Payload Type	RFC 3550	Clause 5.1	SIP Terminal, PABX
P2.5	RTP Parameters Set-A	RTP: SSRC Identification	RFC 3550	Clause 5.1	SIP Terminal, PABX
P2.6	RTP Parameters Set-B	RTP: Sender report RTCP packet version	RFC 3550	Clause 6.4.1	LMGW, MGW
P2.7	RTP Parameters Set-B	RTP: Sequence number	RFC 3550	Clause 5.1	LMGW, MGW
P2.8	RTP Parameters Set-B	RTP: Version and Port	RFC 3550	Clause 5.1	LMGW, MGW
P2.9	RTP Parameters Set-B	RTP: Payload Type	RFC 3550	Clause 5.1	LMGW, MGW
P2.10	RTP Parameters Set-C	RTP: Byte Order, Alignment, and Time Format	RFC 3550	Clause 4	Session Border Controller
P2.11	RTP Parameters Set-C	RTP: Simple Multicast Audio Conference	RFC 3550	Clause 2.1	Session Border Controller

Annexure-P3: IP Conformance Parameters – RTCP – RFC 3551

Parameter Group: IP Conformance (CONFIP)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P3.1	RTCP Parameters Set-A	RTCP: Port Assignment	RFC 3551	Clause 8	SIP Terminal
P3.2	RTCP Parameters Set-A	RTCP: Registering Additional Encodings	RFC 3551	Clause 3	SIP Terminal
P3.3	RTCP Parameters Set-A	RTCP: GSM-EFR	RFC 3551	Clause 4.5.9	SIP Terminal
P3.4	RTCP Parameters Set-A	RTCP: Guidelines 1 for sample-based audio encodings	RFC 3551	Clause 4.3	SIP Terminal
P3.5	RTCP Parameters Set-A	RTCP: Guidelines 2 for sample-based audio encodings	RFC 3551	Clause 4.4	SIP Terminal
P3.6	RTCP Parameters Set-B	RTCP: Port Assignment	RFC 3551	Clause 8	Session Border Controller
P3.7	RTCP Parameters Set-B	RTCP: Registering Additional Encodings	RFC 3551	Clause 3	Session Border Controller

Annexure-P4: IP Conformance Parameters – TCP – RFC 793

Parameter Group: IP Conformance (CONFIP)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P4.1	TCP Parameters	Header Format and Sequence Numbers	RFC 793	Clause 3.1, 3.3 Clause 1.4, 2.3, 3.1, Test terminology as per clause 3.2	MGW, SIP Terminal, PABX SBC

Annexure-P5: IP Conformance Parameters – UDP – RFC 768 and MGCP – H.248

Parameter Group: IP Conformance (CONFIP)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P5.1	UDP Parameters	UDP Format	RFC 768		MGW, LMGW, SBC, Soft Switch, PABX
P5.2	UDP Parameters	User Terminology	RFC 768		MGW, LMGW, SBC, Soft Switch, PABX
P5.3	MGCP Parameters	Connection Model	H.248	Clauses 6.1 & 6.2	MGW, LMGW, Soft Switch

Annexure-P6: IP Conformance Parameters – IPV4 and Dual Stack – RFC 791 and RFC 4213

Parameter Group: IP Conformance (CONFIP) (For IoT devices / gateways: - IPv4 / Dual IP parameters will be tested if feature is available.)

(For IP Terminals: - Dual IP layer operation: DNS parameters will be tested if the feature is available.)

Note : *Applicable for ONT Product variant in ER on PON family: The Test parameters i.e. (i) Dual IP Layer Operation RFC 4213 – Address, (ii) Dual IP Layer Operation RFC 4213 – DNS, will not be applicable for products which supports only bridge mode. In such case, non-blocking of IPv4/IPv6 shall be verified with test report for throughput with IPv4 and IPv6 traffic. Refer Test Case No. 43*

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P6.1	IPV4 Parameters Set-A	Model of operation	RFC 791	Clause 2.2	MGW, SGW, PABX
P6.2	IPV4 Parameters Set-A	Internet Header Format	RFC 791	Clause 3.1	MGW, SGW, PABX, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**
P6.3	IPV4 Parameters Set-A	Addressing	RFC 791	Clause 3.2	MGW, SGW, PABX
P6.4	IPV4 Parameters Set-B	Model of operation	RFC 791	Clause 2.2	SBC
P6.5	IPV4 Parameters Set-B	Gateways	RFC 791	Clause 2.4	SBC, **IoT Gateway**
P6.6	IPV4 Parameters Set-B	Interfaces	RFC 791	Clause 3.3	SBC
P6.7	IPV4 Parameters Set-C	Function Description	RFC 791	Clause 2.3	SOFT SWITCH
P6.8	IPV4 Parameters Set-C	Gateways	RFC 791	Clause 2.4	SOFT SWITCH
P6.9	IPV4 Parameters Set-C	Interfaces	RFC 791	Clause 3.3	SOFT SWITCH
P6.10	Dual IP layer operation: Address	Dual IP layer operation: Address Configuration	RFC 4213	Clause 2.1	WiFi Access Point, WiFi CPE, DSL NT Modem, ONU, ONT, SBC, IP Terminal, , **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera,**

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
					Smart Watch Product should demostrate support to all IPv6 services through respective RFCs and clause numbers.
P6.11	Dual IP layer operation: DNS	Dual IP layer operation: DNS	RFC 4213	Clause 2.2	SBC, IP Terminal, PON ONT Product should demostrate support to all IPv6 services through respective RFCs and clause numbers.
P6.12	Dual IP layer operation: Tunnelling	Dual IP layer operation: Tunnelling	RFC 4213	Clause 3	WiFi Access Point, WiFi CPE, DSL NT Modem, ONU, ONT, OLT, MGW, LMGW, PABX, SBC, Mobile Device, CCNProduct should demostrate support to all IPv6 services through respective RFCs and clause numbers.
P6.13	Dual IP layer operation: Tunnelling	Dual IP layer operation: Tunnelling	RFC 4213	Clause 3.2.1	**IoT Gateway**
P6.14	Dual IP layer operation: Decapsulation	Dual IP layer operation: Decapsulation	RFC 4213	Clause 3.6	**IoT Gateway**
P6.15	Dual IP layer operation: Link Local Address	Dual IP layer operation: Link Local Address	RFC 4213	Clause 3.7	**IoT Gateway**
P6.16	Dual IP Layer Operation RFC 4213 - Static Tunnel MTU	Dual IP Layer Operation RFC 4213 - Static Tunnel MTU	RFC 4213	Clause No. 3.2.1	

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P6.17	Dual IP Layer Operation RFC 4213 - Decapsulation	Dual IP Layer Operation RFC 4213 - Decapsulation	RFC 4213	Clause No. 3.6	
P6.18	Dual IP Layer Operation RFC 4213 - Link-Local Addresses	Dual IP Layer Operation RFC 4213 - Link-Local Addresses	RFC 4213	Clause No. 3.7	
P6.19	Dual IP Layer Operation RFC 4213 - Neighbor Discovery over Tunnels	Dual IP Layer Operation RFC 4213 - Neighbor Discovery over Tunnels	RFC 4213	Clause No. 3.8	
P6.20	Dual IP Layer Operation RFC 4213 - Security Considerations	Dual IP Layer Operation RFC 4213 - Security Considerations	RFC 4213	Clause No. 5	

Annexure-P7: IPv6 Conformance Parameters

Parameter Group: IP Conformance (CONFIP) (For IoT devices / gateways:- IPv6 parameters will be tested if feature is available.)

Note : *Applicable for ONT Product variant in ER on PON family: The Test parameters i.e. (i) IPV6 Header Parameters, (ii) IPV6 Extn Header Parameters, will not be applicable for products which supports only bridge mode. In such case, non-blocking of IPv4/IPv6 shall be verified with test report for throughput with IPv4 and IPv6 traffic. Refer Test Case No. 43.*

S. No.	**Parameter Name**	**Individual Parameter Name**	**IETF RFC**	**Clause/ Section**	**Applicability/ Remarks**
P7.1	IPV6 Header Parameters	Header: Version Field	RFC 2460 / RFC 8200	Clause 3	SIP Terminal, SBC, Mobile Device, ONU, ONT, OLT, CCN, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**
P7.2	IPV6 Header Parameters	Header: Traffic Class	RFC 2460 / RFC 8200	Clause 3	SIP Terminal, SBC, Mobile Device, ONU, ONT, OLT, CCN, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**
P7.3	IPV6 Header Parameters	Header: Flow Label	RFC 2460 / RFC 8200	Clause 3	SIP Terminal, SBC, Mobile Device, ONU, ONT, OLT, CCN, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking**

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
					device, Smart camera, Smart Watch
P7.4	IPV6 Header Parameters	Header: Payload Length	RFC 2460 / RFC 8200	Clause 3	SIP Terminal, SBC, Mobile Device, ONU, ONT, OLT, CCN, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**
P7.5	IPV6 Header Parameters	Header: No next header after IPv6 Header	RFC 2460 / RFC 8200	Clause 3	SIP Terminal, SBC, Mobile Device, ONU, ONT, OLT, CCN, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**
P7.6	IPV6 Header Parameters	Header: Hop Limit	RFC 2460 / RFC 8200	Clause 3	SIP Terminal, SBC, Mobile Device, ONU, ONT, OLT, CCN, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**
P7.7	IPV6 Header Parameters	Header: Source and Destination Address	RFC 2460 / RFC 8200	Clause 3	SIP Terminal, SBC, Mobile Device, ONU, ONT, OLT, CCN, **IoT Gateway,**

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
					Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch
P7.8	IPV6 Extn. Header Parameters	IPv6 Extension Header Order	RFC 2460 / RFC 8200	Clause 4.1	Mobile Device, ONU, ONT, OLT, CCN, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**
P7.9	IPV6 Extn. Header Parameters	IPv6 Extension Header Options	RFC 2460 / RFC 8200	Clause 4.2	Mobile Device, ONU, ONT, OLT, CCN
P7.10	IPV6 Extn. Header Parameters	IPv6 Extension Header Hop by Hop Options	RFC 2460 / RFC 8200	Clause 4.3	Mobile Device, ONU, ONT, OLT, CCN
P7.11	IPV6 Extn. Header Parameters	IPv6 Extension Header Routing	RFC 2460 / RFC 8200	Clause 4.4	Mobile Device, ONU, ONT, OLT,CCN, **IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**
P7.12	IPV6 Extn. Header Parameters	IPV6 Extn. Header Fragment Header	RFC 8200	Clause 4.5	**IoT Gateway, Feedback device, Smart Electricity meter, Tracking device, Smart camera, Smart Watch**

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P7.13	IPV6 Packet Size Issues parameter	IPV6 Packet Size Issues	RFC 8200	Clause 5	**IoT Gateway**
P7.14	IPV6 Extension Header Order	IPV6 Extension Header Order	RFC 2460 / RFC 8200 Clause No. 4.1 RFC 4213	Clause No. 4, 5 Annexure-P7	
P7.15	IPV6 Options	IPV6 Options	RFC 2460 / RFC 8200	Clause No. 4.2 Annexure-P7	
P7.16	IPV6 Routing Header	IPV6 Routing Header	RFC 2460 / RFC 8200	Clause No. 4.4 Annexure-P7	
P7.17	IPV6 Fragment Header	IPV6 Fragment Header	RFC 2460 / RFC 8200	Clause No. 4.5 Annexure-P7	
P7.18	IPV6 Destination Options Header	IPV6 Destination Options Header	RFC 2460 / RFC 8200	Clause No. 4.6 Annexure-P7	
P7.19	IPV6 No Next Header	IPV6 No Next Header	RFC 2460 / RFC 8200	Clause No. 4.7 Annexure-P7	
P7.20	IPV6 Packet Size Issues	IPV6 Packet Size Issues	RFC 2460 / RFC 8200	Clause No. 5 Annexure-P7	
P7.21	IPV6 Upper-Layer Checksums	IPV6 Upper-Layer Checksums	RFC 2460 / RFC 8200	Clause No. 8.1 Annexure-P7	

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P7.22	IPV6 Responding to Packets Carrying Routing Headers	IPV6 Responding to Packets Carrying Routing Headers	RFC 2460 / RFC 8200	Clause No. 8.4 Annexure-P7	

Annexure-P8: IP Conformance Parameters – DTMF – RFC 4733

Parameter Group: IP Conformance (CONFIP)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P8.1	DTMF Parameters Set-A	RTP payload format for named telephones events	RFC 4733	Clause 2	MGW,LMGW
P8.2	DTMF Parameters Set-A	Use of RTP header fields	RFC 4733	Clause 2.2	MGW,LMGW
P8.3	DTMF Parameters Set-A	Payload Format	RFC 4733	Clause 2.3	MGW,LMGW
P8.4	DTMF Parameters Set-B	DTMF: Applications	RFC 4733	Clause 3.1	Soft Switch
P8.5	DTMF Parameters Set-B	DTMF: Congestion Consideration	RFC 4733	Clause 3.3	Soft Switch
P8.6	DTMF Parameters Set-B	DTMF: Events	RFC 4733	Clause 3.2	Soft Switch
P8.7	DTMF Parameters Set-B	DTMF: Payload Format	RFC 4733	Clause 2.3	Soft Switch
P8.8	DTMF Parameters Set-B	DTMF: RTP payload format for named telephones events	RFC 4733	Clause 2	Soft Switch
P8.9	DTMF Parameters Set-B	DTMF: Specification of Events codes for DTMF events	RFC 4733	Clause 3	Soft Switch
P8.10	DTMF Parameters Set-B	DTMF: Use of RTP header fields	RFC 4733	Clause 2.2	Soft Switch
P8.11	DTMF Parameters Set-C	DTMF: Duration negotiation	RFC 4733	Clause 2.3.5	PABX
P8.12	DTMF Parameters Set-C	DTMF: Negotiation of Payload	RFC 4733	Clause 2.5.1.1	PABX
P8.13	DTMF Parameters Set-C	DTMF: Transmission of Event Packet	RFC 4733	Clause 2.5.1.2	PABX
P8.14	DTMF Parameters Set-C	DTMF: Verification of sequence	RFC 4733	Clause 2.2.1	PABX

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
		no. and time stamp			

Annexure-P9: IP Conformance Parameters – SCTP – RFC 4960

Parameter Group: IP Conformance (CONFIP)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P9.1	SCTP Parameters Set-A	SCTP packet Format	RFC 4960	Clause 3	MGW, LMGW, SGW
P9.2	SCTP Parameters Set-A	SCTP common header field descriptions	RFC 4960	Clause 3.1	MGW, LMGW, SGW
P9.3	SCTP Parameters Set-A	Chunk field descriptions	RFC 4960	Clause 3.2	MGW, LMGW, SGW
P9.4	SCTP Parameters Set-A	Optional/variable-length parameters format	RFC 4960	Clause 3.2.1	MGW, LMGW, SGW
P9.5	SCTP Parameters Set-A	Reporting of unrecognized parameters	RFC 4960	Clause 3.2.2	MGW, LMGW, SGW
P9.6	SCTP Parameters Set-A	SCTP association state diagram	RFC 4960	Clause 4	MGW, LMGW, SGW
P9.7	SCTP Parameters Set-B	User Data Fragmentation	RFC 4960	Clause 1.5.3	SBC, Soft Switch
P9.8	SCTP Parameters Set-B	Path Management	RFC 4960	Clause 1.5.7	SBC, Soft Switch
P9.9	SCTP Parameters Set-B	Transmission of DATA Chunks	RFC 4960	Clause 6.1	SBC, Soft Switch
P9.10	SCTP Parameters Set-B	Path Failure Detection	RFC 4960	Clause 8.2	SBC, Soft Switch

Annexure-P10: IP Conformance Parameters – M3UA – RFC 4960 and Signalling over IP – RFC 2719

Parameter Group: IP Conformance (CONFIP)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P10.1	M3UA Parameters	Procedures to Support the M3UA-User	RFC 3332	Clause 4.1	Soft Switch, SGW
P10.2	M3UA Parameters	Establishment of Association and Traffic Between SGs and ASPs	RFC 3332	Clause 5.1	Soft Switch, SGW
P10.3	M3UA Parameters	M3UA Port Number	RFC 3332	Clause 7.2	Soft Switch, SGW
P10.4	M3UA Protocol Extensions Parameter	M3UA Protocol Extensions	RFC 3332	Clause 7.3	Soft Switch, SGW
P10.5	Signalling Protocol Over IP	Gateway Component Functions	RFC2719	Clause 2.1	SGW
P10.6	Signalling Protocol Over IP	SS7 Interworking for Connection Control	RFC2719	Clause 2.2	SGW
P10.7	Signalling Protocol Over IP	ISDN Interworking for Connection Control	RFC2719	Clause 2.3	SGW
P10.8	Signalling Protocol Over IP	Architecture for Database Access	RFC2719	Clause 2.4	SGW
P10.9	Signalling Protocol Over IP	SG to SG	RFC2719	Clause 3.5	SGW

Annexure-P11: IP Conformance Parameters – Functional Tests for IP

Parameter Group: IP Conformance (CONFIP)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P11.1	IPV4 Parameters Set-D	IPV4 Functional Tests	RFC 791	Appendix-II, Test-5	LAN Switch, Router
P11.2	SNMPv2 Parameters	SNMPv2 Functional Tests	RFC 3416	Appendix-II, Test-38	LAN Switch, Router, IP Security Products
P11.3	SNMPv3 Parameters	SNMPv3 Functional Tests	RFC 3410	Appendix-II, Test-39,	LAN Switch, Router, IP Security Products
P11.4	SNMPv2 or Qx Protocol Parameters	SNMPv2 or Qx Protocol functional test		Appendix-II, Test-6	LAN Switch, Router
P11.5	SNMPv3 or Qx Protocol Parameters	SNMPv3 or Qx Protocol functional test		Appendix-II, Test-7, 77	LAN Switch, Router
P11.6	Netconf/Yang	Netconf/Yang Functional test	RFC 6241 RFC 6020	Appendix-II, Test-68	LAN Switch, Router, IP Security Products
P11.7	Dynamic Routing	Dynamic Routing Functional Tests		Appendix-II, Test-8	Router, L3 switch
P11.8	Static Routing	Static Routing Functional Tests		Appendix-II, Test-9	Router, L3 switch
P11.9	TCP Parameters	TCP Functional Tests	RFC 793	Appendix-II, Test-10	Router
P11.10	Mac Learning & Pkt Fwdg	Mac Learning and Packet Forwarding		Appendix-II, Test-11	LAN Switch

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P11.11	Spanning Tree Protocol Test	Spanning Tree Protocol Root Bridge Election Functional Test	IEEE 802.1d	Appendix-II, Test-12	LAN Switch
P11.12	Spanning Tree Protocol Test	Spanning Tree Protocol Port Blocking Functional Test	IEEE 802.1d	Appendix-II, Test-13	LAN Switch
P11.13	OSPFv2	OSPFv2	RFC2328	Appendix-I, Table-1	
P11.14	OSPFv3 for IPv6	OSPFV3	RFC2740	Appendix-I, Table-2	
P11.15	IPV6 Complete Suite	RFC 2460 or 8200	RFC2460/8200	Appendix-I, Table-3	
P11.16	IPV6 Complete Suite	RFC 4861	RFC4862	Appendix-I, Table-4	
P11.17	IPV6 Complete Suite	RFC 4862	RFC4862	Appendix-I, Table-5	
P11.18	IPV6 Complete Suite	RFC 1981	RFC1981	Appendix-I, Table-6	
P11.19	IPV6 Complete Suite	RFC 4443	RFC4443	Appendix-I, Table-7	
P11.20	BGP for IPv6	BGP for IPV6	RFC2545	Appendix-I, Table-8	
P11.21	BGP4		RFC4271	Appendix-I, Table-9	
P11.22	MBGP		RFC4760	Appendix-I, Table-10	
P11.23	LDP		RFC5036	Appendix-I, Table-11	
P11.24	IPSec Functional Test	IPSec Functional Test		Appendix-II, Test-16	
P11.25	NAT Functional Test	NAT Functional Test		Appendix-II, Test-17, 18	
P11.26	Policy Functional Test	Policy Functional Test		Appendix-II, Test-19	
P11.27	IDS Functional Test	IDS Functional Test		Appendix-II, Test-20, 21	
P11.28	IDS for Management & Analytic Equipment	IDS Functional Test for i. Network Security Management Equipment Network Security Analytic		Appendix-II, Test-69	

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
		equipment (Managed & Unmanaged)			
P11.29	IPS Functional Test	IPS Functional Test		Appendix-II, Test-22, 23	IP Security Products
P11.30	UTM URL, Content & Anti-Virus Filtering Functional Test	UTM URL, Content & Anti-Virus Filtering Functional Test		Appendix-II, Test-24, 25, 26	IP Security Products
P11.31	Profile for frequency synchronisation	Profile for frequency synchronisation		Appendix-II, Test-27	PTP GM
P11.32	Profile for time and phase synchronisation with full timing support	Profile for time and phase synchronisation with full timing support		Appendix-II, Test-28	PTP GM
P11.33	Profile for time and phase synchronisation with partial timing support	Profile for time and phase synchronisation with partial timing support		Appendix-II, Test-29	PTP GM
P11.34	PPPoE	PPPoE Functional Test	RFC2516	Appendix-II, Test-14	PON, Router
P11.35	Radius / AAA/ Diameter	Radius Functional Test	RFC2865/ 3539 6733	Appendix-II, Test-15, 67	Router, IP Security Products
P11.36	MPLS-TP Requirement	MPLS-TP Requirement	RFC 5654	Clause 2	MPLS TP CEN Switch (Conformance testing)
P11.37	Ethernet PWE and Service Identification	Ethernet PWE and Service Identification	RFC 4448	Clause 4	MPLS TP Switch (Conformance testing)

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P11.38	TDM PWE and Service Identification	TDM PWE and Service Identification	RFC 3916	Clause 4 & Clause 7.1	MPLS TP Switch (Conformance testing)
P.11.39	Network Visibility, Monitoring and Logging	Network Visibility, Monitoring and Logging Functional Test		Appendix-II, Test-46	IP Security Products
P11.40	Encrypted traffic analysis	Encrypted traffic analysis Functional test		Appendix-II, Test-47	IP Security Products
P11.41	Application visibility and control	Application visibility and control Functional Test		Appendix-II, Test-48	IP Security Products
P11.42	SSL Proxy	SSL Proxy Functional test		Appendix-II, Test-49	IP Security Products
P11.43	Data Loss Prevention	Data Loss Prevention Functional Test		Appendix-II, Test-50	IP Security Products
P11.44	L3 DDoS protection	L3 DDoS protection Functional Test		Appendix-II, Test-51	IP Security Products
P11.45	L4 DDoS protection	L4 DDoS protection Functional Test		Appendix-II, Test-52	IP Security Products
P11.46	L7 DDoS protection	L7 DDoS protection Functional Test		Appendix-II, Test-53	IP Security Products
P11.47	Static Analysis	Static Analysis Functional Test		Appendix-II, Test-54	IP Security Products
P11.48	Manageability SNMPV3	Functional Test		Appendix-II, Test-81	LAN Switch, Router, IP Security Products

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
P11.49	Dynamic Analysis	Dynamic Analysis Functional Test		Appendix-II, Test-55	IP Security Products
P11.50	Protecting against common vulnerabilities -SQL injection	Functional Test		Appendix-II, Test-56	IP Security Products
P11.51	Protecting against common vulnerabilities – Cross Site Scripting (XSS)	Functional Test		Appendix-II, Test-57	IP Security Products
P11.52	Protecting against common vulnerabilities – Protection against Brute forcing.	Functional Test		Appendix-II, Test-58	IP Security Products
P11.53	Protecting against common vulnerabilities – Server Side Request Forgery (SSRF)	Functional Test		Appendix-II, Test-59	IP Security Products
P11.54	Protecting against common vulnerabilities – HTTP method validation	Functional Test		Appendix-II, Test-60	IP Security Products
P11.55	Protecting against common vulnerabilities -Protection against File inclusion attack	Functional Test		Appendix-II, Test-61	IP Security Products
P11.56	Protecting against common vulnerabilities – Command Injection	Functional Test		Appendix-II, Test-62	IP Security Products
P11.57	Protecting against common vulnerabilities – Path traversal	Functional Test		Appendix-II, Test-63	IP Security Products
P11.58	Protecting against common vulnerabilities – Client Side	Functional Test		Appendix-II, Test-64	IP Security Products

S. No.	Parameter Name	Individual Parameter Name	IETF RFC	Clause/ Section	Applicability/ Remarks
	Request Forgery (CSRF)				
P11.59	Protecting against common vulnerabilities – Monitoring & Audit event generation	Functional Test		Appendix-II, Test-65	IP Security Products
P11.60	Reverse Proxy	Functional Test		Appendix-II, Test-66	IP Security Products
P11.61	FC Zone Server	Functional Test	RFC 4936	Appendix-II, Test-70, 71, 72, 73, 74	LAN Switch
P11.62	FC Logins	Functional Test	RFC 4172	Appendix-II, Test-75	LAN Switch
P11.63	FC Name Server	Functional Test	RFC 4438	Appendix-II, Test-76	LAN Switch
P11.64	FC Registered State Change Notifications	Functional Test	RFC 4983	Appendix-II, Test-77	LAN Switch
P11.65	FC Management	Functional Test	RFC 4044	Appendix-II, Test-78	LAN Switch
P11.66	FC Frame Encapsulation	Functional Test	RFC 3643	Appendix-II, Test-79	LAN Switch
P11.67	FC Packet Forwarding	Functional Test	RFC 2625	Appendix-II, Test-80	LAN Switch
P11.68	FC Static Routing	Functional Test	RFC 2625	Appendix-II, Test-82	LAN Switch
P11.69	FC Dynamic Routing	Functional Test	RFC 4626	Appendix-II, Test-83	LAN Switch
P11.70	FC Security Protocols	Functional Test	RFC 5324	Appendix-II, Test-84	LAN Switch

Annexure-P12: IP Conformance Parameters- DHCP

Parameter Group: IP Conformance (CONFIP)

S. No	Parameter Name	Individual Parameter	IETF RFC	Clause / Section
P12.1	DHCP client v4/v6	DHCP 4o6 Client Behavior	RFC 7341	Clause 9
P12.2		DHCP Unique Identifier (DUID)	RFC 8415	Clause 11

Annxeure Q: Optical Fibre (Single Mode) Tests

I. ITU-T G.652.D Optical Fibre – (Variant 1)

SN	Parameter Name	Individual Parameter Name	Standard	Limits/ Values
1	**Geometrical Characteristics**	Mode Field Diameter at 1310 nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-45	9.2 ± 0.4 µm
2		Cladding Diameter	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	125 ± 0.7 µm
3		Cladding Non-circularity	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.8 %
4		Core Clad concentricity error	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.5 µm
5		Coating diameter	IEC 60793-2-50 and IEC 60793-1-21	242 ± 5 µm (uncolor); 252 ± 10µm (color)
6		Coating /Cladding concentricity	IEC 60793-2-50 and IEC 60793-1-21	≤ 12 µm
7	**Transmission Characteristics** (Attenuation of uncabled fibre)	At 1310 nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.34 dB/km
8		At 1550 nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.20 dB/km
9		At 1490 nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.24 dB/km
10		At 1270 nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.40 dB/km
11		At 1625 nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.23 dB/km
12		Water peak attenuation at 1380 to 1390 nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.34 dB/km
13		Sudden irregularity in attenuation	Telcordia GR-20-CORE,2013 and IEC 60793-1-40	≤ 0.1 dB

14	**Transmission Characteristics** (Chromatic Dispersion)	At 1550nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 18.0 ps/nm.Km
15		At 1625nm	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 22.0 ps/nm.Km
16		In 1285-1330nm band	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 3.5 ps/nm.Km
17		In 1270-1340nm band	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 5.3 ps/nm.Km
18		Zero Dispersion slope	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 0.092 ps/(nm^2 Km)
19		Zero Dispersion wavelength range	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	1300 - 1324nm
20	**Transmission Characteristics** (Polarization mode dispersion)	Uncabled Fiber	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.15 ps/√km
21		Link design value for un-cabled fibre	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.06 ps/√km
22	**Transmission Characteristics** (Cutoff wavelength)	Cable cut-off wavelength	ITU-T G.652 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1260nm Max
23	**Transmission Characteristics** (Fibre Macro bend loss)	Change in attenuation when fiber is coiled with 100 turns on 60 ±1.0 mm diameter mandrel	ITU-T G.652 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 0.05 dB at 1550 nm ≤ 0.1 dB at 1625 nm
24		Change in attenuation when fiber is coiled with 1 turn around 32 ± 0.5 mm diameter mandrel	ITU-T G.652 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 0.5 dB at 1550 nm ≤ 1.0 dB at 1625 nm
25		Change in attenuation when fiber is coiled with 100 turns on 50 ±0.5 mm diameter mandrel	ITU-T G.652 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 0.05 dB at 1310 nm
26	**Mechanical Characteristics**	Proof test for minimum strain level	ITU-T G.652, G.650.1 and IEC 60793-2-50, 60793-1-30	1%
27		Peak Stripability force to remove primary coating of the fiber (Unaged,	IEC 60793-2-50, 60793-1-32	1.0 ≤ N ≤ 8.9 N (Peak) 1.0 ≤ N ≤ 5.0 N (Average)

		Water aged, Damp heat aged		
28		Dynamic Tensile Strength Un aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 550 KPSI (3.80Gpa)
29		Dynamic Tensile Strength Aged (Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 440 KPSI (3.00Gpa)
30		Dynamic Fatigue (Unaged and Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-33	≥ 20
31		Fiber Curl	IEC 60793-2-50, 60793-1-34	≥ 4 Meter radius of curvature
32	**Environmental Characteristics of Fiber for both color and uncolor fibres**	Temperature Cycle Test: Temperature Dependence of Attenuation: Induced Attenuation at 1550 nm and 1625 nm at -60°C to +85°C	IEC 60793-2-50 and IEC 60793-1-52	≤ 0.05 dB/Km
33		Temperature-Humidity Cycle Test: Induced attenuation at 1550 nm and 1625 nm at -10C TO +85°C and 95% relative humidity	EIA/TIA 455-73	≤ 0.05 dB/Km
34		Water Immersion Test: Induced attenuation at 1550 nm and 1625 nm due to water immersion at 23 ± 2°C	IEC 60793-2-50 and IEC 60793-1-53	≤ 0.05dB/Km
35		Accelerated Aging (Dry Heat) Test: Induced attenuation at 1550 nm and 1625 nm due to Temperature aging at 85 ± 2° C	IEC 60793-2-50 and IEC 60793-1-51	≤ 0.05 dB/Km
36		Retention of Coating Color: Coated fibre aged for 30 days at 85°C temperature with 95% Humidity and then 20 days in 85°C dry heat	IEC 60793-2-50 and IEC 60793-1-51	No change in colour of coated fibre
37		High Temperature and High Humidity (Damp Heat) Test: Induced attenuation at 1550 nm & 1625 nm at 85°C temperature and 85% Relative Humidity for 30 days	IEC 60793-2-50 and IEC 60793-1-50	≤ 0.05 dB/Km
38		Cable Material Compatibility test for	Telcordia GR-20-CORE,2013; Draft	• Aged coating strip force:

		fibre : Fibre to be aged with filling compound for 30 days at 85°C temperature and 85% Relative Humidity	IEC 60794-1-219	$1.0 \leq F \leq 8.9$ N (Peak) $1.0 \leq F \leq 5.0$ N (Average) • Visual Inspection under 5X magnification: No fibre coatings cracking, splitting, or delamination. • For coloured fibres, colour to be identifiable and no colour transfers to the filling compound. • MEK Rub Test as mentioned below in test no 39.
39	**Colour qualification for color fibres**	MEK RUB Test (Methyl Ethyl Ketone)	Draft IEC 60794-1-219	To be tested by using socked (solvent) tissue paper for ten strokes unidirectional on 10cm length of the fiber. No color trace shall be observed on tissue paper after testing.
40	**Material Properties :**	Fiber Materials: The substances of which the fibres are made	RoHS 3 (EU 2015/863)	Fibre material to be RoHS complied.

N.B.: Latest issue of above mentioned Standards may be referred.

II. ITU-T G.655 Optical Fibre (Variant 2)

SN	Parameter Name	Individual Parameter Name	Standard	Limits/ Values
1	**Geometrical Characteristics**	Mode Field Diameter at 1550 nm	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-45	9.6 ± 0.4 µm
2		Cladding Diameter	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	125 ± 0.7 µm
3		Cladding Non-circularity	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.8 %
4		Core Clad concentricity error	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.5 µm
5		Coating diameter	IEC 60793-2-50 and IEC 60793-1-21	242 ± 5 µm (uncolor); 252 ± 10 µm (color)

6		Coating /Cladding concentricity	IEC 60793-2-50 and IEC 60793-1-21	≤ 12 µm
7	**Transmission Characteristics** (Attenuation of uncabled fibre)	At 1550 nm	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.21 dB/km
8		At 1625 nm	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.23 dB/km
9		Sudden irregularity in attenuation	Telcordia GR-20-CORE,2013 and IEC 60793-1-40	≤ 0.1 dB
10	**Transmission Characteristics** (Chromatic Dispersion)	At 1530 to 1565 nm	ITU-T G.655, G.650.1 and IEC 60793-2-50, 60793-1-42	Min value of Dmin - 1.0 ps/nm.Km Max value of Dmax - 10.0 ps/nm.Km Dmax – Dmin: ≤5.0 ps/nm.km
11		At 1565 to 1625nm	ITU-T G.655, G.650.1 and IEC 60793-2-50, 60793-1-42	Min value of Dmin - 4.0 ps/nm.Km Max value of Dmax - 14.0 ps/nm.Km
12		Dispersion slope at 1550 nm	ITU-T G.655, G.650.1 and IEC 60793-2-50, 60793-1-42	≤ 0.09 ps/(nm^2 Km)
13	**Transmission Characteristics** (Polarization mode dispersion)	Uncabled Fiber	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.15 ps/√km
14		Link design value for un-cabled fibre	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.1 ps/√km
15	**Transmission Characteristics** (Cutoff Wavelength)	Cable cut off wavelength	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1450 nm Max
16	**Transmission Characteristics** (Fibre Macro bend loss)	Change in attenuation when fiber is coiled with 100 turns on 60 ±1.0 mm diameter mandrel	ITU-T G.655 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 0.05 dB at 1550 nm ≤ 0.1 dB at 1625 nm
17		Change in attenuation when fiber is coiled with 1 turn around 32 ± 0.5 mm diameter mandrel	ITU-T G.655 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 0.5 dB at 1550 nm ≤ 0.5 dB at 1625 nm
18	**Mechanical Characteristics**	Proof test for minimum strain level	ITU-T G.655, G.650.1 and IEC 60793-2-50, 60793-1-30	1%
19		Peak Stripability force to remove primary coating of the fiber (Unaged,	IEC 60793-2-50, 60793-1-32	1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average)

		Water aged, Damp heat aged)		
20		Dynamic Tensile Strength (Un aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 550 KPSI (3.80Gpa)
21		Dynamic Tensile Strength Aged (Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 440 KPSI (3.00Gpa)
22		Dynamic Fatigue (Unaged and Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-33	≥ 20
23		Fiber Curl	IEC 60793-2-50, 60793-1-34	≥ 4 Meter radius of curvature
24	**Environmental Characteristics of Fiber (for both color and uncolor fibres)**	Temperature Cycle Test: Temperature Dependence of Attenuation : Induced Attenuation at 1550 nm and 1625 nm at -60°C to +85°C	IEC 60793-2-50 and IEC 60793-1-52	≤ 0.05 dB/Km
25		Temperature-Humidity Cycle Test: Induced attenuation at 1550 nm and 1625 nm at -10° C TO +85° C and 95% relative humidity	EIA/TIA 455-73	≤ 0.05 dB/Km
26		Water Immersion Test: Induced attenuation at 1550 nm and 1625 nm due to water immersion at 23 ± 2°C	IEC 60793-2-50 and IEC 60793-1-53	≤ 0.05dB/Km
27		Accelerated Aging (Dry Heat) Test: Induced attenuation at 1550 nm and 1625 nm due to Temperature aging at 85 ± 2° C	IEC 60793-2-50 and IEC 60793-1-51	≤ 0.05 dB/Km
28		Retention of Coating Color: Coated fibre aged for 30 days at 85°C temperature with 95% Humidity and then 20 days in 85°C dry heat	IEC 60793-2-50 and IEC 60793-1-51	No change in colour of coated fibre
29		High Temperature and High Humidity (Damp Heat) Test: Induced attenuation at 1550 nm & 1625 nm at 85°C temperature and 85% Relative Humidity for 30 days	IEC 60793-2-50 and IEC 60793-1-50	≤ 0.05 dB/Km

30		Cable Material Compatibility test for fibre : Fibre to be aged with filling compound for 30 days at 85°C temperature and 85% Relative Humidity	Telcordia GR-20-CORE,2013; Draft IEC 60794-1-219	• Aged coating strip force: $1.0 \leq F \leq 8.9$ N (Peak) $1.0 \leq F \leq 5.0$ N (Average) • Visual Inspection under 5X magnification: No fibre coatings cracking, splitting, or delamination. • For coloured fibres, colour to be identifiable and no colour transfers to the filling compound. • MEK Rub Test as mentioned below in test no 31.
31	**Colour qualification**	MEK RUB Test (Methyl Ethyl Ketone)	Draft IEC 60794-1-219	To be tested by using socked (solvent) tissue paper for ten strokes unidirectional on 10cm length of the fiber. No color trace shall be observed on tissue paper after testing.
32	**Material Properties :**	Fiber Materials: The substances of which the fibres are made	RoHS 3 (EU 2015/863)	Fibre material to be RoHS complied.

N.B.: Latest issue of above mentioned Standards may be referred.

III. ITU-T G.656 Optical Fibre (Variant 3)

SN	Parameter Name	Individual Parameter Name	Standard	Limits/ Values
1	**Geometrical Characteristics**	Mode Field Diameter at 1550 nm	ITU-T G.656 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-45	9.2 ± 0.4 µm
2		Cladding Diameter	ITU-T G.656 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	125 ± 0.7 µm

3		Cladding Non-circularity	ITU-T G.656 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 1 %
4		Core Clad concentricity error	ITU-T G.656 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.5 µm
5		Coating diameter	IEC 60793-2-50 and IEC 60793-1-21	242 ± 5 µm (uncolor); 252 ± 10µm (color)
6		Coating /Cladding concentricity	IEC 60793-2-50 and IEC 60793-1-21	≤ 12 µm
7	**Transmission Characteristics** (Attenuation of uncabled fibre)	At 1460	ITU-T G.656, G.650.1 and IEC 60793-2-50, 60793-1-40	≤ 0.26 dB/km
8		At 1550 nm	ITU-T G.656, G.650.1 and IEC 60793-2-50, 60793-1-40	≤ 0.21 dB/km
9		At 1625 nm	ITU-T G.656, G.650.1 and IEC 60793-2-50, 60793-1-40	≤ 0.24 dB/km
10		At 1383 nm	ITU-T G.656, G.650.1 and IEC 60793-2-50, 60793-1-40	≤ 0.4 dB/km
11		Sudden irregularity in attenuation	Telcordia GR-20-CORE,2013	≤ 0.05 dB
12	**Transmission Characteristics** (Chromatic Dispersion)	At 1460 to 1550 nm	ITU-T G.656, G.650.1 and IEC 60793-2-50, 60793-1-42	1.0- 9.28 ps/nm.Km
13		At 1550 to 1625 nm	ITU-T G.656, G.650.1 and IEC 60793-2-50, 60793-1-42	3.6 – 14.0 ps/nm.Km
14		Dispersion slope at 1550 nm	ITU-T G.656, G.650.1 and IEC 60793-2-50, 60793-1-42	≤ 0.07 ps/(nm^2 Km)
15	**Transmission Characteristics** (Polarization mode dispersion)	Uncabled Fiber	ITU-T G.656 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.15 ps/√km
16		Link design value for un-cabled fibre	ITU-T G.655 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.2 ps/√km
17	**Transmission Characteristics**	Cable cutoff wavelength	ITU-T G.656 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-	1450 nm Max

	(Cut off wavelength)		44	
18	**Transmission Characteristics** (Fibre Macro bend loss)	Change in attenuation when fiber is coiled with 100 turns on 60 ±1.0 mm diameter mandrel	ITU-T G.656 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 0.05 dB at 1550 nm ≤ 0.1 dB at 1625 nm
19		Change in attenuation when fiber is coiled with 1 turn around 32 ± 0.5 mm diameter mandrel	ITU-T G.656 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 0.5 dB at 1550 nm ≤ 0.5 dB at 1625 nm
20	**Mechanical Characteristics**	Proof test for minimum strain level	ITU-T G.656, G.650.1 and IEC 60793-2-50, 60793-1-30	1%
21		Peak Stripability force to remove primary coating of the fiber (Unaged, Water aged, Damp heat aged)	IEC 60793-2-50, 60793-1-32	1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average)
22		Dynamic Tensile Strength (Un aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 550 KPSI (3.80Gpa)
23		Dynamic Tensile Strength Aged (Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 440 KPSI (3.00Gpa)
24		Dynamic Fatigue Unaged and Damp heat aged	IEC 60793-2-50 and IEC 60793-1-33	≥ 20
25		Fiber Curl	IEC 60793-2-50, 60793-1-34	≥ 4 Meter radius of curvature
26	**Environmental Characteristics of Fiber for both color and uncolor fibres**	Temperature Cycle Test: Temperature Dependence of Attenuation : Induced Attenuation at 1550 nm and 1625 nm at -60°C to +85°C	IEC 60793-2-50 and IEC 60793-1-52	≤ 0.05 dB/Km
27		Temperature-Humidity Cycle Test: Induced attenuation at 1550 nm and 1625 nm at -10°C to +85°C and 95% relative humidity	EIA/TIA 455-73	≤ 0.05 dB/Km
28		Water Immersion Test: Induced attenuation at 1550 nm and 1625 nm due to water immersion at 23 ± 2°C	IEC 60793-2-50 and IEC 60793-1-53	≤ 0.05dB/Km

29		Accelerated Aging (Dry Heat) Test: Induced attenuation at 1550 nm and 1625 nm due to Temperature aging at 85 ± 2° C	IEC 60793-2-50 and IEC 60793-1-51	≤ 0.05 dB/Km
30		Retention of Coating Color: Coated fibre aged for 30 days at 85℃ temperature with 95% Humidity and then 20 days in 85℃ dry heat	IEC 60793-2-50 and IEC 60793-1-51	No change in colour of coated fibre
31		High Temperature and High Humidity (Damp Heat) Test: Induced attenuation at 1550 nm & 1625 nm at 85℃ temperature and 85% Relative Humidity for 30 days	IEC 60793-2-50 and IEC 60793-1-50	≤ 0.05 dB/Km
32		Cable Material Compatibility test for fibre : Fibre to be aged with filling compound for 30 days at 85℃ temperature and 85% Relative Humidity	Telcordia GR-20-CORE,2013; Draft IEC 60794-1-219	• Aged coating strip force: 1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average) • Visual Inspection under 5X magnification: No fibre coatings cracking, splitting, or delamination. • For coloured fibres, colour to be identifiable and no colour transfers to the filling compound. • MEK Rub Test as mentioned below in test no 33.
33	**Colour qualification**	MEK RUB Test (Methyl Ethyl Ketone)	Draft IEC 60794-1-219	To be tested by using socked (solvent) tissue paper for ten strokes unidirectional on 10cm length of the fiber. No color trace shall be observed on tissue paper after testing.
34	**Material Properties :**	Fiber Materials: The substances of which the fibres are made	RoHS 3 (EU 2015/863)	Fibre material to be RoHS complied.

N.B.: Latest issue of above mentioned Standards may be referred.

IV. ITU-T G.657.A1 Optical Fibre (Variant 4)

SN	Parameter Name	Individual Parameter Name	Standard	Limits/ Values
1	**Geometrical Characteristics**	Mode Field Diameter at 1310 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-45	(8.8-9.2) ± 0.4 µm
2		Cladding Diameter	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	125 ± 0.7 µm
3		Cladding Non-circularity	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.8 %
4		Core Clad concentricity error	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.5 µm
5		Coating diameter a) 250µm fibre b) 200µm fibre	IEC 60793-2-50 and IEC 60793-1-21	242 ± 5 µm (uncolor); 252 ± 10 µm (color) 180-210 µm (uncolor); 180-220µm (color)
6		Coating /Cladding concentricity a) 250µm fibre b) 200µm fibre	IEC 60793-2-50 and IEC 60793-1-21	≤ 12 µm ≤ 10 µm
7	**Transmission Characteristics** (Attenuation of uncabled fibre)	At 1310 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.34 dB/km
8		At 1550 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.20 dB/km
9		At 1490 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and	≤ 0.24 dB/km

			IEC 60793-1-40	
10		At 1270 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.40 dB/km
11		At 1625 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.23 dB/km
12		Water peak attenuation at 1380 to 1390 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.34 dB/km
13		Sudden irregularity in attenuation	Telcordia GR-20-CORE,2013 and IEC 60793-1-40	≤ 0.1 dB
14	**Transmission Characteristics** (Chromatic Dispersion)	At 1550nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 18.0 ps/nm.Km
15		At 1625nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 22.0 ps/nm.Km
16		In 1285-1330nm band	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 3.5 ps/nm.Km
17		In 1270-1340nm band	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 5.3 ps/nm.Km
18		Zero Dispersion slope	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 0.092 ps/(nm^2 Km)
19		Zero Dispersion wavelength range	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	1300 - 1324nm
20	**Transmission Characteristics** (Polarization	Un-cabled Fiber	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.15 ps/√km

21	mode dispersion)	Link design value for un-cabled fibre	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.06 ps/√km
22	**Transmission Characteristics** (Cut-off wavelength)	Fiber cut off wavelength for fibre used in Patch cords & Pig-tails (2m sample)	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1260nm Max
23		Cable cut off wavelength	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1260nm Max
24	**Transmission Characteristics** (Fibre Macro bend loss)	Change in attenuation when fibre is coiled with 10 turns on 15 mm radius mandrel	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-47	≤ 0.25 dB at 1550 nm ≤ 1.0 dB at 1625 nm
25		Change in attenuation when fibre is coiled with 1 turn on 10 mm radius mandrel	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-47	≤ 0.75 dB at 1550 nm ≤ 1.5 dB at 1625 nm
26	**Mechanical Characteristics**	Proof test for minimum strain level	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-30	1%
27		Peak Stripability force to remove primary coating of the fiber (Unaged, Water aged, Damp heat aged) a) 250 µm fibre b) 200µm fibre	IEC 60793-2-50, 60793-1-32	1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average) 0.4 ≤ F ≤ 8.9 N (Peak) 0.4 ≤ F ≤ 5.0 N (Average)
28		Dynamic Tensile Strength (Un aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 550 KPSI (3.80Gpa)
29		Dynamic Tensile Strength Aged (Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 440 KPSI (3.00Gpa)
30		Dynamic Fatigue (Unaged and Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-33	≥ 20

31		Fiber Curl	IEC 60793-2-50, 60793-1-34	≥ 4 Meter radius of curvature
32	**Environmental Characteristics of Fiber for both color and uncolor fibres**	Temperature Cycle Test: Temperature Dependence of Attenuation : Induced Attenuation at 1550 nm and 1625 nm at -60°C to +85°C	IEC 60793-2-50 and IEC 60793-1-52	≤ 0.05 dB/Km
33		Temperature-Humidity Cycle Test: Induced attenuation at 1550 nm and 1625 nm at -10° C TO +85° C and 95% relative humidity	EIA/TIA 455-73	≤ 0.05 dB/Km
34		Water Immersion Test: Induced attenuation at 1550 nm and 1625 nm due to water immersion at 23 ± 2°C	IEC 60793-2-50 and IEC 60793-1-53	≤ 0.05dB/Km
35		Accelerated Aging (Dry Heat) Test: Induced attenuation at 1550 nm and 1625 nm due to Temperature aging at 85 ± 2° C	IEC 60793-2-50 and IEC 60793-1-51	≤ 0.05 dB/Km
36		Retention of Coating Color: Coated fibre aged for 30 days at 85℃ temperature with 95% Humidity and then 20 days in 85℃ dry heat	IEC 60793-2-50 and IEC 60793-1-51	No change in colour of coated fibre
37		High Temperature and High Humidity (Damp Heat) Test: Induced attenuation at 1550 nm & 1625 nm at 85℃ temperature and 85% Relative Humidity for 30 days	IEC 60793-2-50 and IEC 60793-1-50	≤ 0.05 dB/Km
38		Cable Material Compatibility test for fibre : Fibre to be aged with filling compound for 30 days at 85℃ temperature and 85% Relative Humidity	Telcordia GR-20-CORE,2013; Draft IEC 60794-1-219	• Aged coating strip force: 1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average) • Visual Inspection under 5X magnification: No fibre coatings cracking, splitting, or

				delamination. • For coloured fibres, colour to be identifiable and no colour transfers to the filling compound. • MEK Rub Test as mentioned below in test no 39.
39	**Colour qualification**	MEK RUB Test (Methyl Ethyl Ketone)	Draft IEC 60794-1-219	To be tested by using socked (solvent) tissue paper for ten strokes unidirectional on 10cm length of the fiber. No color trace shall be observed on tissue paper after testing.
40	**Material Properties :**	Fiber Materials: The substances of which the fibres are made	RoHS 3 (EU 2015/863)	Fibre material to be RoHS complied.

N.B.: Latest issue of above mentioned Standards may be referred.

V. ITU-T G.657.A2 Optical Fibre (Variant 5)

SN	Parameter Name	Individual Parameter Name	Standard	Limits/ Values
1	**Geometrical Characteristics**	Mode Field Diameter at 1310 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-45	**(8.6 to 9.2) ± 0.4 µm**
2		Cladding Diameter	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	125 ± 0.7 µm
3		Cladding Non-circularity	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.8 %
4		Core Clad concentricity error	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.5 µm
5		Coating diameter a) 250µm fibre b) 200µm fibre	IEC 60793-2-50 and IEC 60793-1-21	242 ± 5 µm (uncolor); 252 ± 10 µm (color) 180-210 µm (uncolor); 180-220µm (color)
6		Coating /Cladding concentricity a) 250µm fibre b) 200µm fibre	IEC 60793-2-50 and IEC 60793-1-21	≤ 12 µm ≤ 10 µm
7	**Transmission Characteristics** (Attenuation of uncabled fibre)	At 1310 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.35 dB/km
8		At 1550 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.21 dB/km
9		At 1490 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.24 dB/km
10		At 1270 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and	≤ 0.40 dB/km

			IEC 60793-1-40	
11		At 1625 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.23 dB/km
12		Water peak attenuation at 1380 to 1390 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.35 dB/km
13		Sudden irregularity in attenuation	Telcordia GR-20-CORE,2013 and IEC 60793-1-40	≤ 0.1 dB
14	**Transmission Characteristics** (Chromatic Dispersion)	At 1550nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 18.0 ps/nm.Km
15		At 1625nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 22.0 ps/nm.Km
16		In 1285-1330nm band	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 3.5 ps/nm.Km
17		In 1270-1340nm band	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 5.3 ps/nm.Km
18		Zero Dispersion slope	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 0.092 ps/(nm^2 Km)
19		Zero Dispersion wavelength range	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	1300 - 1324nm
20	**Transmission Characteristics** (Polarization mode dispersion)	Uncabled Fiber	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.2 ps/√km
21		Link design value for un-cabled fibre	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.06 ps/√km

22	**Transmission Characteristics** (Cut off wavelength)	Fiber cut off wavelength for fibre used in Patch cords & Pig-tails (2m sample)	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1260nm Max
23		Cable cut-off wavelength	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1260nm Max
24	**Transmission Characteristics** (Fibre Macro bend loss)	Change in attenuation when fibre is coiled with 10 turns on 15 mm radius mandrel	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-47	≤ 0.03 dB at 1550 nm ≤ 0.1 dB at 1625 nm
25		Change in attenuation when fibre is coiled with 1 turn on 10 mm radius mandrel	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-47	≤ 0.1 dB at 1550 nm ≤ 0.2 dB at 1625 nm
26		Change in attenuation when fibre is coiled with 1 turn on 7.5 mm radius mandrel	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-47	≤ 0.5 dB at 1550 nm ≤ 1.0 dB at 1625 nm
27	**Mechanical Characteristics**	Proof test for minimum strain level	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-30	1%
28		Peak Stripability force to remove primary coating of the fiber (Unaged, Water aged, Damp heat aged) a) 250 µm fibre b) 200µm fibre	IEC 60793-2-50, 60793-1-32	1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average) 0.4 ≤ F ≤ 8.9 N (Peak) 0.4 ≤ F ≤ 5.0 N (Average)
29		Dynamic Tensile Strength (Un aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 550 KPSI (3.80Gpa)
30		Dynamic Tensile Strength Aged (Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 440 KPSI (3.00Gpa)
31		Dynamic Fatigue Unaged and Damp heat aged	IEC 60793-2-50 and IEC 60793-1-33	≥ 20
32		Fiber Curl	IEC 60793-2-50, 60793-1-34	≥ 4 Meter radius of curvature

33	**Environmental Characteristics of Fiber for both color and uncolor fibres**	Temperature Cycle Test: Temperature Dependence of Attenuation : Induced Attenuation at 1550 nm and 1625 nm at -60°C to +85°C	IEC 60793-2-50 and IEC 60793-1-52	≤ 0.05 dB/Km
34		Temperature-Humidity Cycle Test: Induced attenuation at 1550 nm and 1625 nm at -10° C TO +85° C and 95% relative humidity	EIA/TIA 455-73	≤ 0.05 dB/Km
35		Water Immersion Test: Induced attenuation at 1550 nm and 1625 nm due to water immersion at 23±2°C	IEC 60793-2-50 and IEC 60793-1-53	≤ 0.05dB/Km
36		Accelerated Aging (Dry Heat) Test: Induced attenuation at 1550 nm and 1625 nm due to Temperature aging at 85±2° C	IEC 60793-2-50 and IEC 60793-1-51	≤ 0.05 dB/Km
37		Retention of Coating Color: Coated fibre aged for 30 days at 85°C temperature with 95% Humidity and then 20 days in 85°C dry heat	IEC 60793-2-50 and IEC 60793-1-51	No change in colour of coated fibre
38		High Temperature and High Humidity (Damp Heat) Test: Induced attenuation at 1550 nm & 1625 nm at 85°C temperature and 85% Relative Humidity for 30 days	IEC 60793-2-50 and IEC 60793-1-50	≤ 0.05 dB/Km
39		Cable Material Compatibility test for fibre : Fibre to be aged with filling compound for 30 days at 85°C temperature and 85% Relative Humidity	Telcordia GR-20-CORE,2013; Draft IEC 60794-1-219	• Aged coating strip force: 1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average) • Visual Inspection under 5X magnification: No fibre coatings cracking, splitting, or delamination. • For coloured fibres, colour to be

				identifiable and no colour transfers to the filling compound. • MEK Rub Test as mentioned below in test no 40.
40	**Colour qualification**	MEK RUB Test (Methyl Ethyl Ketone)	Draft IEC 60794-1-219	To be tested by using socked (solvent) tissue paper for ten strokes unidirectional on 10cm length of the fiber. No color trace shall be observed on tissue paper after testing.
41	**Material Properties :**	Fiber Materials: The substances of which the fibres are made	RoHS 3 (EU 2015/863)	Fibre material to be RoHS complied.

N.B.: Latest issue of above mentioned Standards may be referred.

VI. G.657.B3 Optical Fibre (Variant 6)

SN	Parameter Name	Individual Parameter Name	Standard	Limits/ Values
1	**Geometrical Characteristics**	Mode Field Diameter at 1310 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-45	8.6 ± 0.4 µm
2		Cladding Diameter	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	125 ± 0.7 µm
3		Cladding Non-circularity	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.8 %
4		Core Clad concentricity error	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.5 µm
5		Coating diameter	IEC 60793-2-50 and IEC 60793-1-21	242 ± 7 µm (uncolor); 252 ± 10 µm (color)
6		Coating /Cladding concentricity	IEC 60793-2-50 and IEC 60793-1-21	≤ 12 µm
7	**Transmission Characteristics**	At 1310 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.35 dB/km

8	(Attenuation of uncabled fibre)	At 1550 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.22 dB/km
9		At 1490 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.24 dB/km
10		At 1270 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.40 dB/km
11		At 1625 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.24 dB/km
12		Water peak attenuation at 1380 to 1390 nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.35 dB/km
13		Sudden irregularity in attenuation	Telcordia GR-20-CORE,2013 and IEC 60793-1-40	≤ 0.1 dB
14	**Transmission Characteristics** (Chromatic Dispersion)	At 1550nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 18.0 ps/nm.Km
15		At 1625nm	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 22.0 ps/nm.Km
16		In 1285-1330nm band	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 3.5 ps/nm.Km
17		In 1270-1340nm band	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 5.3 ps/nm.Km
18		Zero Dispersion slope	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	≤ 0.092 ps/(nm^2 Km)
19		Zero Dispersion wavelength range	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-42	1300 – 1350 nm
20	**Transmission Characteristics** (Polarization mode dispersion)	Uncabled Fiber	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.2 ps/√km
21		Link design value for un-cabled fibre	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.06 ps/√km
22	**Transmission Characteristics** (Cut-off wavelength)	Fiber cut off wavelength for fibre used in Patch cords & Pig-tails	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1260nm Max
23		Cable cutoff wavelength	ITU-T G.657 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1260nm Max
24	**Transmission Characteristics**	Change in attenuation when fibre is coiled with 1 turn on 10 mm radius	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-47	≤ 0.03 dB at 1550 nm ≤ 0.1 dB at 1625 nm

	(Fibre Macro bend loss)	mandrel		
25		Change in attenuation when fibre is coiled with 1 turn on 7.5 mm radius mandrel	ITU-T G.657, G.650.1	≤ 0.08 dB at 1550 nm ≤ 0.25 dB at 1625 nm
26		Change in attenuation when fibre is coiled with 1 turn on 5 mm radius mandrel	IEC 60793-2-50, 60793-1-47	≤ 0.15 dB at 1550 nm ≤ 0.45 dB at 1625 nm
27	**Mechanical Characteristics**	Proof test for minimum strain level	ITU-T G.657, G.650.1 and IEC 60793-2-50, 60793-1-30	1%
28		Peak Stripability force to remove primary coating of the fiber (Unaged, Water aged, Damp heat aged)	IEC 60793-2-50, 60793-1-32	1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average)
29		Dynamic Tensile Strength (Un aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 550 KPSI (3.80Gpa)
30		Dynamic Tensile Strength Aged (Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 440 KPSI (3.00Gpa)
31		Dynamic Fatigue (Unaged and Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-33	≥ 20
32		Fiber Curl	IEC 60793-2-50, 60793-1-34	≥ 4 Meter radius of curvature
33	**Environmental Characteristics of Fiber for both color and uncolor fibres**	Temperature Cycle Test: Temperature Dependence of Attenuation : Induced Attenuation at 1550 nm and 1625 nm at -60°C to +85°C	IEC 60793-2-50 and IEC 60793-1-52	≤ 0.05 dB/Km
34		Temperature-Humidity Cycle Test: Induced attenuation at 1550 nm and 1625 nm at -10° C TO +85° C and 95% relative humidity	EIA/TIA 455-73	≤ 0.05 dB/Km
35		Water Immersion Test: Induced attenuation at 1550 nm and 1625 nm due to water immersion at 23 ± 2°C	IEC 60793-2-50 and IEC 60793-1-53	≤ 0.05dB/Km

36		Accelerated Aging (Dry Heat) Test: Induced attenuation at 1550 nm and 1625 nm due to Temperature aging at 85 ± 2° C	IEC 60793-2-50 and IEC 60793-1-51	≤ 0.05 dB/Km
37		Retention of Coating Color: Coated fibre aged for 30 days at 85°C temperature with 95% Humidity and then 20 days in 85°C dry heat	IEC 60793-2-50 and IEC 60793-1-51	No change in colour of coated fibre
38		High Temperature and High Humidity (Damp Heat) Test: Induced attenuation at 1550 nm & 1625 nm at 85°C temperature and 85% Relative Humidity for 30 days	IEC 60793-2-50 and IEC 60793-1-50	≤ 0.05 dB/Km
39		Cable Material Compatibility test for fibre : Fibre to be aged with filling compound for 30 days at 85°C temperature and 85% Relative Humidity	Telcordia GR-20-CORE,2013; Draft IEC 60794-1-219	• Aged coating strip force: 1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average) • Visual Inspection under 5X magnification: No fibre coatings cracking, splitting, or delamination. • For coloured fibres, colour to be identifiable and no colour transfers to the filling compound. • MEK Rub Test as mentioned below in test no 40.
40	**Colour qualification**	MEK RUB Test (Methyl Ethyl Ketone)	Draft IEC 60794-1-219	To be tested by using socked (solvent) tissue paper for ten strokes unidirectional on 10cm length of the fiber. No color trace shall be observed on tissue paper after testing.
41	**Material Properties :**	Fiber Materials: The substances of which the fibres are made	RoHS 3 (EU 2015/863)	Fibre material to be RoHS complied.

N.B.: Latest issue of above mentioned Standards may be referred.

VII. G.654.D Optical Fibre (Variant 7)

SN	Parameter Name	Individual Parameter Name	Standard	Limits/ Values
1	**Geometrical Characteristics**	Mode Field Diameter at 1550 nm	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-45	(11.5 to 15.0) ± 0.7 µm
2		Cladding Diameter	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	125 ± 1 µm
3		Cladding Non-circularity	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 2.0 %
4		Core Clad concentricity error	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.8 µm
5		Coating diameter	IEC 60793-2-50 and IEC 60793-1-21	242 ± 5 µm (uncolor); 252 ± 10 µm (color)
6		Coating /Cladding concentricity	IEC 60793-2-50 and IEC 60793-1-21	≤ 12 µm
7	**Transmission Characteristics** (Attenuation of uncabled fibre)	At 1550 nm	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-40	≤ 0.20 dB/km
8		At 1625nm	IEC 60793-2-50 and IEC 60793-1-40	≤ 0.40 dB/km
9		Sudden irregularity in attenuation	Telcordia GR-20-CORE,2013 and IEC 60793-1-40	≤ 0.1 dB
10	**Transmission Characteristics** (Chromatic Dispersion)	At 1550 nm	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-42	Maximum 23 ps/nm.Km
11		Dispersion slope at 1550 nm	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-42	≤ 0.070 ps/(nm^2 Km)
12	**Transmission Characteristics**(Polarization mode dispersion)	Uncabled Fiber	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.20 ps/√km
13		Link design value for un-cabled fibre	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.20 ps/√km
14	**Transmission Characteristics** (Cut-off	Cable cut-off wavelength	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1530 nm Max

	wavelength)			
15	**Transmission Characteristic** (Fibre Macro bend loss)	Change in attenuation when fiber is coiled with 100 turns on 60 ±1.0 mm diameter mandrel	ITU-T G.654 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 2.0 dB at 1625 nm
16	**Mechanical Characteristics**	Proof test for minimum strain level	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-30	Minimum 0.69 GPa
17		Peak Stripability force to remove primary coating of the fiber (Unaged, Water aged, Damp heat aged)	IEC 60793-2-50, 60793-1-32	1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average)
18		Dynamic Tensile Strength (Un aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 550 KPSI (3.80Gpa)
19		Dynamic Tensile Strength Aged (Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 440 KPSI (3.00Gpa)
20		Dynamic Fatigue (Unaged and Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-33	≥ 20
21		Fiber Curl	IEC 60793-2-50, 60793-1-34	≥ 4 Meter radius of curvature
22	**Environmental Characteristics of Fiber for both color and uncolor fibres**	Temperature Cycle Test: Temperature Dependence of Attenuation : Induced Attenuation at 1550 nm and 1625 nm at -60°C to +85°C	IEC 60793-2-50 and IEC 60793-1-52	≤ 0.05 dB/Km
23		Temperature-Humidity Cycle Test: Induced attenuation at 1550 nm and 1625 nm at -10° C TO +85° C and 95% relative humidity	EIA/TIA 455-73	≤ 0.05 dB/Km
24		Water Immersion Test: Induced attenuation at 1550 nm and 1625 nm due to water immersion at 23 ± 2°C	IEC 60793-2-50 and IEC 60793-1-53	≤ 0.05dB/Km

25		Accelerated Aging (Dry Heat) Test: Induced attenuation at 1550 nm and 1625 nm due to Temperature aging at 85 ± 2° C	IEC 60793-2-50 and IEC 60793-1-51	≤ 0.05 dB/Km
26		Retention of Coating Color: Coated fibre aged for 30 days at 85℃ temperature with 95% Humidity and then 20 days in 85℃ dry heat	IEC 60793-2-50 and IEC 60793-1-51	No change in colour of coated fibre
27		High Temperature and High Humidity (Damp Heat) Test: Induced attenuation at 1550 nm & 1625 nm at 85℃ temperature and 85% Relative Humidity for 30 days	IEC 60793-2-50 and IEC 60793-1-50	≤ 0.05 dB/Km
28		Cable Material Compatibility test for fibre : Fibre to be aged with filling compound for 30 days at 85℃ temperature and 85% Relative Humidity	Telcordia GR-20-CORE,2013; Draft IEC 60794-1-219	• Aged coating strip force: 1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average) • Visual Inspection under 5X magnification: No fibre coatings cracking, splitting, or delamination. • For coloured fibres, colour to be identifiable and no colour transfers to the filling compound. • MEK Rub Test as mentioned below in test no 29.
29	**Colour qualification**	MEK RUB Test (Methyl Ethyl Ketone)	Draft IEC 60794-1-219	To be tested by using socked (solvent) tissue paper for ten strokes unidirectional on 10cm length of the fiber. No color trace shall be observed on tissue

				paper after testing.
30	**Material Properties :**	Fiber Materials: The substances of which the fibres are made	RoHS 3 (EU 2015/863)	Fibre material to be RoHS complied.

N.B.: Latest issue of above mentioned Standards may be referred.

VIII. ITU-T G.654.E Optical Fibre (Variant 8)

SN	Parameter Name	Individual Parameter Name	Standard	Limits/ Values
1	**Geometrical Characteristics**	Mode Field Diameter at 1550 nm	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-45	(11.5 to 12.5) ± 0.7 µm
2		Cladding Diameter	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	125 ± 1 µm
3		Cladding Non-circularity	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 2.0 %
4		Core Clad concentricity error	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-20	≤ 0.8 µm
5		Coating diameter	IEC 60793-2-50 and IEC 60793-1-21	242 ± 5 µm (uncolor); 252 ± 10 µm (color)
6		Coating /Cladding concentricity	IEC 60793-2-50 and IEC 60793-1-21	≤ 12 µm
7	**Transmission Characteristics** (Attenuation of uncabled fibre)	At 1550 nm	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-40	≤ 0.23 dB/km
8		At 1530nm - 1612nm	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-40	≤ 0.25 dB/km
9		At 1612nm - 1625nm	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-40	≤ 0.35 dB/km
10		Sudden irregularity in attenuation	Telcordia GR-20-CORE, 2013, IEC 60793-1-40	≤ 0.1 dB
11	**Transmission Characteristics** (Chromatic Dispersion)	At 1550 nm	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-42	17 - 23 ps/nm.Km
12		Dispersion slope at 1550 nm	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-42	0.050 - 0.070 ps/(nm^2 Km)
13	**Transmission Characteristics** (Polarization mode dispersion)	Uncabled Fiber	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.20 ps/√km
14		Link design value for un-cabled fibre	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-48	≤ 0.20 ps/√km

15	**Transmission Characteristics** (Cut-off wavelength)	Cable cutoff wavelength	ITU-T G.654 and ITU-T G.650.1; IEC 60793-2-50 and IEC 60793-1-44	1530 nm Max
16	**Transmission Characteristics** (Fibre Macro bend loss)	Change in attenuation when fiber is coiled with 100 turns on 60 ±1.0 mm diameter mandrel	ITU-T G.654 ,ITU-T G.650.1, IEC 60793-2-50 and IEC 60793-1-47	≤ 0.1 dB at 1625 nm
17	**Mechanical Characteristics**	Proof test for minimum strain level	ITU-T G.654, G.650.1 and IEC 60793-2-50, 60793-1-30	Minimum 0.69 GPa
18		Peak Stripability force to remove primary coating of the fiber (Unaged, Water aged, Damp heat aged	IEC 60793-2-50, 60793-1-32	1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average)
19		Dynamic Tensile Strength (Un aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 550 KPSI (3.80Gpa)
20		Dynamic Tensile Strength Aged (Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-31	≥ 440 KPSI (3.00Gpa)
21		Dynamic Fatigue (Unaged and Damp heat aged)	IEC 60793-2-50 and IEC 60793-1-33	≥ 20
22		Fiber Curl	IEC 60793-2-50, 60793-1-34	≥ 4 Meter radius of curvature
23	**Environmental Characteristics of Fiber for both color and uncolor fibres**	Temperature Cycle Test: Temperature Dependence of Attenuation : Induced Attenuation at 1550 nm and 1625 nm at -60°C to +85°C	IEC 60793-2-50 and IEC 60793-1-52	≤ 0.05 dB/Km
24		Temperature-Humidity Cycle Test: Induced attenuation at 1550 nm and 1625 nm at -10° C TO +85° C and 95% relative humidity	EIA/TIA 455-73	≤ 0.05 dB/Km
25		Water Immersion Test: Induced attenuation at 1550 nm and 1625 nm due	IEC 60793-2-50 and IEC 60793-1-53	≤ 0.05dB/Km

		to water immersion at 23 ± 2°C		
26		Accelerated Aging (Dry Heat) Test: Induced attenuation at 1550 nm and 1625 nm due to Temperature aging at 85 ± 2° C	IEC 60793-2-50 and IEC 60793-1-51	≤ 0.05 dB/Km
27		Retention of Coating Color: Coated fibre aged for 30 days at 85°C temperature with 95% Humidity and then 20 days in 85°C dry heat	IEC 60793-2-50 and IEC 60793-1-51	No change in colour of coated fibre
28		High Temperature and High Humidity (Damp Heat) Test: Induced attenuation at 1550 nm & 1625 nm at 85°C temperature and 85% Relative Humidity for 30 days	IEC 60793-2-50 and IEC 60793-1-50	≤ 0.05 dB/Km
29		Cable Material Compatibility test for fibre : Fibre to be aged with filling compound for 30 days at 85°C temperature and 85% Relative Humidity	Telcordia GR-20-CORE,2013; Draft IEC 60794-1-219	• Aged coating strip force: 1.0 ≤ F ≤ 8.9 N (Peak) 1.0 ≤ F ≤ 5.0 N (Average) • Visual Inspection under 5X magnification: No fibre coatings cracking, splitting, or delamination. • For coloured fibres, colour to be identifiable and no colour transfers to the filling compound. • MEK Rub Test as mentioned below in test no 30.
30	**Colour qualification**	MEK RUB Test (Methyl Ethyl Ketone)	Draft IEC 60794-1-219	To be tested by using socked (solvent) tissue paper for ten strokes unidirectional on 10cm length of the fiber. No color trace shall be observed on tissue paper after testing.

31	**Material Properties :**	Fiber Materials: The substances of which the fibres are made	RoHS 3 (EU 2015/863)	Fibre material to be RoHS complied.

N.B.: Latest issue of above mentioned Standards may be referred.

Annexure-R: Energy Consumption Rating (ECR) Group: ECR

S. No.	Interface Name	Parameter Name	Standard Name	Limits/Values	Remarks
R.1	ECR (Energy Consumption Rating) parameter	ECR	TEC 74046	No limit for ECR value.	
R.2	EP (Energy Passport) parameter	EP	TEC 74046	No Test	Note: EP value will be generated by TEC based on ECR parameter.

Annexure-S: Subscriber Identity Module (SIM) Group: SIM

SIM Form factor	Product Variant	Cellular Technology Features				Pre-personalize Application	Remarks
		GSM	WCDMA	LTE/ LTE(A)	5G		
eUICC (M2M)	eUICC-M2M (GSMA compliance) / eSIM-M2M	Yes	Yes	Yes	Yes	SIM USIM ISIM	Single or multiple profile with GSMA Remote Service Provisioning
	eUICC- M2M (Non-GSMA compliance)	Yes	Yes	Yes	Yes	SIM USIM ISIM	Single or multiple profile without GSMA Remote Service Provisioning
eUICC (Consumer)	eUICC – Consumer (GSMA compliance) / eSIM-Consumer	Yes	Yes	Yes	Yes	None	
UICC (Pluggable)	SIM	Yes				SIM	
	USIM	Yes	Yes	Yes	Yes	USIM/SIM	
	ISIM			Yes	Yes	USIM/ ISIM	

S. No.	Parameter Name	Standard	Test Specification	Applicability/ Remarks
S.1	Answer to reset eUICC	Clause 6.3 of ETSI TS 102 221 Rel 9 and above	Test Spec Clause 6 of ETSI 131 120 Clause 6.1 of ETSI TS102 230-1Rel 11 and above	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.2	Physical and Logical Characteristics eSIM	Clause 7 of ETSI TS102 671 Rel 9 and above	Clause 4 and 5 of test specification ETSI TS 131 120	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.3	Voltage classes eUICC	Clause 5.0 ETSI TS 102 221 Rel 9, ETSI TS 102 671 (UICC shall not Power Class A) Rel 9 and above	ETSI TS 131 120 Clause 5	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.4	There shall be only one ISD-R and it is personalized by EUM during manufacturing	Clause 2.2.1.1. GSMA SGP .02 v4.2.1 and above		eUICC - M2M (GSMA compliance) / eSIM-M2M
S.5	No LOCKED state supported to ISD-R	Clause 2.2.1.1. GSMA SGP .02 v4.2.1	Clause 5.2.2 of GSMA SGP .11 v4.1	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.6	ISD-R shall be able to perform Platform management functionon ISD-Ps	Clause 2.2.1.1. GSMA SGP .02 v4.2.1	Clause 4.2.3 ISDP creation and management	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.7	There will be only one ECASD present	Clause 2.2.1.2. GSMA SGP .02 v4.2.1	Clause 5.2 GSMA SGP 11 v4.1	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.8	The ECASD application SHALL be installed by the EUM during eUICC manufacturing	GSMA-SAS-UP compliance manufacturing certificate	GSMA SAS -UP Certificate	eUICC - M2M (GSMA compliance) / eSIM-M2M

S.9	The eUICC SHALL support SCP80 and SCP81	Clause 4.2 of ETSI 102 225rel 9 and above Clause 5, 7 , 8 of ETSI 102 226 rel 9 and above Global Platform Card Specification 2.2 Amendment B v1.1.3 – RAM over HTTP	Global Platform card specification 2.2.1: 2011	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.10	Executing ISD-P creation, key establishment, and profile download	Clause 3.1 GSMA SGP .02 v4.2.1	Clause 4. of GSMA SGP .11v 4.1 interface compliance testing	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.11	Subscription Manager sends enable commands to the eUICC with a previously downloaded profile	Clause 4.1.1.2 GSMA SGP .02 v4.2.1	Clause 4. of GSMA SGP .11v 4.1 interface compliance testing	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.12	Subscription Manager sends disable profile commands tothe eUICC with a previously enabled profile	Clause 4.1.1.3 GSMA SGP .02 v4.2.1	Clause 4. of GSMA SGP .11v 4.1 interface compliance testing	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.13	Subscription Manager sends commands to delete a disabled profile	Clause 4.1.1.4 GSMA SGP .02 v4.2.1	Clause 4. of GSMA SGP .11v 4.1 interface compliance testing	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.14	eUICC Profile Package: Interoperable Format Technical Specification	Trusted connectivity alliance V3.3.1 and above	eUICC-Interop-Profile-Test-Specification-v3.3.1 from TCA	eUICC - M2M (GSMA compliance) / eSIM-M2M
S.15	Answer to reset eSIM content	Clause 6.3 of ETSI TS 102 221 Rel 9 and above	Test Spec Clause 6 of ETSI 131 120 Rel 9 Clause 6.1 of ETSI TS 102 230-1 Rel 11 and above	eUICC – Consumer (GSMA compliance) / eSIM-Consumer

S.16	Voltage classes eUICC	Clause 5.0 ETSI TS 102 221 Rel 9 and above	Clause 5.2 ETSI TS 131 120	eUICC – Consumer (GSMA compliance) / eSIM-Consumer
S.17	If there is no Enabled Profile on the eUICC	Clause 3.4.3 of GSMA SGP .22 RSP Technical Specification v3 and above	Using simulator to Test using LPA in eSIM enabled handset	eUICC – Consumer (GSMA compliance) / eSIM-Consumer
S.18	Remote provisioning – Profile download initiation	Clause 3.1 of GSMA SGP .22 RSP Technical Specification v3 and above	Clause 4 of the test specification GSMA SGP .23 v3.1	eUICC – Consumer (GSMA compliance) / eSIM-Consumer
S.19	Remote provisioning – Profile download and installation	Clause 3.1.3 of GSMA SGP .22 RSP Technical Specification v3 and above	Clause 4 of the test specification GSMA SGP .23 v3.1	eUICC – Consumer (GSMA compliance) / eSIM-Consumer
S.20	Local Profile Management – disable profile, enable profile, Delete profile, list of profile	Clause 3.2 of GSMA SGP .22 RSP Technical Specification v3 and above	Clause 4 of the test specification GSMA SGP .23 v3.1	eUICC – Consumer (GSMA compliance) / eSIM-Consumer
S.21	Local eUICC management - Retrieve eID, eUICC memory Reset	Clause 3.3 of GSMA SGP .22 RSP Technical Specification v3 and above	Clause 4 of the test specification GSMA SGP .23 v3.1	eUICC – Consumer (GSMA compliance) / eSIM-Consumer
S.22	Administrative commands for telecommunications applications in Integrated Circuit Cards (ICC) USIM	Clause 6 of ETSI TS 102 222 Rel 9 and above	Clause 6.6 of ETSI TS 151 017 rel 4 Clause 7.3 of ETSI TS 131 122 rel 17	eUICC -M2M (Non-GSMA compliance)
S.23	Transmission protocols USIM	Clause 7 of ETSI TS 102 221 Rel 9 and above	Transmission protocol tests clause 7 of ETSI 131 230 -1Rel 11 and above	eUICC -M2M (Non-GSMA compliance)
S.24	Minimum application clock frequency USIM	Clause 5 of ETSI TS 102 221 Rel 9 and above	Clause 7 of ETSI TS 131 230-1 Rel 9 and above	eUICC -M2M (Non-GSMA compliance)
S.25	Electrical specification of UICC with terminal interface	Clause 5 of ETSI TS 102 221 Rel 9 and above	Clause 5 of ETSI TS 131 230-1 Rel 11 and above	eUICC -M2M (Non-GSMA compliance)

S.26	Security mechanisms for the (U)SIM application toolkit Stage2	Clause 5 6 7 8 9 of ETSI TS 123.048 (Release 5.and above)	Clause 5 of ETSI TS 131 048 Release 5	eUICC -M2M (Non-GSMA compliance)
S.27	USIM shall support special SSD (Supplementary Secure Domain	Clause 7.2 of Global Platform Specifications Version 2.1.1 or higher	Global Platform Specifications Version 2.1.1 or higher	eUICC -M2M (Non-GSMA compliance)
S.28	Subscriber Identity Module Application Programming Interface (SIM API) for Java Card	Clause 6 and annexure A of ETSI TS 143 019 Rel 5 and above	Clause 5 of Test specification for SIM API for Java Card ETSI TS 151 013 rel 13 and above	eUICC -M2M (Non-GSMA compliance)
S.29	Support for PIN and PUK USIM	ISO7816 4 Clause 9 of ETSI TS 102 221 Rel 9	Clause 6.6.2.9.3 of ETSI TS 151 017 rel 4 and above	eUICC -M2M (Non-GSMA compliance)
S.30	Transmission Speed USIM	Clause 6.3 of ETSI TS 102 221 Rel 9 and above	Clause 6.4.2 of ETSITS102 230-2 Rel 11 and above	eUICC -M2M (Non-GSMA compliance)
S.31	Voltage classes (Class A ClassB Class C at least two consecutive classes Eg AB or BC) USIM	Clause 5 of ETSI TS 102 221 Release 9 and above	Clause 5 of ETSI TS 102 230-1 Rel 11 and above	eUICC -M2M (Non-GSMA compliance)
S.32	Interface protocols SIM	Clause 7A of ETSI TS 131.101 Rel 9 and above	Clause 6.5.2.2 of ETSI TS 102 230-2 Rel 11 and above	SIM – Pluggable Form Factor
S.33	Minimum application clock frequency SIM	Clause 5 of ETSI TS 102 221 Rel 9 and above	Clause 6.3.4 of ETSITS 102 230-2 Rel 11 and above	SIM – Pluggable Form Factor
S.34	Network Security (at least but not limited to A3 A8 algorithm) SIM	Clause 7.1, 7.2 of ETSI TS 151 011 Rel 4	Clause 6.4 of ETSI 151 017 Rel 4	SIM – Pluggable Form Factor
S.35	Passive authentication SIM	Clause 7 of ETSI TS 151 011 Rel 4	Clause 6.4 of ETSI 151 017 Rel 4	SIM – Pluggable Form Factor

S.36	Physical and Logical Characteristics SIM	Clause 4 Of ETSI TS 131 101 Rel.9 and above	Clause 4 of ETSI TS 102 230-1 Rel 11 and above	SIM – Pluggable Form Factor
S.37	Read or Update access to NVM controlled by OperatingSystem and Issuer SIM application.	ISO 7816 4, Clause 9 of ETSI TS 151 011 Rel 4	Clause 6 of ETSI TS 151 017 Rel 4 and above	SIM – Pluggable Form Factor
S.38	Security mechanisms for the SIM application toolkit Stage 2	Clause 5, 6, 7, 8, 9 of ETSI 123 048 Rel 5 and above	Clause 5 of ETSI TS 131 048 Release 5	SIM – Pluggable Form Factor
S.39	SIM Application	Clause 4,5,6,7 of ETSI TS 102 223 Rel 9 and above	Clause 27 of ETSI TS 131 124 Rel 11 and above	SIM – Pluggable Form Factor
S.40	SIM shall support special SSD (Supplementary Secure Domain) for SIM based apps.	Clause 7.2 of Global Platform Specifications of SIM Alliance Forum Version 2.1.1 or higher	Global Platform Specifications Version 2.1.1 or higher	SIM – Pluggable Form Factor
S.41	Subscriber Identity Module Application Programming Interface (SIM API)	Clause 4, 5, 6, 7, 8 ETSI 142 019 rel 5 and above	Clause 5 of ETSI TS 131 213 Rel 11 and above	SIM – Pluggable Form Factor
S.42	Subscriber Identity Module Application Programming Interface (SIM API) for Java Card TM	Clause 6 and Annexure-A of ETSI TS 143 019 Rel 5 and above	Clause 5 of ETSI TS 131 213 Rel 11 and above	SIM – Pluggable Form Factor
S.43	Transmission Speed SIM	Clause 6.3 of ETSI TS 102 221 Rel 9 and above	Clause 6.4.2 of ETSITS102 230-2 Rel 11 and above	SIM – Pluggable Form Factor
S.44	Voltage classes (Class A ClassB Class C at least two consecutive classes eg AB or BC) SIM	Clause 5 of ETSI TS 131.101 Rel 9 and above	Clause 5 of ETSI TS 102 230-1 Rel 11 and above	SIM – Pluggable Form Factor

S.45	Administrative commands for telecommunications applications in Integrated Circuit Cards (ICC) ISIM	Clause 6 of ETSI TS 102 222 Rel 5 and above Clause 4, 5, 6, 7 of ETSI TS 131 103 Rel 9 and above	Clause 6.6 of ETSI TS 151 017 rel 4 Clause 7.3 of ETSI TS 131 122 rel 17	UICC based ISIM – PluggableForm Factor
S.46	Interface protocols ISIM	Clause 6.3 of ETSI TS 102 221 rel 9 and above	Clause 6.5.2.2 of ETSI TS 102 230-2 Rel 11 and above	UICC based ISIM – PluggableForm Factor
S.47	Minimum application clock frequency ISIM	Clause 5 of ETSI TS 102 221 Rel 9 and above	Clause 6.3.4 of ETSITS 102 230-2 Rel 11 and above	UICC based ISIM – PluggableForm Factor
S.48	Physical and Logical Characteristics ISIM	Clause 4 Of ETSI TS 131 101 Rel.9 and above	Clause 4 of ETSI TS 102 230-1 Rel 11 and above	UICC based ISIM – PluggableForm Factor
S.49	Security mechanisms for the (U)SIM application toolkit Stage2 ISIM	Clause 5, 6, 7, 8, 9 of ETSI 123 048 rel 5 and above	Clause 5 of ETSI TS 131 048 Release 5	UICC based ISIM – PluggableForm Factor
S.50	SIM shall support special SSD (Supplementary Secure Domain) for SIM based apps ISIM.	Clause 7.2 of Global Platform Specifications of SIM Alliance Forum version 2.1.1 or higher	Global Platform Specifications Version 2.1.1 or higher	UICC based ISIM – PluggableForm Factor
S.51	Support for PIN and PUK Characteristics of the IP Multimedia Services Identity Module (ISIM) application	ISO7816 4 Clause 9 of ETSI TS 102 221 Rel 9 and above	Clause 6.6.2.9.3 of ETSI TS151 017 Rel 4	UICC based ISIM – PluggableForm Factor
S.52	Transmission Speed ISIM	Clause 6.3 of ETSI TS 102 221 Rel 9 and above	Clause 6.4.2 of ETSITS102 230-2 Rel 11 and above	UICC based ISIM – PluggableForm Factor
S.53	Voltage classes (Class A ClassB Class C at least two consecutive classes e.g. AB or BC)	Clause 5 of ETSI TS 131.101 Rel 9 and above	Clause 5 of ETSI TS 102 230-1 Rel 11 and above	UICC based ISIM – PluggableForm Factor

S.54	ISIM commands	Clause 7 of ETSI 131 103 Rel 9 and above	Clause 7.2 3GPP TR 31.829 V13	UICC based ISIM – PluggableForm Factor
S.55	Hardware accelerator to enable Subscription Concealed Identifier (SUCI)	Clause 4.4.11.8 of ETSI 131 102 Rel 16 and above	Clause 5.3.3, 5.3.4 of ETSI 131 121 rel 15 and above	UICC based ISIM – PluggableForm Factor
S.56	Subscription Permanent Identifier (SUPI)	Clause 4.4.11.10 of ETSI 131 102 Rel 16 and above	Testing with 5G NR Simulator	UICC based ISIM – PluggableForm Factor
S.57	UE Route Selection Policy (URSP)	Clause 5.2.34 of ETSI 131 102 Rel 16 and above	Testing with 5G NR Simulator	UICC based ISIM – PluggableForm Factor
S.58	GET IDENTITY (SUCI initiation)	Clause 7.5 of ETSI 131 102 Rel 16 and above	Clause 5.3.3 of ETSI 131 121 Rel 16 and above Clause 7.3.3 of ETSI 131 122 Rel 17	UICC based ISIM – PluggableForm Factor
S.59	Get IDENTITY for SUPI type NSI or GLI when SUCI calc done by USIM Hw	Clause 7.5.2.1 of ETSI TS 131 102 Rel 17 and above	Clause 7.3.3 of ETSI 131 122 Rel 16 and above	UICC based ISIM – PluggableForm Factor
S.60	Administrative commands for telecommunications applications in Integrated Circuit Cards (ICC) USIM	Clause 6 of ETSI TS 102 222 Release 5 and above	Clause 6.6 of ETSI TS 151 017 rel 4 Clause 7.3 of ETSI TS 131 122 rel 17	USIM – Pluggable FormFactor
S.61	Interface protocols USIM	Clause 6.3 of ETSI TS 102 221 rel 9 and above	Clause 6.5.2.2 of ETSI TS 102 230-2 Rel 11 and above	USIM – Pluggable FormFactor
S.62	Minimum application clock frequency USIM	Clause 5 of ETSI TS 102 221 Rel 9 and above	Clause 6.3.4 of ETSITS 102 230-2 Rel 11 and above	USIM – Pluggable FormFactor
S.63	Physical and Logical Characteristics USIM	Clause 4 Of ETSI TS 131 101 Rel.9 and above	Clause 4 of ETSI TS 102 230-1 Rel 11 and above	USIM – Pluggable FormFactor
S.64	Security mechanisms for the (U)SIM application toolkit Stage 2	Clause 5, 6, 7, 8, 9 of ETSI 123 048 rel 5 and above	Clause 5 of ETSI TS 131 048 Release 5	USIM – Pluggable FormFactor

S.65	SIM shall support special SSD (Supplementary Secure Domain) for SIM based apps.	Clause 7.2 of Global Platform Specifications of SIM Alliance Forum Version 2.1.1 or higher	Global Platform Specifications Version 2.1.1 or higher	USIM – Pluggable FormFactor
S.66	Subscriber Identity Module Application Programming Interface (SIM API) for Java CardV TM Stage 2 USIM	Clause 6 7 of ETSI TS 143.019 (Release V5.6.0 and above)	Clause 6 and Annexure-A of ETSI TS 143 019 Rel 5 and above	USIM – Pluggable FormFactor
S.67	Subscriber Identity Module Application Programming Interface (SIM API) Stage 1 USIM	Clause 4, 5, 6, 7, 8 ETSI 142 019 rel 5 and above	Clause 5 of ETSI TS 131 213 Rel 11 and above	USIM – Pluggable FormFactor
S.68	Support for PIN and PUK USIM	ISO7816 4 Clause 9 of ETSI TS 102 221 Rel 9	Clause 6.6.2.9.3 of ETSI TS151 017 rel 4	USIM – Pluggable FormFactor
S.69	Transmission Speed USIM	Clause 6.3 of ETSI TS 102 221 Rel 9 and above	Clause 6.4.2 of ETSITS102 230-2 Rel 11 and above	USIM – Pluggable FormFactor
S.70	Voltage classes (Class A ClassB Class C at least two consecutive classes Eg AB or BC)	Clause 5 of ETSI TS 131.101 Rel.9 and above	Clause 5 of ETSI TS 102 230-1 Rel 11 and above	USIM – Pluggable FormFactor
S.71	Authentication 3G/4G procedure	Clause 11.1.16 of ETSI 102 221 Rel 17 Auth Procedure Clause 7.1 of ETSI 131 102 Rel 15	Clause 3 of ETSI TS 135 206 rel 14	USIM – Pluggable FormFactor
S.72	Characteristics of the Universal Subscriber Identity Module (USIM) application	Clause 4.0 of ETSI 131 102 Rel 16 and above	Clause 4,6,7 of ETSI 131 122 Rel 16 and above	USIM – Pluggable FormFactor
S.73	Hardware accelerator to enable Subscription Concealed Identifier (SUCI)	Clause 4.4.11.8 of ETSI 131 102 Rel 16 and above	Clause 5.3.3, 5.3.4 of ETSI 131 121 rel 15 and above	USIM – Pluggable FormFactor

S.74	Subscription Permanent Identifier (SUPI)	Clause 4.4.11.10 of ETSI 131 102 Rel 16 and above	Testing with 5G NR Simulator	USIM – Pluggable FormFactor
S.75	UE Route Selection Policy (URSP)	Clause 5.2.34 of ETSI 131 102 Rel 16 and above	Testing with 5G NR Simulator	USIM – Pluggable FormFactor
S.76	GET IDENTITY (SUCI initiation)	Clause 7.5 of ETSI 131 102 Rel 16 and above	Clause 5.3.3 of ETSI 131 121 Rel 16 and above Clause 7.3.3 of ETSI 131 122 Rel 17	USIM – Pluggable FormFactor
S.77	Power saving mode	Clause 5.1.10 of ETSI 102 Rel 15 and above	Clause 13 of ETSI 131 121 Rel 15 and above	USIM – Pluggable FormFactor
S.78	Get IDENTITY for SUPI type NSI or GLI when SUCI calc done by USIM Hw	Clause 7.5.2.1 of ETSI TS 131 102 Rel 17 and above	Clause 7.3.3 of ETSI 131 122 Rel 16 and above	USIM – Pluggable FormFactor
S.79	Authentication procedure for 5G AKA	Clause 6.1.3.2 of ETSI TS 133 501 Rel 17 and above	Clause 7.3.1 of ETSI 131 122 Rel 16 and above	USIM – Pluggable FormFactor
S.80	Manage Channel	Clause 11.1.17 od ETSI 102 221 Rel 17 and above	Clause 6.5.7 of ETSI TS 131 122 Rel 11	USIM – Pluggable FormFactor
S.81	Get Challenge	Clause 11.1.18 of ETSI 102 221 Rel 9 and above	Clause 6.8.1.18 of ETSI 131 122 Rel 11	USIM – Pluggable FormFactor
S.82	Pre-personalized Profiles ISIM	Clause 4 of ETSI TS 131 103 Rel 9 and above	Clause 6 of ETSI TS 131 103 Rel 9 and above	Pre-personalized Profiles ISIMfor eUICC - M2M (GSMA compliance) / eSIM-M2M
S.83	Pre-personalized Profiles SIM	Clause 10 of ETSI TS 151.011 Rel 4	Clause 5 of ETSI TS 151.017 release 4	Pre-personalized Profiles SIMfor eUICC - M2M (GSMA compliance) / eSIM-M2M

S.84	Pre-personalized Profiles USIM	Clause 4,5 of ETSI TS 131 102 Rel 12 and above	Clause 7 of ETSI TS 131 102 Rel 12 and above	Pre-personalized ProfilesUSIM for eUICC - M2M (GSMA compliance) / eSIM-M2M
S.85	Specification of the Subscriber Identity Module Mobile Equipment (SIM ME) interface USIM	Clause 5, 6 of ETSI TS 151 011 Release 4	Clause 6.3 of ETSI TS 151 017 rel 4	SIM-ME-USIM Interface foreUICC - M2M (Non-GSMA compliance)
S.86	Pre-personalized Profiles ISIM	Clause 4 of ETSI TS 131 103 Rel 9 and above	Clause 6 of ETSI TS 131 103 Rel 5 and above	Pre-personalized Profiles ISIMfor eUICC - M2M (Non- GSMA compliance)
S.87	Pre-personalized Profiles SIM	Clause 10 of ETSI TS 151.011 Rel 4	Clause 5 of ETSI TS 151.011	Pre-personalized Profiles ISIMfor eUICC - M2M (Non- GSMA compliance)
S.88	Pre-personalized Profiles USIM	Clause 4. 5 of ETSI TS 131 102 Rel 9 and above	Clause 7 of ETSI TS 131 102 Rel 9 and above	Pre-personalized Profiles ISIMfor eUICC - M2M (Non- GSMA compliance)
S.89	Software Components shall include Operating System and SIM Tool Kit Applications	Clause 4,5,6,7 of ETSI TS 102 223 Rel 9 and above	Clause 27 of ETSI TS 131 124 Rel 11 and above	SIM-ME Interface for SIM –Pluggable Form Factor
S.90	Specification of the Subscriber Identity Module Mobile Equipment (SIM ME) interface	ISO-7816-4 ETSI TS 151.011 Release 4 or higher.	Clause 6.6.2.9.3 of ETSI TS151 017 rel 4	SIM-ME Interface for SIM –Pluggable Form Factor
S.91	Specification of the Subscriber Identity Module Mobile Equipment (SIM ME) interface USIM- Pluggable	ISO-7816-4 ETSI TS 151.011 Release 4 or higher.	Clause 6.6.2.9.3 of ETSI TS151 017 rel 4	SIM-ME-USIM for USIM – Pluggable Form Factor

ANNEXURE TO ER of RADIO BROADCAST RECEIVER

Annex-R-A1-Safety	As per Annexure I
Annex-R-A1-Freq	As per Annexure II, Table I. Testing as per Test Setup I in Annexure III.
Annex-R-A1-Navigation	1. GPS 2. NavIC (Regional GNSS system of India) Testing as per As per Test Setup II in Annexure III.
Annex-R-A1-Radio_conformance	As per Annexure-IV

Annexure I

Conformance to following safety standards is required:	Testing requirements
a) The equipment shall conform to IS 616:2017/IEC 60065:2014 -„Audio, Video and similar electronic apparatus- Safety requirements‟. OR The equipment shall conform to IEC 62368- 1: 2018 "Audio/video, information and communication technology equipment - Part 1: Safety requirements". b) In case of secondary cells and batteries used in portable equipments, conformance to standard IS 16046(Part2): 2018/ IEC 62133-2: 2017) "Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications": Lithium systems.	Test results from Designated CAB of TEC to be submitted for compliance

Annexure II

Table 1

Frequency bands		**Applications**
Medium Frequency (MF)	526, 5 kHz to 1 606, 5 kHz.	Radio Broadcasting
High Frequency (HF):	3 950 kHz to 4 000 kHz, 5 900 kHz to 6 200 kHz, 7 200 kHz to 7 450 kHz, 9 400 kHz to 9 900 kHz, 11 600 kHz to 12 100 kHz, 13 570 kHz to 13 870 kHz, 15 100 kHz to 15 800 kHz, 17 480 kHz to 17 900 kHz, 18 900 kHz to 19 020 kHz, 21 450 kHz to 21 850 kHz and 25 670 kHz to 26 100 kHz	
VHF band I:	47 MHz to 68 MHz.	
VHF band II:	87,5 MHz to 108 MHz.	
VHF band III:	174 MHz to 230 MHz.	
L band I	1 164 MHz to 1 300 MHz	GNSS
L band II	1 559 MHz to 1 610 MHz	
S band	2483.5 MHZ to 2500 MHz	

Note:

i. The equipment may operate in part of the bands or cover the full bands listed in Table 1 above.

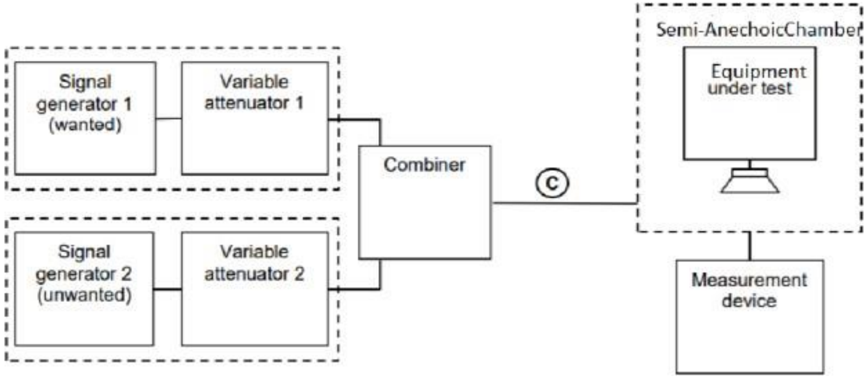
ii. The above mentioned frequencies are for the purpose of prescribing technical specifications and don't specify the actual allocation of above mentioned services in India. The actual allocation w.r.t to any services will be as per license conditions/regulations of Government of India.

iii. All the frequency bands mentioned in the table above, may be revised as per the "National Frequency Allocation Plan (NFAP)" in force.

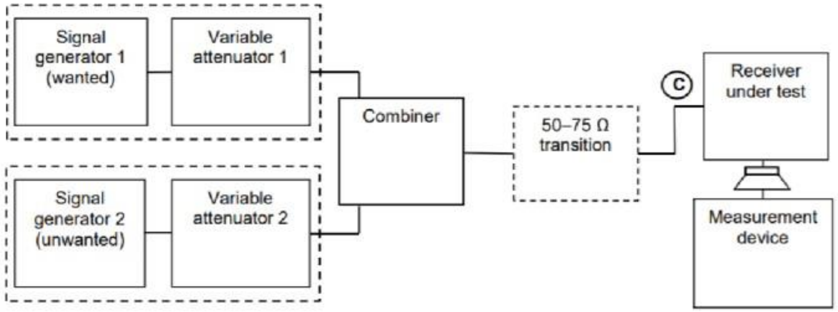
Test Setup I: To verify the frequency of operation of the ET (as per applicability defined in standard ETSI EN 303 345-1)

The setups are representative and may vary depending on the equipment under test and specific test methodology.

I. General Test requirement – Radiated Measurements



II. General Test requirement – Conducted Measurements



Test Setup II: To verify support for GNSS

a) To verify support for GPS/NaVIC

Parameter Name	Support for geolocation through GPS/NaVIC
Test Details	Test for facility of identifying the location through satellite- based GPS/NaVIC
Test instruments required	None
Test Setup	Powered on EUT (Equipment Under Test)
Test Procedure	i. Power on the EUT. ii. If the EUT is SIM enabled then deactivate the SIM. iii. Go to Settings through appropriate menu in the device to enable GPS/NaVIC functionality. iv. Locate the settings to turn Location „ON".
Expected Result	i. Verify that the device is able to display location using satellite based GPS/NaVIC, when SIM (if present) is deactivated.

Annexure IV

Conformance to the following latest in force/valid versions of standards as applicable:			
Sr. No.	**Standard**	**Applicability**	Test results and certificate from TEC Designated CAB shall be submitted for compliance.
1.	ETSI EN 303 345	Applicable to Radio broadcast receivers, intended to support analog AM/FM or DRM digital modulation only. **Note**: Conformance shall only be required for each of the frequency bands co-located Annexure I Table I of this documents and ETSI EN303 345-1.	
2.	ETSI EN 303 413	Applicable to Radio broadcast receivers intended for reception of GNSS signals	

ANNEXURES TO ER FOR OPTICAL FIBRE CABLE

Annexure-Tx-A1-OFC:	Optical Fibre Cable for Duct Applications (Duct, Micro Duct)
Annexure-Tx-A2-OFC:	Optical Fibre Cable for Direct Buried application
Annexure-Tx-A3-OFC:	Optical Fibre Cable for Aerial Applications (ADSS Over Power Line, ADSS on Aerial alignment, and Optical Ground Wire-OPGW)
Annexure-Tx-A4-OFC:	Optical Fibre Cable for Access Network Applications (Indoor Cable, Access Outdoor Cable, Indoor-Outdoor Cable, In-Home Cable)
Annexure-Tx-A5-OFC:	Optical Fibre Cable for Direct Surface Application (DSA)
Annexure-Tx-A6-OFC:	Hybrid Cable (Optical and Metallic)

Annexure-Tx-A1-OFC: Optical Fibre Cables for Duct Application (Duct, Micro-duct)

A1.1 Parameter Group: Optical Fibre Cables- Duct

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.36 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.22 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm: ≤ 0.05dB & Fiber strain ≤ 0.6% when subjected to a Tensile load of 9.81 x 1.3 W Newton (where, W- mass of 1 Km of cable in Kg)	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to a Compressive load of 1500 N/2000N	1500 N (for Un-armoured) 2000N (for Armoured

					)
8		Impact	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Impact of 10Nm	3 Impact at 3 locations
9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles.	
10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D- diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	The bending rate shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP-85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.

13	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15 dB when subjected to following temperature cycle: TA2 temperature: - 20°C TA1 temperature: - 10°C TB1 temperature: + 60°C TB2 temperature: + 70°C. No. of temperature cycle : 2	
14		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a	
				minimum of 168 hours.	
15		Water Blocking Test / Water Penetration Test	IEC 60794-1-22	Test duration: 24 Hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
16		Termite and Rodent Test	The manufacturer shall submit Undertaking that the Anti-termite/Anti-Rodent dopants used if any, are non-toxic and non-hazardous		
17		Electrical continuity test	IEC 60794-1-24/IEC 60794-1-403	The metallic elements shall be continuous.	Applicable for cable having Metallic Armoured/ metallic Strength element

18	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
19	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
20		Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other.	Applicable for Ribbon Fibre Only
21		Ribbon Twist Test	Telecordia GR-20/ IEC 60794-1-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
22		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: ≤ 0.05dB	Applicable for Ribbon Fibre Only
23	**Safety Requirement**	The material used in the manufacturing of the OFC shall be non- toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	

24	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
25	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
26	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
27	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
28	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

A1.2 Parameter Group: Optical Fibre Cables- Micro Duct

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.36 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.22 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm: ≤ 0.05dB & Fiber strain ≤ 0.6% when subjected to a Tensile load of 9.81 x 1 W Newton (where, W - mass of 1 Km of cable in Kg)	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to a compressive load of 500N	
8		Impact	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Impact of 1 Nm	3 Impact at 3 locations
9		Bend Test	IEC 60794-1-21	Change in attenuation at	

				1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles	
10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D-diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	The bending rate shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP-85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.

13	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15dB when subjected to following temperature cycle: TA2 temperature: -20°C TA1 temperature: -10°C TB1 temperature: + 60°C TB2 temperature: + 70°C. No. of temperature cycle: 2	
14		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	
15		Water Blocking Test/ Water Penetration Test	IEC 60794-1-22	Test duration: 24 Hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
16		Termite and Rodent Test	The manufacturer shall submit Undertaking that the Anti- termite/Anti-Rodent dopants used if any, are non-toxic and non-hazardous		

17	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
18	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
19		Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other	Applicable for Ribbon Fibre Only
20		Ribbon Twist Test	Telecordia GR-20/ IEC 60794-	The ribbon shall not show any	Applicable for
			1-23	separation of individual fibres from the ribbon structure after completion of the twist test.	Ribbon Fibre Only
21		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: ≤ 0.05dB	Applicable for Ribbon Fibre Only

22	**Safety Requirement**	The material used in the manufacturing of the OFC shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	
23	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
24	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
25	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
26	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
27	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219			

Annexure-Tx-A2-OFC: Optical Fibre Cables for Direct Buried Application

A2.1 Parameter Group: Optical Fibre Cable- Direct Buried

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.36 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.22 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm: ≤ 0.05dB & Fiber strain ≤ 0.6% when subjected to a Tensile load of 9.81 x 1.3 W Newton (where, W- mass of 1 Km of cable in Kg)	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550 nm : ≤ 0.05 dB when subjected to a compressive load of 2500 N/3500 N	2500 N (for Un-armoured cable) 3500 N (for Armoured cable)

8		Impact	IEC 60794-1-21	Change in attenuation at 1310 & 1550nm: ≤ 0.05dB when subjected to Impact of 25Nm	3 Impact at 3 locations
9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm:≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles.	
10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D- diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	The bending rate shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP- 85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.

13	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15dB when subjected to following temperature cycle: TA2 temperature: -20°C TA1 temperature: -10°C TB1 temperature: +60°C TB2 temperature: +70°C No. of temperature cycle : 2	
14		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	
15		Water Blocking Test/ Water Penetration Test	IEC 60794-1-22	Test duration: 24 Hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
16		Termite and Rodent Test	The manufacturer shall submit Undertaking that the Anti-termite/ Anti-Rodent dopants used if any, are non-toxic and non-hazardous		

17		Electrical continuity test	IEC 60794-1-24/IEC 60794-1-403	The metallic elements shall be continuous.	Applicable for cable having Metallic Armoured/ metallic Strength element
18	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
19	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
20		Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be	Applicable for Ribbon Fibre Only
				distinguished from each other.	
21		Ribbon Twist Test	Telecordia GR-20 /IEC 60794-1-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
22		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: ≤ 0.05dB	Applicable for Ribbon Fibre Only

23	**Safety Requirement**	The material used in the manufacturing of the OFC shall be non- toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	
24	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
25	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
26	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
27	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

28	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206**)** for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

Annexure-Tx-A3-OFC: Optical Fibre Cables for Aerial Applications (ADSS over Power line, ADSS on Aerial alignment and Optical Ground Wire-OPGW)

A3.1 Parameter Group: Optical Fibre Cable-ADSS along Power Line

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.36 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.22 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do-- -
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		

Span Length	Tensile Load
≤ 50m	9.81 x 1.5 W
51m -100m	9.81 x 2.0 W
101m -150m	9.81 x 2.5 W
151m-200m	9.81 x 3.0 W
201m -300m	9.81 x 4.0 W
> 300m	9.81 x 6.0 W

6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm: ≤ 0.05dB & Fiber strain ≤ 0.6 % when subjected to following Tensile load (in Newton) for Span Length as under: where, W- mass of 1 Km of cable in Kg	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to a compressive load of 1500N	
8		Impact	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Impact of 10 Nm	3 Impact at 3 locations
9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles	
10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D-diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	The bending rate shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP-85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.

12		Cable Drip Test	IEC 60794-1-22 ,	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.
13		Galloping Test	IEC 60794-1-21 / IEEE 1222	Galloping cycles – 100000 The test frequency shall be the single- loop resonant frequency. The minimum peak to-peak antinode amplitude/loop length ratio shall be maintained at a value of 1/25, as measured in the active span. Change in attenuation at 1310 & 1550nm: ≤ 0.05dB after the test	
14		Electrical Test/ Tracking & Erosion Test	IEC 60794-4-20/ IEEE Std 1222/ASTM D 2309- 97	Tracking on the outside of sheath shall not result in erosion at any point of sheath.	Applicable for ADSS cable with Anti-track PE Jacket over power line ≥ 33 kV
15	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15dB when subjected to following temperature cycle: TA2 temperature: - 20°C TA1 temperature: - 10°C TB1 temperature: + 60°C	
				TB2 temperature: + 70°C No. of temperature cycle : 2	
16		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	

17		Water Blocking Test/Water Penetration Test	IEC 60794-1-22	Test duration: 24 Hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
18	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
19	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
20		Separability o f individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other.	Applicable for Ribbon Fibre Only
21		Ribbon Twist Test	Telecordia GR-20/ IEC 60794-1-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
22		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: ≤ 0.05dB	Applicable for Ribbon Fibre Only
23	**Safety Requirement**	The material used in th e manufacturing of		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	

		the OFC shall be			
		non-toxic and dermatologically safe in its life time and shall not be hazardous to health.			
24	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
25	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
26	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
27	**Mechanical Characteristics of Fibre used in**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

	the cable	
28	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

A 3.2 Parameter Group: Optical Fibre Cable-ADSS on Aerial alignment

<table>
<tr><th>SN</th><th>Parameter Name</th><th>Individual Parameter Name</th><th>Standard Name</th><th>Limits/Values</th><th>Applicability</th></tr>
<tr><td>1</td><td rowspan="5">Transmission Characteristics</td><td>Attenuation at 1310nm</td><td>IEC 60793-1-40</td><td>≤ 0.36 dB/Km</td><td>Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x</td></tr>
<tr><td>2</td><td>Attenuation at 1550nm</td><td>IEC 60793-1-40</td><td>≤ 0.22 dB/Km</td><td>--Do--</td></tr>
<tr><td>3</td><td>Attenuation at 1625nm</td><td>IEC 60793-1-40</td><td>≤ 0.25 dB/Km</td><td>--Do--</td></tr>
<tr><td>4</td><td>PMD Cabled Loose Fibre</td><td>IEC 60793-1-48</td><td rowspan="2">≤ 0.3 ps/√km</td><td rowspan="2">--Do--</td></tr>
<tr><td>5</td><td>PMD Cabled Ribbon Fibre</td><td>IEC 60793-1-48</td></tr>
<tr><td>6</td><td>Mechanical Characteristics</td><td>Tensile Strength</td><td>IEC 60794-1-21</td><td>Change in attenuation at 1550 nm: ≤ 0.05dB & Fiber strain ≤ 0.6 % when subjected to following Tensile load (in Newton) for Span Length as under:
<table><tr><th>Span Length</th><th>Tensile Load</th></tr><tr><td>≤ 50m</td><td>9.81 x 1.5 W</td></tr><tr><td>51m -100m</td><td>9.81 x 2.0 W</td></tr><tr><td>101m -150m</td><td>9.81 x 2.5 W</td></tr><tr><td>151m-200m</td><td>9.81 x 3.0 W</td></tr><tr><td>201m -300m</td><td>9.81 x 4.0 W</td></tr><tr><td>>300m</td><td>9.81 x 6.0 W</td></tr></table>
where, W- mass of 1 Km of cable in Kg</td><td></td></tr>
</table>

7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to a compressive load of 1500N	
8		Impact	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Impact of 10Nm	3 Impact at 3 locations
9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles	
10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D-diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	The bending rate shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP-85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.

13		Galloping Test	IEC 60794-1-21/ IEEE 1222	Galloping cycles – 100000 The test frequency shall be the single-loop resonant frequency. The minimum peak to-peak antinode amplitude/loop length ratio shall be maintained at a value of 1/25, as measured in the active span. Change in attenuation at 1550nm: ≤ 0.05dB after the test	
14	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15dB when subjected to following temperature cycle: TA2 temperature: - 20°C TA1 temperature: - 10°C TB1 temperature: + 60°C TB2 temperature: + 70°C No. of temperature cycle : 2	
15		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm:	
				≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	
16		Water Blocking Test/ Water Penetration Test	IEC 60794-1-22	Test duration: 24 Hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
17	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.

18	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
19		Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other.	Applicable for Ribbon Fibre Only
20		Ribbon Twist Test	Telecordia GR-20/ IEC 60794-1-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
21		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: ≤ 0.05dB	Applicable for Ribbon Fibre Only
22	**Safety Requirement**	The material used in the manufacturing of the OFC shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	
23	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

24	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
25	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
26	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
27	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

A3.3 Parameter Group: Optical Ground Wire - OPGW

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.36 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.22 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength (Ultimate)	IEEE 1138	The ultimate tensile strength of the OPGW cable shall meet or exceed 100% of the RTS of the cable. Any outer layer strand failing below 75 % of the cable RTS shall constitute cable failure.	
7		Creep Test	IEEE 1138	Elongation of the cable for desired TS should meet the criteria.	
8		Stress Strain Test	IEEE 1138	(i) The breaking strength of the OPGW cable shall meet or exceed 100% of the RTS of the cable. (ii) Should meet the specified Modulus of elasticity(MOE) value of the OPGW cable.	

9		Strain Margin Test/ MRDT Test	IEEE 1138	The cable shall show no permanent increase in optical attenuation greater than 0.05 dB from preload to the maximum rated design tension (MRDT) of the cable at 1550nm wavelength	
10		Sheave Test	IEEE 1138 /IEC-60794- 1-2-E9	(i) The Ovality of the cable or optical units at the measured locations shall not exceed 10 %. (ii) There shall be no cracking or breaking of any component of the OPGW cable. This shall be visually examined. (iii) Attenuation shall not be greater than 0.1 dB/test fiber km at 1550nm wavelength	
11		Crush Test	IEEE 1138 / IEC 60794- 1-2-E3	(i) Ovality of the cable or optical fiber units shall be < 10 %. (ii) There shall be no cracking or breaking of any component of the OPGW cable. This shall be visually examined (iii) Attenuation shall not be greater than 0.05 dB/ fiber at 1550nm wavelength	

12		Bend Test	IEEE 1138 / IEC 60794-1-2-E11 (Procedure-I)	(i) There shall be no cracking or breaking of any component of the OPGW cable. This shall be visually examined (ii) Attenuation shall not be greater than 0.05 dB/ fiber at 1550nm wavelength	
13		Torsion Test/Twist Test	IEEE 1138	(i) There shall be no cracking or breaking of any component of the OPGW cable. This shall be visually examined. (ii) Attenuation shall not be greater than 0.10 dB/test fiber km at	
				1550nm wavelength	
14		Aeolian Vibration Test	IEEE 1138	(i) There shall be no cracking or breaking of any component of the OPGW cable or the supporting hardware. This shall be visually examined. (ii) Attenuation shall not be greater than 0.2 dB/test fiber km at 1550nm wavelength	
15		Galloping Test	IEEE 1138	(i) There shall be no Cracking or breaking of any component of the OPGW cable or the supporting hardware. This shall be visually examined. (ii) Attenuation shall not be greater than 0.2 dB/test fiber km at 1550nm wavelength	

16		Drip Test	IEEE 1138	At the end of 24 h, the water-blocking compound shall not flow (drip or leak) at 65 °C. Flow quantity should meet the criteria.	
17	**Electrical Characteristics**	DC Resistance	IEEE 1138	The actual dc resistance of the OPGW cable shall not exceed the dc resistance stated by the manufacturer at the specified temperature.	
18		Short Circuit Test	IEEE 1138 /IEC 60794- 1-2-H1	(i) Any cracking or breaking of any component of the optical sample shall constitute failure. This assessment is made with the naked eye. (ii) Attenuation shall not be greater than 0.05 dB/test fiber km at 1550nm wavelength (iii) There shall be no birdcaging of any of the strands of the optical sample. (iv) Temperature of any metallic	
				component and inside of fiber unit shall not exceed the criteria.	

19		Lightning Arc Test	IEEE 1138 / IEC 60794-1-402	(i) After the lightning strike application, the cable sample shall experience no permanent increase in optical attenuation greater than 0.10 dB for the concatenated loop at nominally 1550 nm wavelength. (ii) In all five qualifying lightning strike locations, visually, there shall be no damage (holes, cracks, etc.) to the integrity of the metallic tube. (iii) The minimum remaining strength of any of the tested cable sections shall be greater than the 70% of the cable RTS	
20	**Environmental Characteristics**	Water Penetration Test	IEEE 1138	(i) A 1.0 m section of OPGW cable shall be prepared for this test.All components of the cable shall be removed from the fluid-blocked optical fiber unit that contains the optical fibers. (ii) No water shall leak through the open end of the 1.0 m sample. If the first sample fails, one additional 1.0 m sample, taken from a section of OPGW cable immediately	

				adjacent to the first sample, may be tested for acceptance.	
21		Temperature Cycle Test	IEEE 1138	Attenuation shall not be greater than 0.2 dB/test fiber km at 1550nm wavelength	
22	**Safety Requirement**	The material used in the manufacturing of the OFC shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	
23	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

24	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
25	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
26	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
27	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried out as per IEC 60794-1-219

Annexure-Tx-A4-OFC: Optical Fibre Cables for Access Network Applications (Indoor Cable, Access Outdoor Cable, Indoor-Outdoor Cable, In-Home Cable)

A4.1 Parameter Group: Optical Fibre Cable –Indoor

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.40 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.657
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.30 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.40 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm: ≤ 0.05dB & Fiber strain ≤ 0.6% when subjected to a Tensile load of 9.81 x 1 W Newton (where, W-mass of 1 Km of cable in Kg)	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to a compressive load of 1000N	
8		Impact	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Impact of 1 Nm	3 Impact at 3 locations

9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles	
10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤	The bending rate shall be
				0.05dB when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D-diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP-85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.
13	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15 dB when subjected to following temperature cycle: TA2 temperature: - 20°C TA1 temperature: - 10°C TB1 temperature: + 60°C TB2 temperature: + 70°C No. of temperature cycle : 2	

14		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	
15		Water Blocking Test/ Water Penetration Test	IEC 60794-1-22	Test duration: 24 Hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the
				with ultraviolet light detector.	examination.
16	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
17	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
18		Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to	Applicable for Ribbon Fibre Only

				be distinguished from each other.	
19		Ribbon Twist Test	Telecordia GR-20 /IEC 60794-1-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
20		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: ≤ 0.05dB	Applicable for Ribbon Fibre Only
21	**Safety Requirement**	Flame Spread-Single cable/Flame propagation for single cable/Flame retardant test single cable/ Flammability test single cable	IEC 60332-1-2	Char less than 0.54 m at completion of test	
22		Flame Spread- Bunched cable/ Flame propagation for bunched cable/Flame retardant test bunched cable/Flammability test	IEC 60332-3-24, Cat C	Char less than 2.5 m at completion of the test	Applicable for riser applications only
		bunched cable			

23		Smoke Test/Smoke density/Smoke density under fire conditions/Smoke density of cable burning	IEC 61034-2	Minimum transmittance 60%	
24		Acid gas (Toxicity) (Test on toxic gases evolved during combustion of materials from cables)/pH Test/pH & Conductivity/Conductivity Test/Degree of acidity	IEC 60754-2	pH not less than 4.3 Conductivity not more than 10 µS/mm	
25		The material used in the manufacturing of the OFC shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the statement.	
26	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
27	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
28	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

29	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
30	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

A4.2 Parameter Group: Optical Fibre Cable- Access Outdoor

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values	Applicability
1	**Transmission Characteristics**	Attenuation at 1310 nm	IEC 60793-1-40	≤ 0.36 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x
2		Attenuation at 1550 nm	IEC 60793-1-40	≤ 0.22 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm: ≤ 0.05dB & Fiber strain ≤ 0.6% when subjected to a Tensile load of 9.81 x 1 W Newton (where, W- mass of 1 Km of cable in Kg)	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm: ≤0.05dB when subjected to a compressive load of 500N	
8		Impact	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Impact of 10Nm.	3 Impact at 3 locations
9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles.	

10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D-diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	The bending rate shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP-	Cable shall be free from any optical & visual physical damage.
				85A for 10 cycles.	
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.
13	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15dB when subjected to following temperature cycle: TA2 temperature: -20°C TA1temperature:-10°C TB1 temperature:+60°C. TB2 temperature: +70°C. No. of temperature cycle : 2	

14		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	
15		Water Blocking Test/Water Penetration Test	IEC 60794-1-22	Test duration: 24 Hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
16	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
17	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
18		Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus.	Applicable for Ribbon Fibre Only

				- The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other.	
19		Ribbon Twist Test	Telecordia GR-20/ IEC 60794-1-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
20		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: ≤ 0.05dB	Applicable for Ribbon Fibre Only
21	**Safety Requirement**	The material used in the manufacturing of the OFC shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	
22	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
23	**Transmission Characteristics of Fibre used in the Cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

	(Chromatic Dispersion)	
24	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
25	**Mechanical**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective
	Characteristics of Fibre used in the cable	type of Optical fibre used in the cable
26	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried out as per IEC 60794-1-219

A4.3 Parameter Group: Optical Fibre Cables - Indoor-Outdoor

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.36 dB/Km (A1) ≤ 0.37 dB/Km (A2) ≤ 0.37 dB/Km (B3)	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.657
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.22 dB/Km (A1) ≤ 0.23 dB/Km (A2) ≤ 0.24 dB/Km (B3)	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km (A) ≤ 0.26 dB/Km (B3)	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm: ≤ 0.05dB when subjected to a Tensile load of 9.81 x 1W Newton (where, W- mass of 1 Km of cable in Kg)	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm : ≤ 0.05dB when subjected to a compressive load of 1000 N	
8		Impact	IEC 60794-1-21	Change in attenuation at 1550nm : ≤ 0.05dB when subjected to Impact of 10Nm	3 Impact at 3 locations
9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles	

10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D- diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	The bending rate shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP- 85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry- Dry Cable Design.
13	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15 dB when subjected to following temperature cycle: TA2 temperature: - 20°C TA1 temperature: - 10°C TB1 temperature: + 60°C TB2 temperature: + 70°C No. of temperature cycle : 2	
14		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	

15		Water Blocking Test/ Water Penetration Test	IEC 60794-1-22	Test duration: 24 Hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
16	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
17	**Characteristics of**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
18	**Cable Elements (Ribboned Fibre)**	Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other.	Applicable for Ribbon Fibre Only
19		Ribbon Twist Test	Telecordia GR-20/ IEC 60794-1-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
20		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: $\leq$ 0.05dB	Applicable for Ribbon Fibre Only

21	**Safety Requirement**	Flame Spread-Single cable/Flame propagation for single cable/Flame retardant test single cable/ Flammability test single cable	IEC 60332-1-2	Char less than 0.54 m at completion of test	Test applicable only for indoor component of the cable in case cable design involves part of main cable to be used as indoor cable
22		Smoke Test/Smoke density/Smoke density under fire conditions/Smoke density of cable burning	IEC 61034-2	Minimum transmittance 60%	Test applicable only for indoor component of the cable in case cable design involves part of main cable to be used as indoor cable
23		Acid gas (Toxicity) (Test on toxic gases evolved during combustion of materials from cables) /pH Test/pH & Conductivity/Conductivity Test/Degree of acidity	IEC 60754-2	pH not less than 4.3 Conductivity not more than 10 µS/mm	Test applicable only for indoor component of the cable in case cable design involves part of main cable to be used as indoor cable
24		The material used in the		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the	
		manufacturing of the OFC shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.		material used in manufacturing of Optical fibre cable to substantiate the requirement.	
25	**Geometrical Characteristics of Fibre used in the**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

	cable	
26	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
27	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
28	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
29	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

A4.4 Parameter Group: Optical Fibre Cable – In-home

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values (as per ITU-T L.111)	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.40 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.657
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.30 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.40 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21, /ITU-T Rec. L.111	Length under test:0.5 m. Test loads: rated tensile load, TS = 5 N, long term load, TL = 30 % of TS. Attenuation change: no change at 1550nm No fibre and cable breakage.	
7		Crush Resistance	IEC 60794-1-21, /ITU-T Rec. L.111	Compressive force: 490 N/ 100 mm. Compression time:1 min. Attenuation change: 0.20 dB under the load, no change after test at 1550 nm. No fibre and cable breakage.	
8		Impact	IEC 60794-1-21, /ITU-T Rec. L.111	Impact energy:0.3 kg at 0.1 m height. Hammer: flat hammer. Number/location of impacts: 3 places separated at least 0.5 m, 1 impacts at each place. Maximum attenuation change: no change after the test at 1550 nm. No fibre and cable breakage, imprint on cable could be	

				compromised.	
9		Bend Test	IEC 60794-1-21, /ITU-T Rec. L.111	Number of turns in the helix: 4 Mandrel diameter: minimum bend diameter (as per 6.2.1/L.111) + 10 %.	
				Test temperature: -10 ℃. Maximum attenuation change: 0.20 dB during the test, no change after the test at 1550 nm. No fibre and cable breakage.	
10		Repeated Bend Test	IEC 60794-1-21, /ITU-T Rec. L.111	Number of cycles:10. Tensioning: minimum tension; support the specimen as needed. Bending radius: per 6.2.1. Maximum attenuation change: no change after the test at 1550 nm. No fibre and cable breakage.	
11		Torsion Test	IEC 60794-1-21, /ITU-T Rec. L.111	Test gauge length:0.5 m. Tensioning: minimum tension; support the specimen as needed. Attenuation change: no change at 1550 nm No fibre and cable breakage.	

12	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22, /ITU-T Rec. L.111	Change in attenuation at 1550nm: ≤ 0.15 dB when subjected to following temperature cycle: TA2 temperature: - 20°C TA1 temperature: - 10°C. TB1 temperature: + 60°C. TB2 temperature: + 70°C. No. of temperature cycle : 2	
13		Cable Aging test	IEC 60794-1-22, /ITU-T Rec. L.111	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	
14	**Safety Requirement**	Flame Spread-Single cable/Flame propagation for single cable/Flame retardant test single cable/ Flammability test single cable	IEC 60332-1-2	Char less than 0.54 m at completion of test	
15		Smoke Test/Smoke density/Smoke density under fire conditions/Smoke density of cable burning	IEC 61034-2	Minimum transmittance 60%	
16		Acid gas (Toxicity) (Test on toxic gases evolved during combustion of materials from cables) /pH Test/pH & Conductivity/Conductivity Test/Degree of acidity	IEC 60754-2	pH not less than 4.3 Conductivity not more than 10 μS/mm	

17		The material used in the manufacturing of the OFC shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	
18	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
19	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
20	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
21	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
22	**Colour**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective			

	qualification for color fibres	type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

Annexure-Tx-A5-OFC: Optical Fibre Cables for Direct Surface Application (DSA)

A5.1 Parameter Group: Optical Fibre Cable –DSA

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values (as per ITU-T Rec. L.110)	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.36 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.22 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm: ≤ 0.05dB & Fiber strain ≤ 0.6% when subjected to a Tensile load of 9.81 x 1 W Newton (where, W- mass of 1 Km of cable in Kg)	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to a compressive load of 2200N	
8		Impact	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Impact of 25Nm	3 Impact at 3 locations

9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles.	
10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when cable is flexed with 1 cycle in 2sec to 5sec with Pulley diameter of 20D (D-diameter of cable) and Load shall be as per FOTP 104. Total number of cycles be 25.	The bending rate shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP-85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.

13	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15dB when subjected to following temperature cycle: TA2 temperature: - 20°C TA1 temperature: - 10°C. TB1 temperature: + 60°C. TB2 temperature: + 70°C. No. of temperature cycle :	
14		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	
15		Water Blocking Test/Water	IEC 60794-1-22	Test duration: 24 Hours	No water shall be detected
		Penetration Test		Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
16		Termite and Rodent Test	The manufacturer shall submit Undertaking that the Anti-termite/Anti-Rodent dopants used if any, are non-toxic and non-hazardous		
17		Electrical continuity test	IEC 60794-1-24/IEC 60794-1-403	The metallic elements shall be continuous.	Applicable for cable having Metallic Armoured/ metallic Strength element

18	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
19	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
20		Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other.	Applicable for Ribbon Fibre Only
21		Ribbon Twist Test	Telecordia GR-20/ IEC 60794-1-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
22		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: $\leq$ 0.05dB	Applicable for Ribbon Fibre Only

23	**Safety Requirements**	The material used in the manufacturing of the OFC shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health.		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	
24	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
25	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
26	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
27	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

28	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

Annexure-Tx-A6-OFC: Hybrid Cables (Optical and Metallic)

A6.1 Parameter Group: Hybrid Cables (Optical and Metallic)

SN	Parameter Name	Individual Parameter Name	Standard Name	Limits/Values (as per ITU-T Rec. L.109/ IEC 62807-3 (under study)	Applicability
1	**Transmission Characteristics**	Attenuation at 1310nm	IEC 60793-1-40	≤ 0.36 dB/Km	Applicable to respective type of Optical fibre used in the cable as per ITU-T G.65x
2		Attenuation at 1550nm	IEC 60793-1-40	≤ 0.22 dB/Km	--Do--
3		Attenuation at 1625nm	IEC 60793-1-40	≤ 0.25 dB/Km	--Do--
4		PMD Cabled Loose Fibre	IEC 60793-1-48	≤ 0.3 ps/√km	--Do--
5		PMD Cabled Ribbon Fibre	IEC 60793-1-48		
6	**Mechanical Characteristics**	Tensile Strength	IEC 60794-1-21	Change in attenuation at 1550 nm ≤ 0.05dB & Fiber strain ≤ 0.6% when subjected to a Tensile load of 9.81 x 1 W Newton (where, W- mass of 1 Km of cable in Kg)	
7		Crush Resistance	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected compressive load of 2000N or as agreed by user	

8		Impact	IEC 60794-1-21	Change in attenuation when subjected to Impact load of 25Nm, at 1550nm: ≤ 0.05dB.	3 impacts at 3 locations
9		Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Bend around a mandrel of diameter of 20D for 10 cycles	
10		Repeated Bend Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB	The bending rate
				when cable is flexed with 1 cycle in 2 sec to 5 sec with Pulley diameter of 20D (D-diameter of cable) and Load shall be as per FOTP 104 Total number of cycles be 25.	shall be approximately one cycle in 2s to 5s and cable shall be free from any optical & visual physical damage.
11		Torsion Test	IEC 60794-1-21	Change in attenuation at 1550nm: ≤ 0.05dB when subjected to Torsion with a load as per FOTP-85A for 10 cycles.	Cable shall be free from any optical & visual physical damage.
12		Cable Drip Test	IEC 60794-1-22	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.	Not applicable for Dry-Dry Cable Design.

13	**Environmental Characteristics**	Temperature Cycling	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.15 dB when subjected to following temperature cycle: TA2 temperature: - 20°C TA1 temperature: - 10°C TB1 temperature: + 60°C TB2 temperature: + 70°C No. of temperature cycle : 2	
14		Cable Aging test	IEC 60794-1-22	Change in attenuation at 1550nm: ≤ 0.05dB, when cable is exposed to 85 °C ± 2 °C for a minimum of 168 hours.	
15		Water Blocking Test/ Water Penetration Test	IEC 60794-1-22	Test duration: 24 hours Sample length: 3 m Water Head Height: 1m No dye shall be detected when the end of the 3m length is examined with ultraviolet light detector.	No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
16		Lightning Test	ITU-T Rec. L.109 FOTP-	The cable shall withstand the current level of	Applicable for
			181, ITU-T K-47	greater than 105 K. Amp. There shall not be any damage to the fibre & Inner Sheath of the cable and change in attenuation of the fibre after the test shall be < 0.05 dB for 1550 nm.	Armoured cable.

17		Termite and Rodent Test	The manufacturer shall submit Undertaking that the Anti-termite/Anti-Rodent dopants used if any, are non-toxic and non- hazardous		
18		Electrical continuity test	IEC 60794-1-24/IEC 60794-1-403	The metallic elements shall be continuous.	. Applicable for cable having Metallic Armoured/ metallic Strength element
19	**Characteristics of Cable Elements (Buffer Tube)**	Kink resistance Test	IEC 60794-1-23	No damage or kink on surface of tube when tested 4 times with Kink radius less than 15xD, D is the diameter of the tube.	Applicable for all type of Loose tube, Tight Buffer and Micromodule.
20	**Characteristics of Cable Elements (Ribboned Fibre)**	Ribbon Dimension	IEC 60794-1-23	As per IEC standard of different fibre count Ribbon	Applicable for Ribbon Fibre Only
21		Separability of individual fibres from ribbon	IEC 60794-1-23	- Breakout shall be accomplished without specialized tools or apparatus. - The fibre breakout procedure shall not be permanently detrimental to the fibre optical and mechanical performance; - Any colour coding of fibres shall remain sufficiently intact to enable individual fibres to be distinguished from each other.	Applicable for Ribbon Fibre Only

22		Ribbon Twist Test	Telecordia GR-20/ IEC 60794-3-23	The ribbon shall not show any separation of individual fibres from the ribbon structure after completion of the twist test.	Applicable for Ribbon Fibre Only
23		Ribbon Torsion Resistance	IEC 60794-1-31	Change in attenuation at 1550nm: ≤ 0.05dB	Applicable for Ribbon Fibre Only

24	**Electrical Characteristics – Power Feeding Wires**	As per clause 6.1.2 of ITU-T L.109	IEC 60228 IEC 60502-1 IEC 60227-1 IEC 61156-1 IEC 61196-1-10x BS EN 50525 BS EN 60304	The cross-section of the metallic wire should be designed according to the transmission voltage, transmission distance and the power consumption. Under extreme operating conditions, the heat generated by conductors should not make the cable temperature exceed the maximum allowed temperature in detailed specifications of the cable element materials.	IEC 60228 for following Conductor Strands/Class: • Class 1: Solid conductor • Class 2: Stranded conductor intended for fixed installation • Class 5: Flexible conductor • Class 6: Very Flexible conductor Conductor Size/Area (AWG/SQMM) to be decided on Power delivery over distances based on max allowable Voltage drop The Insulated Copper Conductor Shall be meet the Electrical requirement of BS EN 50525 Colour Scheme for Conductor Insulation shall be as per BS EN 60304 Maximum No of Cores: 2 to 12 cores

					Operating Temp: -10 deg C to 60 deg C Low Voltage Application: 12, 24,48 & 57 V DC Low & Medium Power (15 W to 100 W) Distance support up to 1000 meter
25	**Electromagnetic compatibility**	Transfer impedance and Coupling attenuation	IEC 61156-1	Cable shall be electromagnetically complied.	
26	**Safety Requirements**	Flame Spread-Single cable	IEC/EN 60332-1-2	Char less than 0.54 m at completion of test	
27		Flame Spread-Bunched cable	IEC/EN 60332-3-24, Cat C	Char less than 2.5 m at completion of the test	
28		Smoke Test	IEC/EN 61034-2 ASTM D5424	Minimum transmittance 60%	ASTM D5424 for Smoke density
29		Acid gas (Toxicity) (Test on toxic gases evolved during combustion of materials from cables)	IEC/EN 60754-2		

30		Requirements for fire performance of Optical/metallic hybrid cables should meet fire safety regulations.	IEC TR 62222		Test on electric and optical fibre cables under fire condition
31		The material used in the manufacturing of the OFC shall be non- toxic and dermatologically		The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of Optical fibre cable to substantiate the requirement.	
		safe in its life time and shall not be hazardous to health.			
32	**Geometrical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
33	**Transmission Characteristics of Fibre used in the Cable (Chromatic Dispersion)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			
34	**Transmission Characteristics of Fibre used in the cable (Fibre Macro bend loss)**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable			

35	**Mechanical Characteristics of Fibre used in the cable**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable
36	**Colour qualification for color fibres**	The manufacturer shall submit MTCTE Certificate in compliance to ER of Optical Fibre(ER No. TEC70112206) for respective type of Optical fibre used in the cable OR Test shall be carried as per IEC 60794-1-219

ANNEXURE TO ER FOR TRACKING DEVICE

Annex-R-A1-Navigation	1. GPS 2. NavIC (Regional GNSS system of India) Testing as per Test Setup II in Annexure III.

ANNEXURE II

Table 1 for Frequency Allocation *

Frequency Bands		Application
L band I	1164MHz to 1300 MHz	GNSS
L band II	1559 MHz to 1610 MHz	
S Band	2483.5 MHz to 2500MHz	

Note: 1

i. The equipment may operate in part of the bands or cover the full bands listed in Table 1 above.

ii. The above-mentioned frequencies are for the purpose of prescribing technical specifications and don't specify the actual allocation of above-mentioned services in India. The actual allocation w.r.t to any services will be as per license conditions/regulations of Government of India.

iii. All the frequency bands mentioned in the table above, may be revised as per the "National Frequency Allocation Plan (NFAP)" in force.

Note

(i) 1164 to 1215MHz allocated to AERONAUTICAL RADIONAVIGATION, AERONAUTICAL RADIONAVIGATION (Earth-to-space) as per NFAP 2018

(ii) 1215 to 1240 Fixed Mobile Radiolocation as per NFAP 2018.

(iii) 1240 to 1300 MHz Fixed Mobile Radionavigation Earth Exporation – Satellite (Space to Earth) as per NFAP 2018.

(iv) 1300 to 1350 MHz allocated to AERONAUTICAL RADIONAVIGATION, AERONAUTICAL RADIONAVIGATION (Earth-to-space) as per NFAP 2018.

(v) 1350 to 1400 MHz Fixed Mobile Radiolocation as per NFAP 2018.

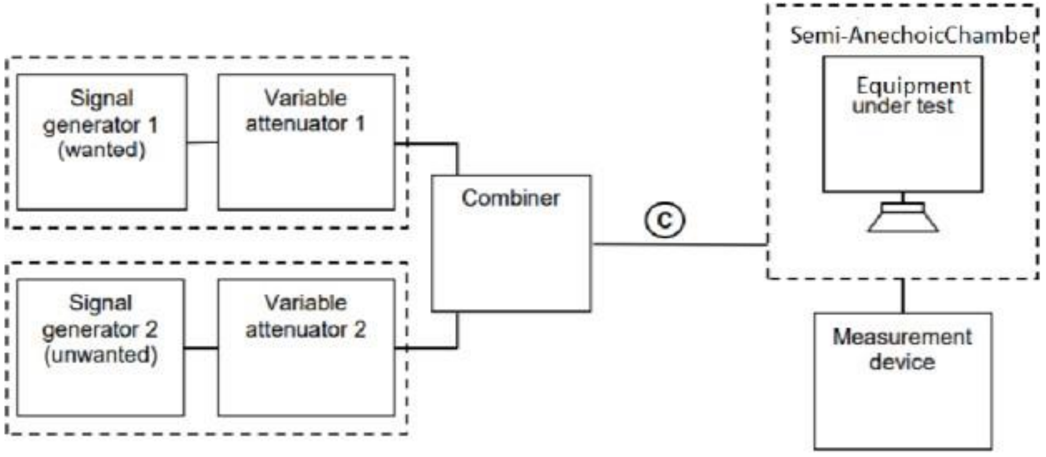
(vi) 2483.5 to 2500 MHz – Fixed Mobile, Fixed mobile satellite (Space to Earth) Radio location Radio Termination – Satellite

ANNEXURE III

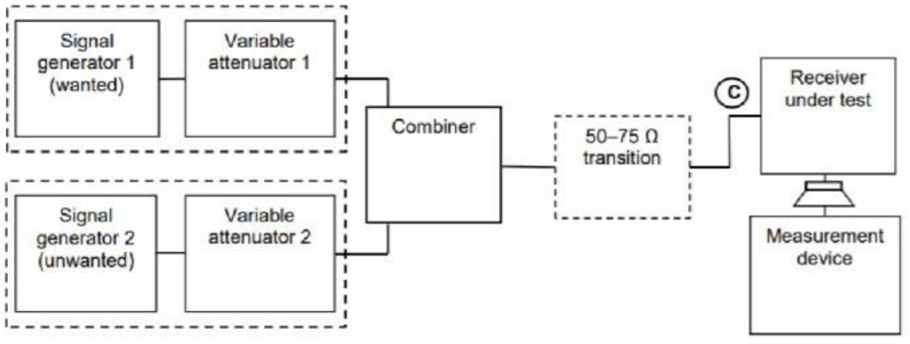
Test Setup I: To verify the frequency of operation of the EUT (as **per** applicability defined in standard ETSI EN 303 345-1)

The setups are representative and may vary depending on the equipment under test and specific test methodology.

I. General Test requirement – Radiated Measurements



II. General Test requirement – Conducted Measurements



<u>Test Setup II: To verify support for GNSS</u>

a) To verify support for GPS/NaVIC

Parameter Name	Support for geolocation through GPS/NaVIC
Test Details	Test for facility of identifying the location through satellite- based GPS/NaVIC
Test instruments required	None
Test Setup	Powered on EUT (Equipment Under Test)
Test Procedure	v. Power on the EUT. vi. If the EUT is SIM enabled then deactivate the SIM. vii. Go to Settings through appropriate menu in the device to enable GPS/NaVIC functionality. viii. Locate the settings to turn Location „ON‟.
Expected Result	ii. Verify that the device is able to display location using satellite based GPS/NaVIC, when SIM (if present) is deactivated.

ANNEXURE IV

Conformance to the following latest in force/valid versions of standards as applicable:			
Sr.No.	**Standard**	**Applicability**	
1	ETSI EN 303 413	Applicable to Radio broadcast receivers intended for reception of GNSS signals	Test Results and certificate from TEC designated CAB shall be submitted for Compliance

Appendix-I

IP Conformance Test Cases for RFCs

The Appendix-I consist of 11 tables, from Table -1 to Table - 11

Table-1: OSPFv2 as per RFC 2328

Parameter Group: IP Conformance (CONFIP)

RFC Section	RFC Clause	Remarks
9.2	First, a Hello Packet may be received from a neighbour claiming to be itself the Backup Designated Router. Alternatively, a Hello packet may be received from a neighbour claiming to be itself the Designated Router, and indicating that there is no Backup Designated Router. In either case there must be bidirectional communication with the neighbour, i.e., the router must also appear in the neighbour's Hello Packet. This event signals an end to the Waiting state.	
13(5b)	In some cases (e.g., the state of the receiving interface is DR and the LSA was received from a router other than the Backup DR) the LSA will be flooded back out the receiving interface	
13.5	Circumstances:- LSA is more recent than database copy, but was not flooded back out receiving interface. Backup:- Delayed acknowledgment sent if advertisement received from Designated Router, otherwise do nothing. All other States:- Delayed acknowledgment sent.	
13(5a)	If there is already a database copy, and if the database copy was received via flooding and installed less than MinLSArrival seconds ago, discard the new LSA (without acknowledging it) and examine the next LSA (if any) listed in the Link State Update packet.	
8.1 & 8.2	The OSPF packet header is verified. The fields specified in the header must match those configured for the receiving interface. If they do not, the packet should be discarded	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-2: OSPFv3 as per RFC 2740

Parameter Group: IP Conformance (CONFIP)

RFC Section	RFC Clause	Remarks
3.1.3	The Interface ID that the neighbour advertises in its Hello Packets must be recorded in the neighbour structure. The router will include the neighbour’s Interface ID in the router's router-LSA when either a) advertising a point-to-point link to the neighbour or b) advertising a link to a network where the neighbour has become Designated Router.	
A.3.2	All routers connected to a common link must agree on certain parameters (HelloInterval and RouterDeadInterval). These parameters are included in Hello packets, so that differences can inhibit the forming of neighbour relationships. The Hello packet also contains fields used in Designated Router election (Designated Router ID and Backup Designated Router ID), and fields used to detect bi-directionality (the Router IDs of all neighbours whose Hellos have been recently received).	
3.2.2	The receiving router must be an area border router, and the Router ID specified in the packet (the source router) must be the other end of a configured virtual link. The receiving interface must also attach to the virtual link's configured Transit area. If all of these checks succeed, the packet is accepted and is from now on associated with the virtual link (and the backbone area).	
3.2.2	The fields specified in the header must match those configured for the receiving interface. If they do not, the packet should be discarded	
3.4.3.1	Consider the router-LSA that router RT3 would originate for Area 1 in Figure 1. Only a single interface must be described, namely that which connects to the transit network N3. It assumes that RT4 has been elected Designated Router of Network N3	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-3: IPV6 as per RFC 2460

Parameter Group: IP Conformance (CONFIP)

RFC Section	RFC Clause	Remarks
4.1	IPv6 nodes must accept and attempt to process extension headers in any order and occurring any number of times in the same packet,	
4.2	The Option Type identifiers are internally encoded such that their highest-order two bits specify the action that must be taken if the processing IPv6 node does not recognize the Option Type: 11 - discard the packet and, only if the packet's Destination Address was not a multicast address, send an ICMP Parameter Problem, Code 2, message to the packet's Source Address, pointing to the unrecognized Option Type.	
4.2	The Option Type identifiers are internally encoded such that their highest-order two bits specify the action that must be taken if the processing IPv6 node does not recognize the Option Type: 01 - discard the packet.	
4.2	The Option Type identifiers are internally encoded such that their highest-order two bits specify the action that must be taken if the processing IPv6 node does not recognize the Option Type: 10 - discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, send an ICMP Parameter Problem, Code 2, message to the packet's Source Address, pointing to the unrecognized Option Type.	
4.4	If Segments Left is zero, the node must ignore the Routing header and proceed to process the next header in the packet, whose type is identified by the Next Header field in the Routing header.	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-4: IPV6 as per RFC 4861

Parameter Group: IP Conformance (CONFIP)

RFC Section	RFC Clause	Remarks
6.1.1	A router MUST silently discard any received Router Solicitation messages that do not satisfy all of the following validity checks: - The IP Hop Limit field has a value of 255, i.e., the packet could not possibly have been forwarded by a router.	
6.1.2	A node MUST silently discard any received Router Advertisementmessages that do not satisfy all of the following validity checks: - The IP Hop Limit field has a value of 255, i.e., the packetcould not possibly have been forwarded by a router.	
6.2.2	A router MUST NOT send Router Advertisements out any interface that is not an advertising interface.	
7.1.1	A node MUST silently discard any received Neighbour Solicitation messages that do not satisfy all of the following validity checks: - The IP Hop Limit field has a value of 255, i.e., the packet could not possibly have been forwarded by a router.	
7.1.2	node MUST silently discard any received Neighbour Advertisementmessages that do not satisfy all of the following validity checks: - The IP Hop Limit field has a value of 255, i.e., the packetcould not possibly have been forwarded by a router.	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-5: IPV6 as per RFC 4862

Parameter Group: IP Conformance (CONFIP)

RFC Section	RFC Clause	Remarks
5.4.2	In order to improve the robustness of the Duplicate Address Detectionalgorithm, an interface MUST receive and process datagrams sent tothe all-nodes multicast address or solicited-node multicast addressof the tentative address during the delay period. This does notnecessarily conflict with the requirement that joining the multicast group be delayed.	
5.4	Duplicate Address Detection MUST NOT be performed on anycastaddresses (note that anycast addresses cannot syntactically bedistinguished from unicast addresses).	
7.1.1	A node MUST silently discard any received Neighbour Solicitationmessages that do not satisfy all of the following validity checks: - The IP Hop Limit field has a value of 255, i.e., the packet could not possibly have been forwarded by a router.	
7.1.1	The contents of the Reserved field, and of any unrecognized options,MUST be ignored. Future, backward-compatible changes to the protocol may specify the contents of the Reserved field or add new options;backward-incompatible changes may use different Code values.	
7.1.2	A node MUST silently discard any received Neighbour Advertisementmessages that do not satisfy all of the following validity checks: - The IP Hop Limit field has a value of 255, i.e., the packet could not possibly have been forwarded by a router.	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-6: IPV6 as per RFC 8201

Parameter Group: IP Conformance (CONFIP)

RFC Section	RFC Clause	Remarks
4	If a node receives a Packet Too Big message reporting a next-hop MTU that is less than the IPv6 minimum link MTU, it must discard it. A node must not reduce its estimate of the Path MTU below the IPv6 minimum link MTU on receipt of a Packet Too Big message.	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-7: IPV6 as per RFC 4443

Parameter Group: IP Conformance (CONFIP)

RFC Section	RFC Clause	Remarks
2.2	(a) If the message is a response to a message sent to one of thenode's unicast addresses, the Source Address of the reply MUST bethat same address.	
	If the message is a response to a message sent to any otheraddress, such as - a multicast group address, - an anycast address implemented by the node, or - a unicast address that does not belong to the node; the Source Address of the ICMPv6 packet MUST be a unicast address belonging to the node	
2.4	If an ICMPv6 informational message of unknown type is received,it MUST be silently discarded.	
2.4	An ICMPv6 error message MUST NOT be originated as a result ofreceiving the following: (e.3) A packet destined to an IPv6 multicast address.	
2.4	An ICMPv6 error message MUST NOT be originated as a result ofreceiving the following: (e.6) A packet whose source address does not uniquely identify asingle node -- e.g., the IPv6 Unspecified Address, an IPv6multicast address, or an address known by the ICMP messageoriginator to be an IPv6 anycast address.	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-8: BGP for IPV6 as per RFC 2545

Parameter Group: IP Conformance (CONFIP)

RFC Section	RFC Clause	Remarks
3	The link-local address shall be included in the Next Hop field if and only if the BGP speaker shares a common subnet with the entity identified by the global IPv6 address carried in the Network Address of Next Hop field and the peer the route is being advertised to In all other cases a BGP speaker shall advertise to its peer in the Network Address field only the global IPv6 address of the next hop (the value of the Length of Network Address of Next Hop field shall be set to 16)	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned confirmation in ER, please obtain confirmation from Helpdesk before submitting application.

Table-9: BGP4 for IPV4 as per RFC 4271

Parameter Group: IP Conformance (CONFIP)

RFC Section	**RFC Clause**	**Remarks**
9.2	When a BGP speaker receives an UPDATE message from an internal peer, the receiving BGP speaker SHALL NOT re-distribute the routing information contained in that UPDATE message to other internal peers	
6.1	if the Length field of the message header is less than 19 or greater than 4096, then the Error Subcode MUST be set to Bad Message Length. The Data field MUST contain the erroneous Length field.	
6.3	If an optional attribute is recognized, then the value of this attribute MUST be checked. If an error is detected, the attribute MUST be discarded, and the Error Subcode MUST be set to Optional Attribute Error. The Data field MUST contain the attribute (type, length, and value)	Not Applicable for MPLS Router
6.1	If the Marker field of the message header is not as expected, then a synchronization error has occurred and the Error Subcode MUST be set to Connection Not Synchronized, if the Length field of an OPEN message is less than the minimum length of the OPEN message	
6.8	Upon receipt of an OPEN message, the local system MUST examine all of its connections that are in the Open Confirm state	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-10: MBGP as per RFC 4760

Parameter Group: IP Conformance (CONFIP)

RFC Section	**RFC Clause**	**Remarks**
7	If a BGP speaker receives from a neighbour an Update message that contains the MP_REACH_NLRI or MP_UNREACH_NLRI attribute, and the speaker determines that the attribute is incorrect, the speaker MUST delete all the BGP routes received from that neighbour whose AFI/SAFI is the same as the one carried in the incorrect MP_REACH_NLRI or MP_UNREACH_NLRI attribute	

Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Table-11: LDP as per RFC 5036

Parameter Group: IP Conformance (CONFIP)

RFC Section	**RFC Clause**	**Remarks**
2.2.2	An LDP Identifier is a six-octet quantity used to identify an LSR label space. The first four octets identify the LSR and must be a globally unique value, such as a 32-bit router Id assigned to the LSR.	
2.5.2	An LSR MUST advertise the same transport address in all Hellos that advertise the same label space	
2.5.6	After an LDP session has been established, an LSR must arrange that its peer receive an LDP PDU from it at least every KeepAlive timeperiod to ensure the peer restarts the session KeepAlive Timer	
2.7	When the next hop for a prefix changes, the LSR must retrieve the label advertised by the new next hop from the LIB for use in forwarding.	
2.8.1	The Label Request message MUST include a Hop Count TLV.	

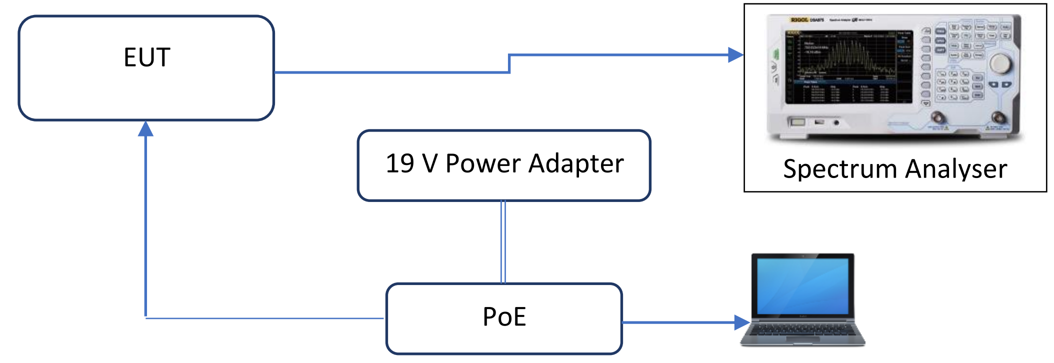
Note: Wherever a particular IP test is implemented in a product through a RFC different from what is mentioned in ER, please obtain confirmation from Helpdesk before submitting application.

Appendix-II

Test Setup and Test Procedures

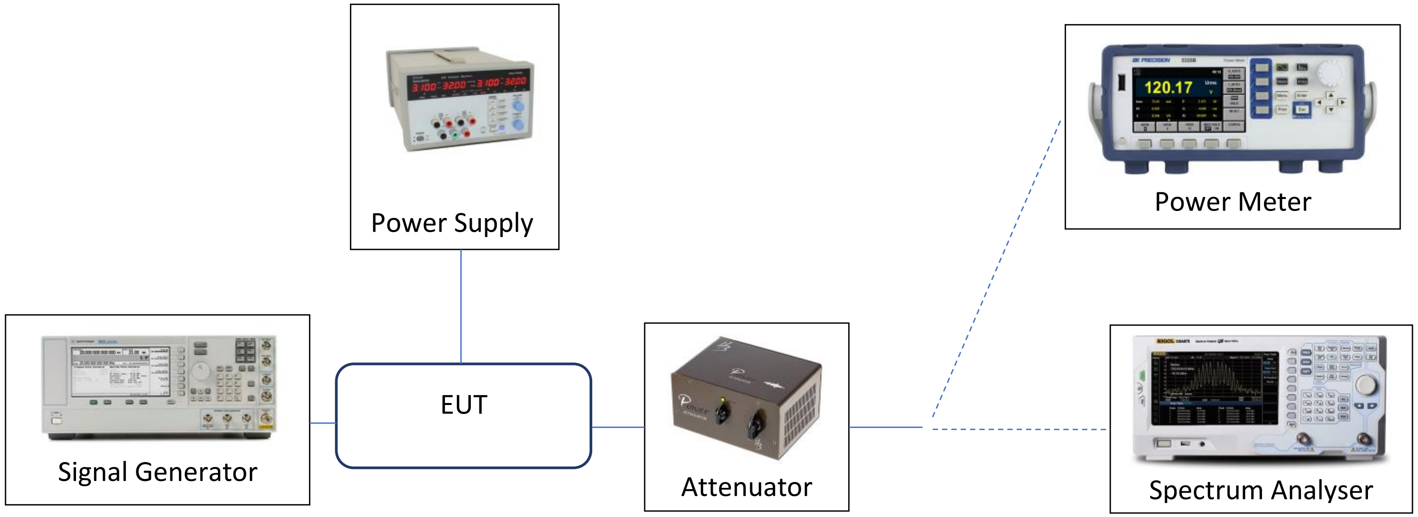
The Appendix consist of 43 tests from Test 1 to Test 43

Test No.1

Parameter Name	Frequency and EIRP for Wi-Fi and Point to Point/ Point to Multipoint Radio Interface
Test Details	Frequency of Operation and Peak Power Measurement Test Setup
Test instruments required	Spectrum Analyzer
Test Setup	
Test Procedure	1. Make the setup as shown above. 2. Configure the Spectrum Analyser for a) Center Frequency as required. b) SPAN of 20MHz c) RBW of 3KHz 3. Configure EUT in different modes of operation. 4. Measure peak power shown in Spectrum analyser.
Expected Results	1. Record peak power and attach trace

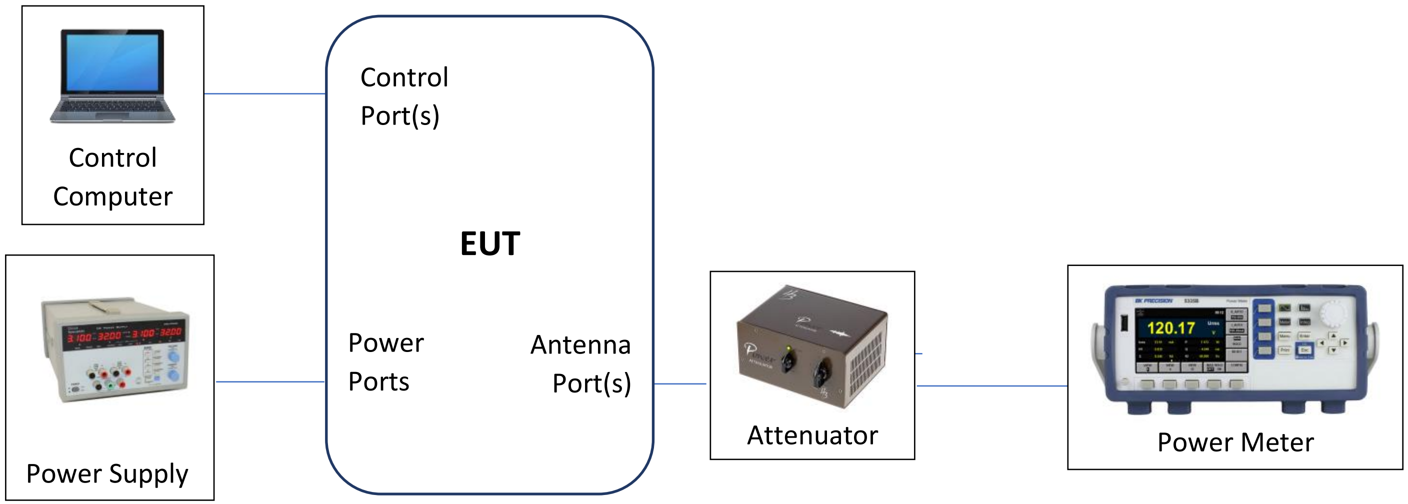
Note: This is a representative setup and may be adapted as per the requirement of testing for the equipment.

Test No.2

<table>
<tr><td>Parameter Name</td><td>Frequency of Operation and Transmit Power for Satellite Equipment</td></tr>
<tr><td>Test Details</td><td>Typical setup of Frequency of Operation & Transmit Power measurement for Satellite System Equipment</td></tr>
<tr><td>Test instruments required</td><td>Signal Generator
Spectrum Analyser
Attenuator
Power Meter
Power Supply</td></tr>
<tr><td>Test Setup</td><td>
</td></tr>
<tr><td>Test Procedure</td><td>1. For measurement of Transmit Power, Power Meter is to be connected to the Equipment Under Test(EUT).
2. For measurement of Frequency of Operation, Spectrum Analyser (with DC block if required) is to be connected to the EUT.</td></tr>
<tr><td>Expected Results</td><td>3. Record peak power and attach trace</td></tr>
</table>

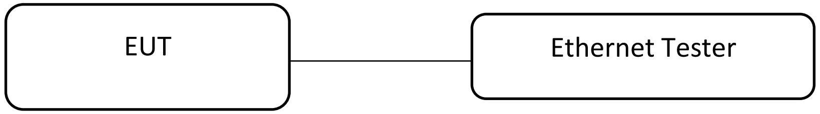
Note: This is a representative setup and may be adapted as per the requirement of testing for the equipment.

Test No.3

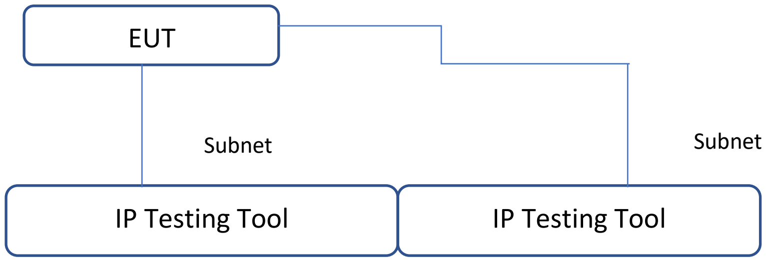
Parameter Name	Transmit power for PTP/ PMP Radio Interface
Test Details	Typical setup of Transmit power Measurement
Test instruments required	Power Meter Power Supply Attenuator
Test Setup	
Test Procedure	1. For measurement of Transmit Power, Power Meter is to be connected to the Equipment Under Test (EUT).
Expected Results	2. Record peak power and attach trace

Note: This is a representative setup and may be adapted as per the requirement of testing for the equipment.

Test No.4

Parameter Name	Link Speed and Auto-negotiation FE, Link Speed and Auto-negotiation GE
Test Details	Test for Ethernet Link Speed (100/1000) and Auto-negotiation
Test instruments required	Ethernet Tester supporting 100/1000 mbps link
Test Setup	
Test Procedure	1. Connect the Ethernet Tester to the applicable/ supported Ethernet interface of the EUTas shown above. 2. Configure the EUT to use auto-negotiation on its selected Ethernet port. 3. Configure the Ethernet Tester to run at 100 mbps speed and see if it is able to connect to the EUT. The Ethernet link between the Ethernet Tester and EUT should be active and report 100mbps link speed (if link speed 100 mbps is supported by the EUT). 4. Configure the Ethernet Tester to run at 1000 mbps speed and see if it is able to connect to the EUT. The Ethernet link between the Ethernet Tester and EUT should be active and report 1000mbps link speed. (if link speed 1000 mbps is supported by the EUT).
Expected Results	1. The Ethernet link between the Ethernet Tester and EUT should be active and report 100 or 1000 mbps link speed as per the link speed supported by the EUT

Test No.5

Parameter Name	IPV4 Functional Tests
Test instruments required	IP Testing Tool
Test Setup	
Test Procedure	1. Connect the IP Testing Tool to the Ethernet interface of the router as shown above. 2. Configure the IP interfaces of the EUT and IP Testing Tool for back-to-back communication from/ to IP Testing Tool. 3. Configure static/ dynamic routing on the EUT to reach local LAN subnets from the IP Testing Tool. 4. Perform IPv4 ping test from IP Testing Tool to IP Testing Tool and verify that it is successful and that there is no packet drop. 5. Perform file transfer test from IP Testing Tool to IP Testing Tool and verify that it is successful.
Expected Results	1. IPv4 Ping test should be successful with zero packet loss. 2. File transfer test should be successful. 3. Enclose screenshots and IP Testing Tool traces of the IPV4 communication.

Test No.6

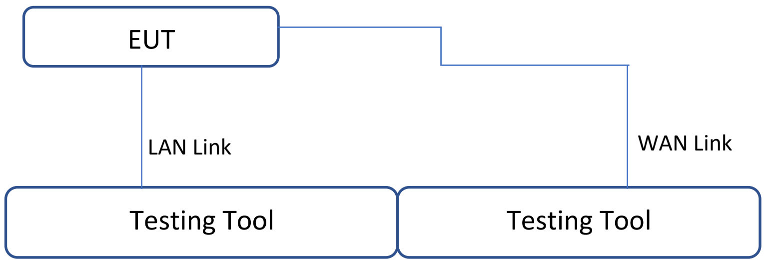
Parameter Name	SNMPv2 or Qx Protocol Functional Tests
Test Details	Test for management: SNMPv2, or Qx (check TRAP, GET and SET operations)
Test instruments required	1. PC/Laptop – 1 Numbers (SNMP or Qx Manager) 2. Switch – 1 Numbers
Test Setup	
Test Procedure	**For SNMP,** 1.) Configure the EUT to run SNMP agent and NMS (PC) to run SNMP manager application by using correct parameters. 2.) Testing of TRAP message: The NMS uses SNMPv2 to manage the SNMP agent, and the agent automatically sends notifications to report events to the NMS. Configure the SNMP agent to send traps to the manager. Use a wrong community name to get the value of a MIB node on the agent. You can see an authentication failure trap on the SNMP manager. 3.) Test “SetRequest” operation: SNMP Testing node (SNMP manager) sends SNMPv2c “SetRequest” to set SysName to “EUT1”. Verify the SysName value on the EUT. It should match the value “EUT1” set using ‘SetRequest’ function from the SNMP manger. 4.) Test SNMP GET Operation (single Object): Testing node (SNMP Manager) sends SNMPv2c “GetRequest” scalar object to get sysName.0 1.3.6.1.2.1.1.5.0 in system group in MIB II, to Agent. The agent should respond with “SysName value as “EUT1” as set in the previous step, verifying that the EUT support SNMP GET function. **For Qx,** 1) Configure the EUT to run Qx agent and NMS (PC) to run Qx manager application by using correct parameters. 2) Testing of TRAP message: The NMS uses Qx to manage the Qx agent, and the agent automatically sends notifications to report events to the NMS. Configure the Qx agent to send traps to the manager.

	3) Test “Write” operation: Qx Testing node (Qx manager) sends Qx“Write” to set Name to “EUT1”. Verify the Name value on the EUT. It should match the value “EUT1” set using ‘Write function from the Qx manger. 4) Test “Read” Operation (single Object): Testing node (Qx Manager) sends “Read” scalar object to get Name on Agent. The agent should respond with Name value as “EUT1” as set in the previous step, verifying that the EUT support Qx Read function.
Expected Results	1.) TRAP should be sent by EUT (Agent) to Testing Node (SNMP or Qx Manager). 2.) Set Request operation should be able to set SysName object in agent (EUT), or Write operation should be able to set Name in Qx agent (EUT), 3.) GetRequest operation should be able to get SysName Object from agent(EUT) Read operation should be able to get Name Object from Qx agent(EUT) Attach screenshots for above successful operations.

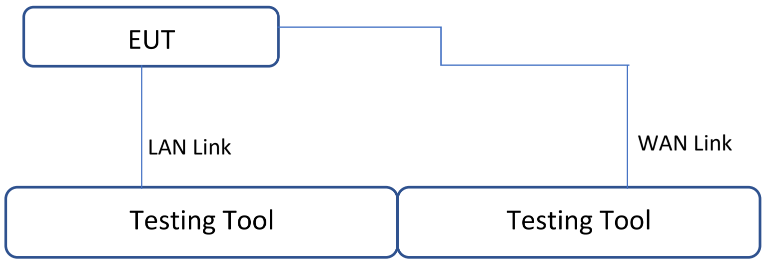
Test No.7

Parameter Name	SNMPv3 or Qx Protocol Functional Tests
Test Details	Test for SNMPv3 or Qx management
Test instruments required	1. PC/Laptop – 1 Numbers (SNMP/Qx Manager) 2. Switch – 1 Numbers
Test Setup	
Test Procedure	**For SNMP** • Configure the agent on EUT and SNMP manager on PC/NMS to use SNMPv3 with security level setting to Auth.Priv. Set Authentication to SHA and Privacy (encryption) to DES. • The NMS uses SNMPv3 to monitor and manage the agent • The agent automatically sends notifications to report events to the NMS. • The NMS and the agent perform authentication when they establish an SNMP session. The authentication algorithm is SHA and the authentication key is xxxxxx. The NMS and the agent also encrypt the SNMP packets between them by using the DES algorithm and encryption key yyyyyy **For Qx** • Configure the agent on EUT and Qx manager on PC/NMS to use Qx with security level setting to AuthPriv. Set SSH between EUT and NMS to enable authentication and encryption. • The NMS uses Qx to monitor and manage the agent • The agent automatically sends notifications to report events to the NMS. • The NMS and the agent perform authentication when they establish an Qx session based on SSH. The NMS and the agent encrypt the packets by using SSH
Expected Results	• Use correct authentication credentials to access the agent. - Attach traces for successful encrypted authentication with correct credentials • Use incorrect authentication credentials to access the agent - Attach traces for failed authentication with incorrect credentials

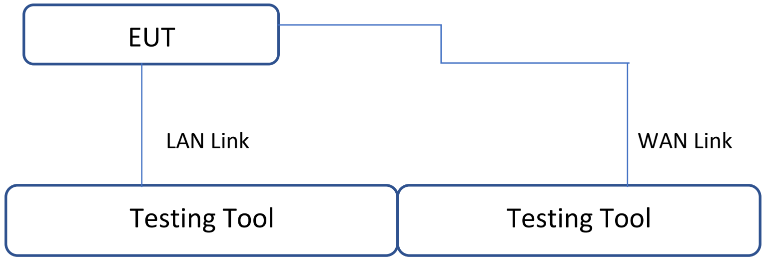
Test No.8

Parameter Name	Dynamic Routing Functional Tests
Test Details	Test for Dynamic Routing Table entry
Test instruments required	IP Testing Tool
Test Setup	
Test Procedure	1. Connect the interface as the case may be, as shown in the setup diagram 2. Connect the Testing Tool to the Ethernet interface of the EUT as shown above. 3. Configure the IP interfaces of the EUT and Testing Tool for back-to-back communication between two ports of Testing Tool. 4. Verify that no static or dynamic routing table entry exists on the EUT and that ping to the WAN port of Testing Tool is not working through LAN Port of Testing Tool. 5. Configure Dynamic Routing (OSPFv2 & OSPFv3) on the EUT to reach each subnet from other subnet using dynamic routing. Static routing should NOT be used in this case. 6. Perform back-to-back ping test from Testing Tool through EUT and verify that it is successful and that there is no packet drop. 7. Verify the existence of dynamic routing table entry of remote LAN subnet on the EUT using dynamic routing.
Expected Results	1. There should be routing table entry of the remote LAN subnet on the EUT using dynamic routing protocol (OSPF). 2. The ping test should be successful to the remote LAN subnet IP address.

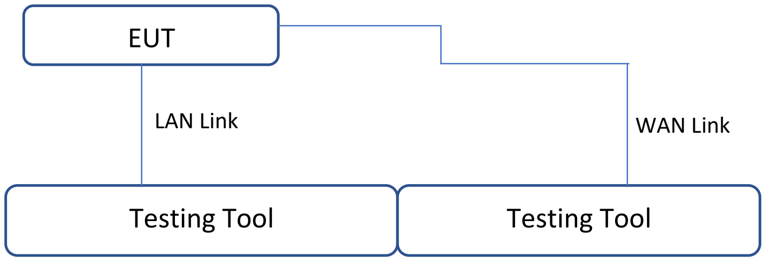
Test No.9

Parameter Name	Static Routing Functional Tests
Test Details	Test for Static Routing Table entry
Test instruments required	Testing Tool
Test Setup	
Test Procedure	1. Connect the interface as the case may be, as shown in the setup diagram 2. Connect the Testing Tool to the Ethernet interface of the EUT as shown above. 3. Configure the IP interfaces of the EUT and Testing Tool for back-to-back communication between two ports of Testing Tool. 4. Verify that no static or dynamic routing table entry exists on the EUT and that ping to the WAN port of Testing Tool is not working through LAN Port of Testing Tool. 5. Configure static routing on the EUT to reach each subnet from other subnet. 6. Perform ping test from back-to-back ping test from Testing Tool through EUT and verify that it is successful and that there is no packet drop. 7. Verify the existence of routing table entry of remote LAN subnet on the EUT using static routing.
Expected Results	1. There should be routing table entry of the remote LAN subnet on the EUT using static route. 2. The ping test should be successful to the remote LAN subnet IP address.

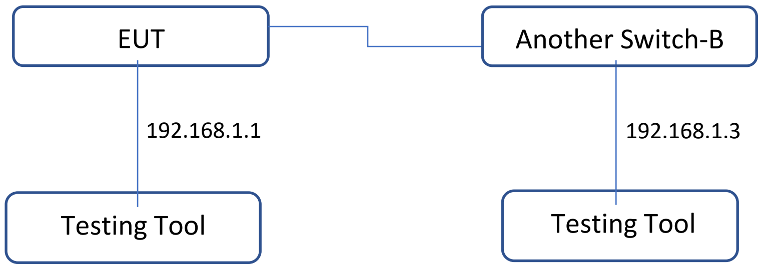
Test No.10

Parameter Name	TCP Functional Tests
Test Details	Test for TCP protocol
Test instruments required	IP Testing Tool
Test Setup	
Test Procedure	1. Connect the Testing Tool to the Ethernet interface of the router as shown above. 2. Configure the Testing Tool and the EUT for back-to-back communication between two ports of Testing Tool. 3. Configure static/ dynamic routing on the EUT to reach each subnet from other subnet. 4. Install/ ensure availability of FTP server and FTP client on Testing Tool for performing file transfer test. 5. Perform file transfer test between the two ports of Testing Tool and verify that it is successful through EUT as per the above-mentioned setup. 6. The EUT must also support Secure Shell (SSH) functionality. Configure the EUT to support Secure Shell (SSH) on its local IP address. 7. Connect to the EUT using Secure Shell (SSH) from Testing Tool to verify that Secure Shell (SSH) connection is established and EUT can be configured remotely using Secure Shell (SSH) sessions. 8. Capture packets at various stages to verify functionality of Sequence Numbers and TCP Header Formats.
Expected Results	1. File transfer test should be successful. 2. Secure Shell (SSH) connection to EUT from Testing Tool should be successful. 3. Enclose screenshots and Testing Tool traces of the communication, and indicate various Headers and Sequence Numbers.

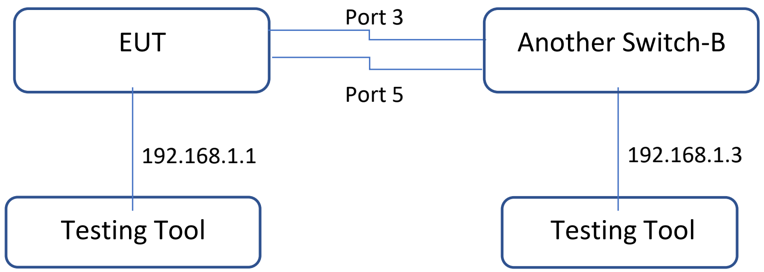
Test No.11

Parameter Name	Mac Learning and Packet Forwarding Tests
Test Details	Mac Learning and Packet Forwarding
Test instruments required	IP Testing Tool
Test Setup	
Test Procedure	1. Connect Interface-A of Testing Tool with EUT and ping EUT. 2. Ensure MAC address of Interface-A of Testing Tool is visible in EUT's MAC address table and Interface-B MAC address is not visible. (e.g. show mac-add). 3. Connect Interface-B of Testing Tool to EUT and ping Testing Tool through Interface-A. Ping should be successful. 4. Check EUT's MAC address table. MAC address of Interface-B of Testing Tool should be visible in table.
Expected Results	1. Ping from Interface-B to Interface-A should be successful, showing successful packet forwarding. 2. MAC address should be visible on EUT's MAC table. (This is not mandatory for Unmanaged LAN Switch variant) 3. Enclose screenshot for successful test.

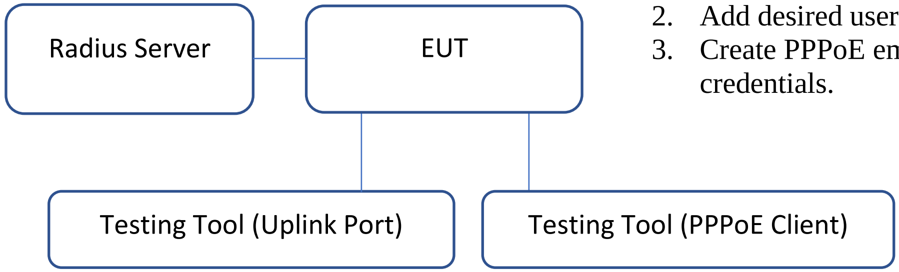
Test No.12

Parameter Name	Spanning Tree Protocol Root Bridge Election Functional Test
Test Details	Test for Spanning tree protocol (STP) – Root Bridge Election
Test instruments required	IP Testing Tool Another Switch
Test Setup	
Test Procedure	1. Enable STP (802.1d) at both EUT and other switch, keeping priority value the same. 2. Verify from C-BPDU from Testing Tool that it contains information about bridge id (Priority/ MAC Address). 3. Depending on computed bridge id, Verify from C-BPDU messages that EUT either becomes the Root Bridge, or allows the other switch to become Root Bridge.
Expected Results	1. The switch, which has the lowest root bridge ID, will be elected as the root bridge. 2. Attach screenshot and Testing Tool traces as artefacts.

Test No.13

Parameter Name	Spanning Tree Protocol Port Blocking Functional Test
Test Details	Test for Spanning tree protocol (STP) – Port Blocking
Test instruments required	Testing Tool Another Switch
Test Setup	
Test Procedure	1. Create setup as in test STP-1 2. Create Switch-B as root bridge 3. Connect additional ports of EUT and switch-B to create one more link
Expected Results	3. STP should automatically block port 5 4. Evidence: Print status of port 3 and 5 from EUT

Test No.14

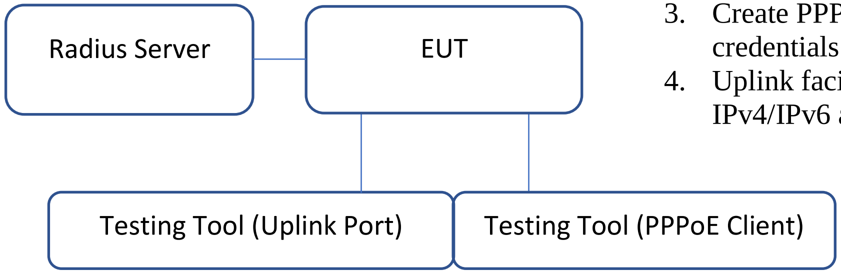
Parameter Name	PPPoE as per RFC 2516
Test Details	
Test instruments required	Test tool for emulating PPPoE Client and uplink port Linus Server with Radius Tool
Pre-Test Setup And Test Setup	 1. Setup free radius server on the Linux machine 2. Add desired user credentials in user file on the radius server. 3. Create PPPoE emulation on the test tool with the same user credentials.
Test Steps	1. Start the PPPoE client emulation from test tool. 2. Verify that PADI was received on the box by using CLI 3. Check that authentication was successful by using CLI 4. Issue show PPPoE statistics again to see that DUT has sent PADO, received PADR and send PADS packet by using CLI. (Note: since subscriber bring up happens very fast you might be able to see all the packet count in step 2 itself.) 5. Check on DUT to see that subscriber has come up by executing CLIs 6. Stop the PPPoE client emulation from test tool. 7. Check that PADT message was received on the DUT using CLI 8. Check that subscriber entry has been cleared from the DUT using CLI
Expected Results	1. For Step 2, CLI output contains correct PADI packet count. 2. For Step 3, Authentication is granted. 3. For Step 4, CLI output contains correct PADO, PADR and PADS packet count. 4. For Step 5, CLI contains correct subscriber count and state. 5. For Step 6, PADT is received on the DUT after PPPoE client emulation is stopped in the test tool. 6. For Step 8, CLI output returns subscriber count as 0

Test No.15

<table>
<tr><td>Parameter Name</td><td colspan="2">Radius</td></tr>
<tr><td>Test instruments required</td><td colspan="2">Test tool for emulating PPPoE Client and uplink port

Linus Server with Radius Tool</td></tr>
<tr><td>Pre-Test Setup

And

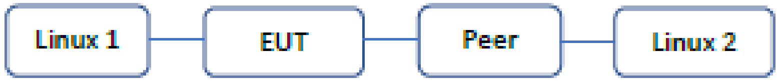
Test Setup</td><td colspan="2">

1. Setup free radius server on the Linux machine
2. Add desired user credentials in user file on the radius server.
3. Create PPPoE emulation on the test tool with the same user credentials.
4. Uplink facing port on the DUT configured with appropriate IPv4/IPv6 addressed and ARP/NDP resolved on the test tool.</td></tr>
<tr><td colspan="2">Test Steps</td><td>Expected Results</td></tr>
<tr><td colspan="2">1. Start the PPPoE client emulation from test tool.
2. Verify that PADI was received on the box by using CLI
3. Check that authentication request was received on the DUT by using CLI
4. Check that Access-Accept was received on the DUT by using CLI
5. Stop the PPPoE client emulation from test tool.
6. Check that PADT message was received on the DUT using CLI

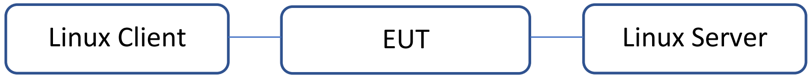
7. Check that subscriber entry has been cleared from the DUT using CLI
8. Create a mismatch between user credentials in PPPoE client emulation and free radius user file.
9. Start the PPPoE client emulation from test tool.
10. Verify that access-reject has been received on the DUT using CLI
11. Check that no subscriber comes up if Access-reject has been received from the radius server using CLI</td><td>•
• CLI output contains correct PADI packet count.
• Authentication is granted.
• Accept counter increments correctly in the CLI output.
•
• PADT is received on the DUT after PPPoE client emulation is stopped in the test tool.
• CLI output contains Active subscriber count as 0
•

•
• Reject counter increments correctly in the CLI output
• CLI output contains Active subscriber count as 0</td></tr>
</table>

Test No.16

Parameter Name	Ping traffic through Policy based IPSec Tunnel
Test instruments required	Peer Device Two Linux machines
Pre-Test Setup And Test Setup	 1. Configure IKE and IPsec under Security configuration options on both EUT and PEER devices. 2. To route the required traffic through the tunnel, add the configured VPN under the required policy on both EUT and PEER devices 3. If EUT needs to be act as Initiator, then configure establish tunnel immediately only at the EUT side 4. If EUT needs to be act as responder, then configure establish tunnel immediately only at the PEER side
Test Case Steps	1. Send ping traffic from Linux1 to Linux2 or Linux2 to Linux1 2. Verify fields under security IPsec /IKE CLI
Expected Results	**1. Configure & Establish tunnel immediately:** a. As soon as configuration gets committed verify P1 and P2 SA is up on both the devices. b. role (initiator or responder) should be proper under ike cli based on the configuration on both the devices c. There should not be any ping packet drop d. packet statistics under ipsec cli should match with actual sent traffic. e. configured Policy through which tunnel is formed should be visible in ipsec sa cli **2. Configure & Establish tunnel on-traffic:** a. There will be one or more ping packet drop and packet statistics should match accordingly under ipsec cli b. P1 and P2 SA should be up on both the devices c. role (initiator or responder) should be proper under ike cli based on traffic d. configured Policy through which tunnel is formed should be visible in ipsec sa cli

Test No.17

Parameter Name	Test Source NAT with PAT with multiple source ip addresses.
Test instruments required	One Linux client with hping2 tool installed One linux machines
Pre-Test Setup And Test Setup	 1. Install hping2 on Linux Client to initiate traffic from multiple source addresses 2. On Linux server, add route for nat-pool address used in nat configuration on DUT 3. Configure source nat pool on DUT with single IP address 4. Configure source nat rule-set on DUT with ‘from’ and ‘to’ and also match condition like ‘source-address’ and ‘destination-address’ Note:PAT is enabled by default
Test Case Steps	1. Start sending traffic with hping2 tool from Linux client with first IP to Linux server IP address 2. Again, Initiate hping2 by incrementing the source IP in ‘source-ip’ field
Expected Results	1. For Step 1, verify that cli output of flow session shows nat-translation. Test considered pass if the source address is natted with the address from the pool specified. 2. Also, check source nat-translation hit count is incrementing in cli output 3. For step 2, Verify that port address translation is seen in cli output of security flow session

Test No.18

Parameter Name	Test Source NAT NAT64 related feature
Test instruments required	One Linux client One linux server
Pre-Test Setup And Test Setup	 1. To configure NAT64, you need to have a pool of single IPs which will be the IPv4 address of the server. 2. We need a destination NAT configuration to translate the IPv6 address into IPv4 address in the destination field of the incoming packet. 3. The destination address is IPv4, but the source address is IPv6. Thus, we must apply the source NAT in order to change the IPv6 address to IPv4 in the source field of the packet.
Test Case Steps	1. Initiate traffic from Linux client 2. Verify nat translation has worked by checking flow session on DUT
Expected Results	1. Check how the sessions are being established:

Test No.19

Parameter Name	Verify Source Address any, destination specific, application any action = deny
Test instruments required	One Linux client One linux server
Pre-Test Setup And Test Setup	 1. Configure IPs on the eth interfaces of both the linux machines.
Test Case Steps	1. Configure security zones and add interfaces to it. 2. (Ex: Configure a security zone "trust" and add the interface connected to one of the linux machines to it. Configure another security zone "untrust" and add router's other interface to it.) 3. Create address book entries to specify the source and destination address. 4. Create a policy (say p1) from zone trust to zone untrust and vice-versa, with source address any name, destination address as address book name, application any. 5. Set a deny condition for the policy. 6. (For ex: set security policies from-zone trust to-zone untrust policy p1 then deny) 7. Commit the configuration. 8. Send traffic from H0 to H1.
Expected Results	1. Traffic should not be allowed due to the deny policy.

Test No.20

Parameter Name	Verify the packet capture of the attack logs
Test instruments required	2 Linux server, syslog, ftp client and server
Pre-Test Setup And Test Setup	 1. IDP license is installed 2. IDP security package is installed 3. Configure IDP with FTP:USER: ROOT attack and attack to fw policy 4. Configure the packet-log server and the port details 5. Enable 5 packets to capture pre and post the attack.
Test Case Steps	1. Start the packet-log server to capture the packets 2. Start the FTP server 3. Start FTP traffic with user as root
Expected Results	1. IDP attack table should not have the attack detected 2. The packet log tool should have the attack details and the pre and post attack packet captured 3. IDP attack log should be generated and the packet log id should be matching with the packet log attack details

Test No.21

Parameter Name	Check the attack detection over https session
Test instruments required	2 Linux as server client, openssl, curl.
Pre-Test Setup And Test Setup	 1. IDP license is installed 2. IDP security package is installed 3. Configure a ssl proxy profile and attach to the fw policy 4. Configure an IDP with custom http attack and attach to the same IDP policy
Test Case Steps	1. Start the openssl server. 2. Send the https traffic using curl from client
Expected Results	1. IDP attack table should have the custom http attack detected

Test No.22

Parameter Name	Close Client and Server Action for TCP in IPS Rule Base
Test instruments required	2 Linux servers
Pre-Test Setup And Test Setup	 1. IDP license is installed 2. IDP security package is installed 3. Configure an http attack with close client and server as action
Test Case Steps	1. Start the tcp dump on both client and server. 2. Send the http attack traffic.
Expected Results	1. http attack should be detected 2. client and server should have received RST packet to close the tcp connection 3. IDP attack log should have the action as close-client-and-server as action

Test No.23

Parameter Name	Close Client Action for UDP in IPS Rule Base
Test instruments required	2 Linux servers
Pre-Test Setup And Test Setup	 1. IDP license is installed 2. IDP security package is installed 3. Configure a dns attack with close client as action
Test Case Steps	1. Start the tcp dump on client. 2. Send the dns attack traffic from client.
Expected Results	1. DNS attack should be detected. 2. Server should not receive the packet. 3. IDP attack log should have the action as DROP as action.

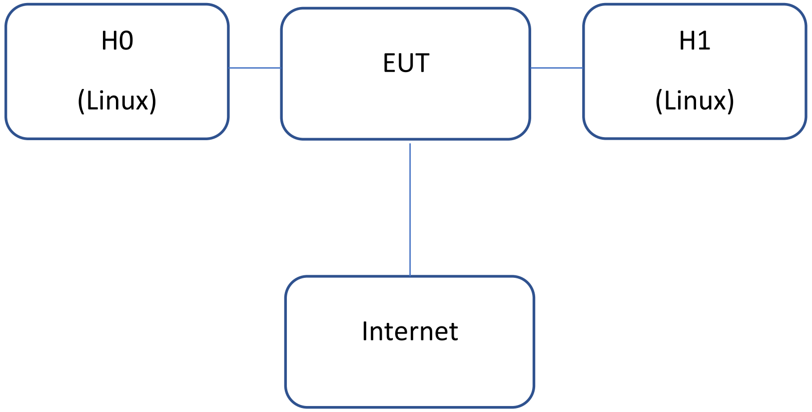
Test No.24

Parameter Name	http with block-extension-list
Test instruments required	2 Linux servers
Pre-Test Setup And Test Setup	 1. Configure UTM custom objects for file extension list such as vbs, pl, tst 2. Configure the UTM content filtering feature profile with the block-extension for those file extension list 3. Configure notifications options as message and content for the message 4. Attach the profile to the fw policy. 5. Configure the security logging
Test Case Steps	1. Start the HTTP server and have the files with different extension 2. From client get vbs, pl, txt and html files using curl
Expected Results	1. Other than html file all are blocked 2. In the utm content filtering statistics, the extension blocked counter should increment accordingly 3. Verify the content filtering blocked message in the syslog

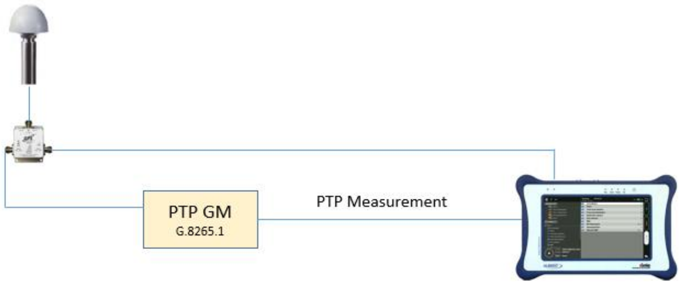
Test No.25

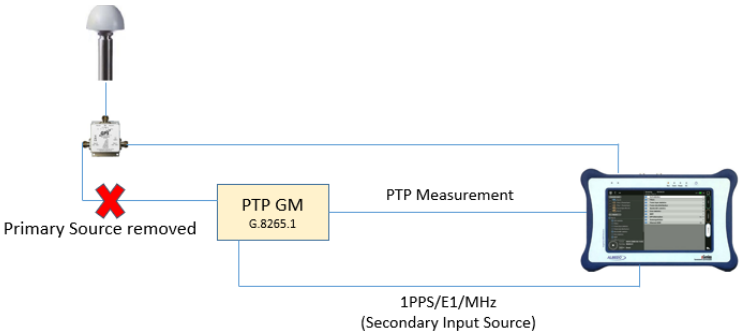
Parameter Name	File extension blocking
Test instruments required	2 Linux servers
Pre-Test Setup And Test Setup	 1. Configure UTM custom objects for filename extension list for com and exe 2. Configure the UTM content filtering feature profile with the block-extension for those filename extension list 3. Configure content filtering UTM policy for ftp upload and download 4. Configure notifications options as message and content for the message 5. Attach the profile to the fw policy. 6. Configure the security logging
Test Case Steps	1. Start the FTP server and have the files with different extension 2. From client, do ftp and get exe and com extension files 3. From client do ftp and put exe and com extension files
Expected Results	1. GET and PUT of exe and com files are blocked with proper error message 2. In the utm content filtering statistics, the Base on extension list counter should increment accordingly 3. Verify the content filtering blocked message in the syslog

Test No.26

Parameter Name	Test with Infected file for ALL Protocol
Test instruments required	2 Linux servers
Pre-Test Setup And Test Setup	 1. DUT should have internet access through one of the revenue interfaces 2. Sophos license should be installed 3. Sophos av is configured and the pattern is up to date 4. Configure Sophos anti-virus profile for http, ftp up/down, smtp, pop and imap 5. Attach the profile to the utm policy 6. Attach the utm policy to the fw policy
Test Case Steps	1. Send the following traffic with the virus file attached (HTTP GET/POST, FTP GET/PUT, SMTP, IMAP and POP3)
Expected Results	1. The virus file should be blocked with the proper error message 2. The virus file should be detected and the threat-found incremented in the anti-virus statistics 3. Verify the av virus detected message in the syslog

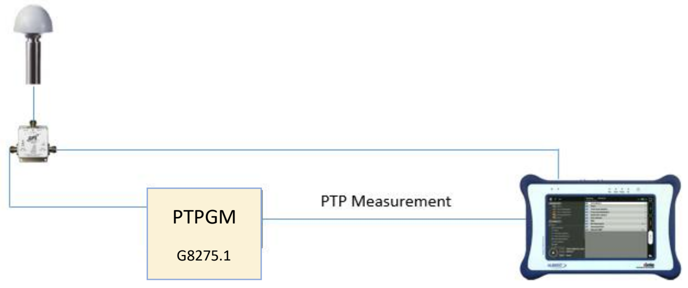
Test No.27

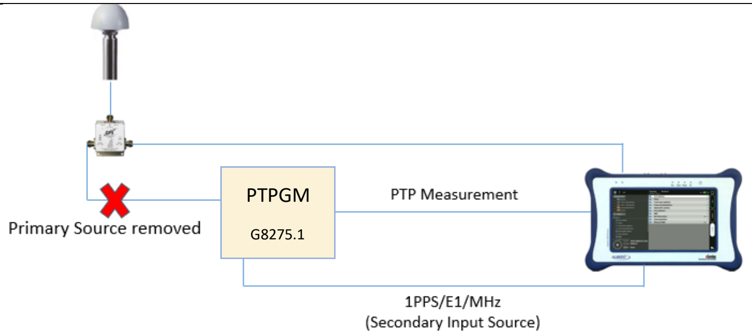
Parameter Name	Profile for frequency synchronisation
Test Details	Support for PTP frequency profile: G.8265.1 & monitor 1) PTP messages exchanged between Master & Slave 2) Protocol statistics of GM for e.g. GM IP, GM Identity, GM clock class & value etc. 3) GM locking with auxiliary interfaces and observe relevant protocol statistics.
Test instruments required	Synch tester Splitter GPS Antenna Connecting Cables Laptop
Test Setup 1 Test Setup 2	Setup 1: Follow Test procedure instructions 4 to 7  Setup 2: Follow Test procedure instruction 8

	
Test Procedure	1. Connect GNSS signal to PTP GM and Tester. Wait for sufficient (approx. 1-2 hours) time so that GM and Tester are locked to UTC. 2. Now, configure PTP GM as per the settings mentioned below: ITU-T G.8265.1 -- frame {udp} addressing-mode {unicast} one-step {enable|disable} path-delay-mechanism {e2e|disable} domain <4..23> priority1 - priority2 - localpriority <1..255> class <80..110> BMCA "Static BMCA" sync-interval <0.125 msg/s..128 msg/s> delay-request-interval <0.125 msg/s..128 msg/s> announce-tx-interval <0.125 msg/s..8 msg/s> 3. After configuring PTP GM with correct Frequency profile setting (**through CLI & GUI**). Configure the Sync Tester with same parameters & connect the Tester to the configured PTP port on GM. 4. **Verify:** if PTP GM has ping option & able to ping Tester's IP. Also verify if VLAN tagging is possible on PTP messages.

	5. **Verify:** If GM is sharing all the relevant protocol information to the Tester for e.g. i) GM IP ii) GM Identity iii) GM Priority iv) GM Clock class & value v) GM Clock Source 6. **Verify:** Message Exchange between Master & Slave i.e. i) Sync ii) Follow-up iii) Delay Request iv) Delay Response etc. 7. Now, remove the GPS antenna cable from the PTP GM and see if the **Clock class** in the tester changes to a different value (Locked mode clock class to Holdover clock class). **8.** Configure Primary input clock in PTP GM as GNSS and set a secondary input clock as well (for e.g. 1PPS, E1, MHz). Sync Tester can be used to give secondary input to the GM. Now remove the primary input clock from the GM and **verify that GM automatically switches to secondary input source.**
Expected Results	1. Verify GM configuration through GUI & CLI. 2. Verify Test procedure - Steps 4 to 8. Results should match the configured value as per ITU-T Standard. 3. Attach screenshots.

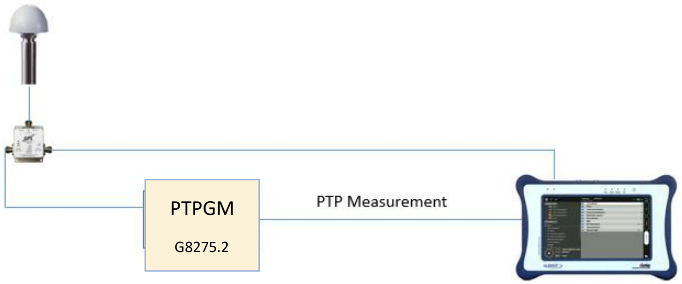
Test No.28

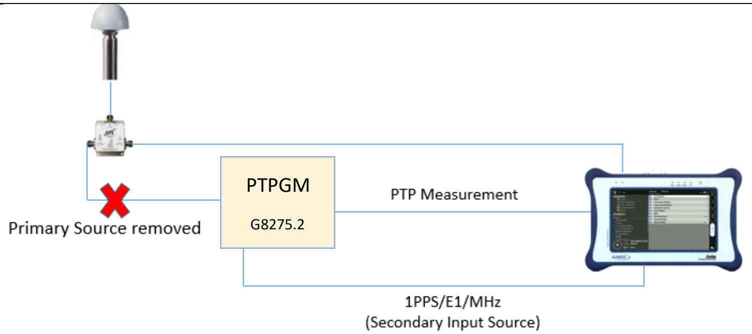
Parameter Name	Profile for time and phase synchronisation with full timing support
Test Details	Support for PTP phaseprofile: G8275.1 1) PTP messages exchanged between Master & Slave 2) Protocol statistics of GM for e.g. GM MAC, GM Identity, GM clock class & value etc. 3) GM locking with auxiliary interfaces and observe relevant protocol statistics.
Test instruments required	Synch tester (e.g. xGenius) Splitter GPS Antenna Connecting Cables Laptop
Test Setup 1 Test Setup 2	Setup 1: Follow Test procedure instructions 4 to 7  Setup 2: Follow Test procedure instruction 8

	
Test Procedure	1. Connect GNSS signal to PTP GM and Tester. Wait for sufficient (approx. 1-2 hours) time so that GM and Tester are locked to UTC. 2. Now, configure PTP GM as per the settings mentioned below: ITU-T G.8275.1 -- frame {ethernet} addressing-mode {multicast} one-step {enable|disable} path-delay-mechanism {e2e} domain <24..43> priority1 <128> priority2 <0..255> localpriority <1..255> class {6|7|140|150|160|248|255} BMCA "Alternate BMCA" sync-interval <16 msg/s> delay-request-interval <16 msg/s> announce-tx-interval <8 msg/s> 3. After configuring PTP GM with correct Phase profile (full on-path) setting **(through CLI & GUI).** Configure the Sync Tester with same parameters & connect the Tester to the configured PTP port on GM. 4. **Verify:** if VLAN tagging is possible on the PTP messages. 5. **Verify:** If GM is sharing all the relevant protocol information to the Tester for e.g. i) GM MAC

	ii) GM Identity iii) GM Priority iv) GM Clock class & value v) GM Clock Source 6. **Verify**: Message Exchange between Master & Slave i.e. i) Sync ii) Follow-up iii) Delay Request iv) Delay Response etc. 7. Now, remove the GPS antenna cable from the PTP GM and see if the Clock class in the tester changes to a different value (Locked mode clock class to Holdover clock class). 8. Configure Primary input clock in PTP GM as GNSS and set a secondary input clock as well (for e.g. 1PPS, E1, MHz). Sync Tester can be used to give secondary input to the GM. Now remove the primary input clock from the GM and **verify that GM automatically switches to secondary input source.**
Expected Results	1. Verify GM configuration through GUI (Graphic User Interface) &CLI (Command Line Interface). 2. Verify Test procedure - Steps 4 to 8. Results should match the configured value as per ITU-T Standard. 3. Attach Screenshot.

Test No.29

Parameter Name	Profile for time and phase synchronisation with partial timing support
Test Details	Support for PTP phase profile: G.8275.2 1) PTP messages exchanged between Master & Slave 2) Protocol statistics of GM for e.g. GM IP, GM Identity, GM clock class & value etc. 3) GM locking with auxiliary interfaces and observe relevant protocol statistics.
Test instruments required	Synch tester (e.g. xGenius) Splitter GPS Antenna Connecting Cables Laptop
Test Setup 1 Test Setup 2	Setup 1: Follow Test procedure instructions 4 to 7  Setup 2: Follow Test procedure instruction 8

	
Test Procedure	1. Connect GNSS signal to PTP GM and Tester. Wait for sufficient (approx. 1-2 hours) time so that GM and Tester are locked to UTC. 2. Now, configure PTP GM as per the settings mentioned below: ITU-T G.8275.2 -- frame {udp} addressing-mode {unicast} one-step {enable|disable} path-delay-mechanism {e2e|disable} domain <44..63> priority1 <128> priority2 <0..255> localpriority <1..255> class {6|7|140|150|160|248|255} BMCA "Alternate BMCA" sync-interval <1 msg/s..128 msg/s> delay-request-interval <1 msg/s..128 msg/s> announce-tx-interval <1 msg/s..8 msg/s> 3. After configuring PTP GM with correct Phase profile (partial on-path) setting (**through CLI & GUI**). Configure the Sync Tester with same parameters & connect the Tester to the configured PTP port on GM. 4. **Verify:** if PTP GM has ping option & able to ping Tester's IP. Also verify if VLAN tagging is possible on the PTP messages. 5. **Verify:** If GM is sharing all the relevant protocol information to the Tester for e.g. i) GM IP ii) GM Identity

	iii) GM Priority iv) GM Clock class & value v) GM Clock Source 6. **Verify:** Message Exchange between Master & Slave i.e. i) Sync ii) Follow-up iii) Delay Request iv) Delay Response etc. 7. Now, remove the GPS antenna cable from the PTP GM and verify if the **Clock class** in the tester changes to a different value (Locked mode clock class to Holdover clock class). 8. Configure Primary input clock in PTP GM as GNSS and set a secondary input clock as well (for e.g. 1PPS, E1, MHz). Sync Tester can be used to give secondary input to the GM. Now remove the primary input clock from the GM and **verify that GM automatically switches to secondary input source.**
Expected Results	1. Verify GM configuration through GUI & CLI. 2. Verify Test procedure - Steps 4 to 8. Results should match the configured value as per ITU-T Standard. 3. Attach screenshots.

Test No.30

Parameter Name	Mobile device - Non-Zero IMEI/MEID/ESN
Test Details	Test for Identification of Equipment Identity for mobile device for GSM/ UMTS/ LTE/ CDMA
Test instruments required	None
Test Setup	Powered on EUT
Test Procedure	1. Press *#06# to display IMEI / MEID / ESN. 2. Copy down the displayed IMEI/ MEID/ ESN.
Expected Results	1. Check that the displayed IMEI / MEID / ESN is not all zeroes/ null.

Test No.31

Parameter Name	Mobile Emergency Support - Panic button
Test Details	Test for functioning of Panic button in Feature phone
Test instruments required	None
Test Setup	1. Power on EUT. 2. If the device has a keypad lock, invoke it to lock the key pad.
Test Procedure 1	1. Press Numeric Key “5” on the feature phone keypad for more than 10 seconds. 2. If a call is not invoked, repeat step 1 with numeric key “9”. 3. Disconnect the call if invoked. 4. Remove keypad lock. 5. Repeat step 1, 2 and 3.
Test Procedure 2	1. Switch on the mobile screen. If there is a screen protector (wallpaper), invoke it. If there is a screen lock, invoke it to lock the screen. 2. Switch off screen display. 3. Press panic (red) button for more than 3 seconds 4. Disconnect the call if invoked.
Expected Results	1. Check that emergency call is invoked in both cases by actions in step 2 and 5. 2. Wallpaper ON + Screen Lock ON + Screen Off + Long press panic (red) button once => Emergency call

Test No.32

Parameter Name	Mobile Emergency Support - Panic button
Test Details	Test for functioning of Panic button in Smart phone
Test instruments required	None
Test Setup	Powered on EUT.
Test Procedure 1	1. Switch on the mobile so that the screen is lit. If there is a screen protector (wallpaper), invoke it. If there is a screen lock, invoke it to lock the screen. 2. Switch off screen display. 3. Short Press power-on button thrice in quick succession. 4. Disconnect the call if invoked. 5. With screen protector and screen lock invoked and screen display switched on, repeat step 3 and 4.
Test Procedure 2	1. Switch on the mobile screen. If there is a screen protector (wallpaper), remove it. If there is a screen lock, invoke it to lock the screen. 2. Check if a Soft emergency call button is visible even in screen lock mode. 3. Invoke emergency call by touching it. 4. Disconnect the call if invoked.
Test Procedure 3	1. Switch on the mobile screen. If there is a screen protector (wallpaper), invoke it. If there is a screen lock, invoke it to lock the screen. 2. Switch off screen display. 3. Press panic (red) button for more than 3 seconds 4. Disconnect the call if invoked.
Expected Results	1. Wallpaper ON + Screen Lock ON + Screen Off + Short press power on button thrice => Emergency call 2. Wallpaper ON + Screen Lock ON + Screen Lit + Short press power on button thrice => Emergency call 3. Wallpaper Off + Screen Lock ON + Screen Lit + Softemergency call button touch => Emergency call 4. Wallpaper ON + Screen Lock ON + Screen Off + Long press panic (red) button once => Emergency call

Test No.33

Parameter Name	Mobile Emergency Support - GPS Location
Test Details	Test for facility of identifying the location through satellite-based GPS in smart phone handsets.
Test instruments required	None
Test Setup	Powered on EUT.
Test Procedure	1. Switch on the mobile and deactivate SIM(s). 2. Go to settings through appropriate menu. 3. Locate settings for “Location” and turn the “Location” Off and On. 4. Use any suitable App to display current location of mobile.
Expected Results	1. Verify that Mobile phone is able to display location using satellite-based GPS, when SIM(s) are deactivated.

Test No.34

Parameter Name	Mobile Emergency Support – Call on 112
Test Details	Test for facility to dial 112 with Keypad lock, without SIM or without registration on PLMN.
Test instruments required	None
Test Setup	Powered on EUT. Test SIM without subscription.
Test Procedure 1	1. Switch on the mobile screen. If there is a screen protector (wallpaper), remove it. If there is a screen lock, invoke it to lock the screen. 2. Check if either keypad, or an icon/ link to display the keypad is visible. In case of later, click icon/ link to display keyboard. 3. Invoke emergency call by dialing 112. 4. Disconnect the call if invoked.
Test Procedure 2	1. Remove SIM from mobile. Switch on the mobile. If there is a screen protector (wallpaper), remove it. If there is a screen lock, invoke it to lock the screen. 2. Repeat steps 2, 3 and 4 of Procedure 1.
Test Procedure 3	1. Insert test SIM and switch ON mobile. 2. Verify that mobile is trying to be registered to some available PLMN. 3. Repeat procedure 2 with test SIM.
Expected Results	1. It is possible to dial the emergency number 112 even if the key pad is locked, as verified through Procedure 1. 2. It is possible to dial the emergency number 112 without SIM, as verified through Procedure 2. 3. The mobile phone, which has not successfully registered shall nevertheless be able to make emergency call attempts on an available PLMN, as verified through Procedure 3.

Test No.35

Parameter name	Display of SAR Value
Test Details	Test for Display of SAR Value
Test Instruments required	None
Test Setup	Powered on EUT
Test Procedure	Press *#07# to get SAR Value.
Expected Result	Check that SAR Value is less than 1.6 W/Kg.

Test No. 36

(A) Applicable for Mobile USER Equipment/ Other Terminal equipment having cellular interface:

Parameter name	Operating Frequency
Test Details	Test for checking of Operating Frequency
Test Instruments required	Base Station Emulator, Signal generator, spectrum analyser, required software
Test Setup	Powered on EUT
Test Procedure	1. Check that the frequency of operation as per its data sheet/ information given by the vendor is as per the Applicable National Frequency Allocation Plan 2. If the step 1 above is okay, then – a. Put the Device Under Test (DUT) in Airplane or Switch Off mode. b. Configure Base Station Emulator for required frequency and technology. c. Switch on the DUT and initiate a call. d. Check that the DUT is connected to the Base Station Emulator and that either the call goes through or a data session is established. e. Carry out steps a-d for all the technology – frequency combinations supported by the DUT as per its data sheet/ information given by the vendor.
Expected Results	The DUT should be connected to the emulator for all the technology – frequency combinations supported by the DUT as per its data sheet/ information given by the vendor and either the call goes through or a data session is established.

(B) Applicable for Base Station for Cellular Network:

Parameter name	Operating Frequency
Test Details	Test for checking of Operating Frequency
Test Instruments required	UE Emulator, Signal generator, spectrum analyser, required software
Test Setup	Powered on EUT
Test Procedure	1. Check that the frequency of operation as per its data sheet/ information given by the vendor is as per the Applicable National Frequency Allocation Plan 2. If the step 1 above is okay, then – a. Put the Device Under Test (DUT) in Switch Off mode. b. Configure UE for required frequency and technology. c. Switch on the DUT and ensure that the UE emulator connects to the DUT. d. Carry out steps a-c for all the technology – frequency combinations supported by the DUT as per its data sheet/ information given by the vendor.
Expected Results	The DUT should be connected to the emulator for all the technology – frequency combinations supported by the DUT as per its data sheet/ information given by the vendor.

Note: Alternatively, a self-declaration along with supporting test reports by any test lab in respect of transmitter or receiver parameters as specified in the ER, wherein frequency of operation/ frequency band is mentioned, can be taken as compliance to this test.

Test No.37

Parameter name	Indian Language Support for Mobile Phones
Test Details	1. Test for checking Message input capability 2. Test for checking Message Readability
Test Instruments/ Documents required	1. Standard Font for English and 22 Indian Languages (Both in Soft Copy and Printed Copy) 2. Computer/ Laptop with Data Card/ Dongle and in-built SMS Application
Test Setup	Powered on EUT with an active SIM Card
Test Procedure 1	i) Input all the characters of English language one by one and check that the displayed character matches with the character typed on keypad. ii) Repeat above step i) for Hindi. iii) Repeat above step i) for any other (at-least one) Indian Language as declared by the manufacturer.
Test Procedure 2	i) Input all the characters of English language to make a text in a computer/ Laptop and using Data Card/ Dongle through SMS Application send it to the DUT. ii) Read and compare the text character by character to see that the sent message and the received message are the same. iii) Repeat above step for Hindi and all (twenty-one) other Indian languages.
Expected Results for Message input capability	The DUT should have in-built capability for inputting of the following languages: a) English b) Hindi and c) Any other (at-least one) Indian Language
Expected Results for Message Readability	The DUT should have the capability to display all the languages as follows: a) English b) Hindi and c) All (twenty-one) other Indian Languages

Test No.38

Parameter Name	SNMPv2 Functional Tests
Test Details	Test for management: SNMPv2 (check TRAP, GET and SET operations)
Test instruments required	SNMP Test Tool (SNMP Manager)
Test Setup	
Test Procedure	1. Configure the EUT to run SNMP agent and SNMP Test Tool (NMS) to run SNMP manager application by using correct parameters. 2. Testing of TRAP message: The NMS uses SNMPv2 to manage the SNMP agent, and the agent automatically sends notifications to report events to the NMS. 3. Configure the SNMP agent to send traps to the manager. 4. Use a wrong community name to get the value of a MIB node on the agent. You can see an authentication failure trap on the SNMP manager. 5. Test "SetRequest" operation: SNMP Testing node (SNMP manager) sends SNMPv2c "SetRequest" to set SysName to "EUT1". Verify the SysName value on the EUT. It should match the value "EUT1" set using 'SetRequest' function from the SNMP manger. 6. Test SNMP GET Operation (single Object): Testing node (SNMP Manager) sends SNMPv2c "GetRequest" scalar object to get sysName.0 1.3.6.1.2.1.1.5.0 in system group in MIB II, to Agent. The agent should respond with "SysName value as "EUT1" as set in the previous step, verifying that the EUT support SNMP GET function.
Expected Results	1. TRAP should be sent by EUT (Agent) to Testing Node (SNMP Manager). 2. SetRequest operation should be able to set SysName object in agent (EUT) 3. GetRequest operation should be able to get SysName Object from agent (EUT) 4. Attach screenshots for above successful operations.

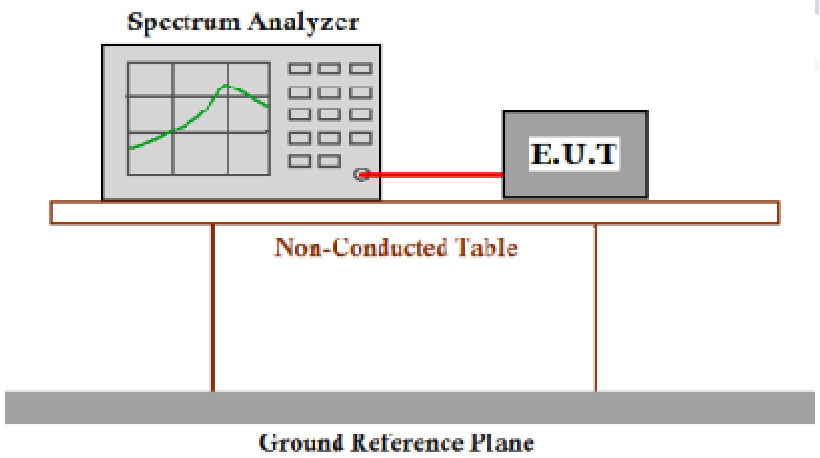
Test No.39

Parameter Name	SNMPv3 Functional Tests
Test Details	Test for SNMPv3 management
Test instruments required	SNMP Test Tool (SNMP Manager)
Test Setup	
Test Procedure	1. Configure the agent on EUT and SNMP manager on SNMP Test Tool to use SNMPv3 with security level setting to AuthPriv. Set Authentication to SHA and Privacy (encryption) to DES. 2. The NMS uses SNMPv3 to monitor and manage the agent 3. The agent automatically sends notifications to report events to the NMS. 4. The NMS and the agent perform authentication when they establish an SNMP session. The authentication algorithm is SHA and the authentication key is xxxxxx. The NMS and the agent also encrypt the SNMP packets between them by using the DES algorithm and encryption key yyyyyy
Expected Results	1. Use correct authentication credentials to access the agent. 2. Attach traces for successful encrypted authentication with correct credentials 3. Use incorrect authentication credentials to access the agent 4. Attach traces for failed authentication with incorrect credentials

Test No.40

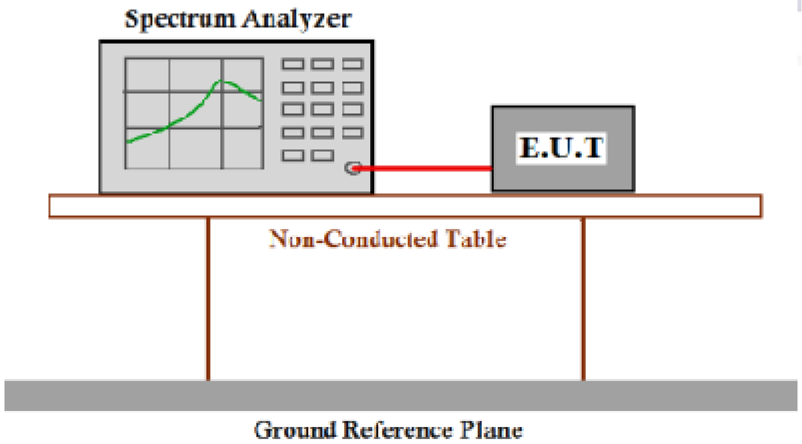
Parameter Name	Support for priority for emergency calls
Test Details	As per Department of Telecom No. 16-04/ 2015-AS-III/NP/67/120 dated 4th May 2016
Standard	3GPP TS 23.067 Enhanced Multi-Level Precedence and Pre-emption service (eMLPP): Stage 2
Test Procedure	1. The call to emergency number is given priority. 2. The emergency numbers are accessible irrespective of balance/ limit. 3. The numbers are routed through other operator, if the signal of the operator, to which the Subscriber is subscribed, is low or unavailable. 4. The numbers are diallable with or without SIM (subject to implementation)
Expected Results	Compliance

Test No. 41

Parameter name	Frequency of operation for BLE interface
Test details	Band edge limitations (Ref Standard : -)
Test instruments required	Spectrum analyzer Power Supply
Test setup	
Test Procedure	1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum analyzer or power meter. 2. Set instrument center frequency to the frequency of the emission to be measured (must be within 2MHz of the authorized band edge). 3. Set span to 2MHz, 4. RBW=100kHz, VBW≥3×RBW 5. Detector=peak

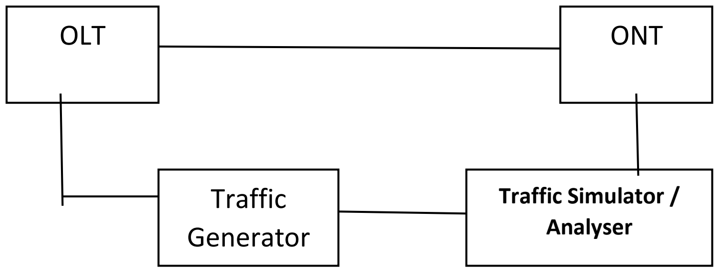
	6. Sweep time =auto, 7. Trace mode=max hold. 8. Allow sweep to continue until the trace stabilizes(required measurement time may increase for low duty cycle applications) 9. Measure the power of the peaks outside the band.
Expected results	2400MHz - 2483.5MHz

Test No. 42

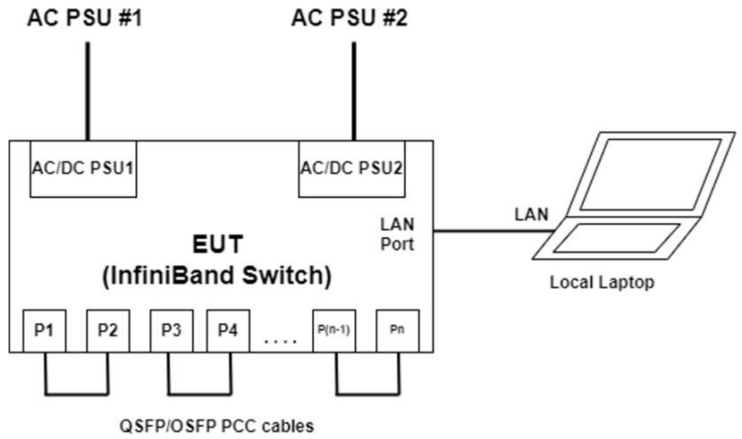
Parameter name	EIRP of BLE interface, Maximum Transmitted power for BLE interface, RF Output Power
Test details	Peak power measurement
Test instruments required	Spectrum analyzer Power Supply
Test setup	

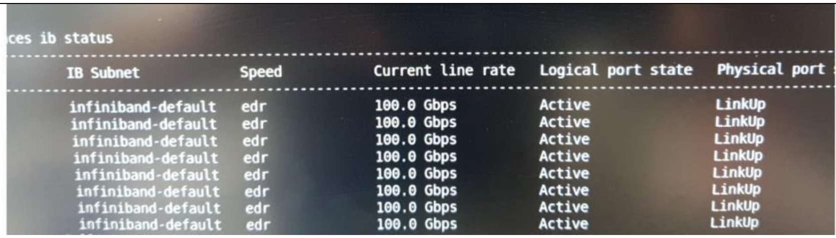
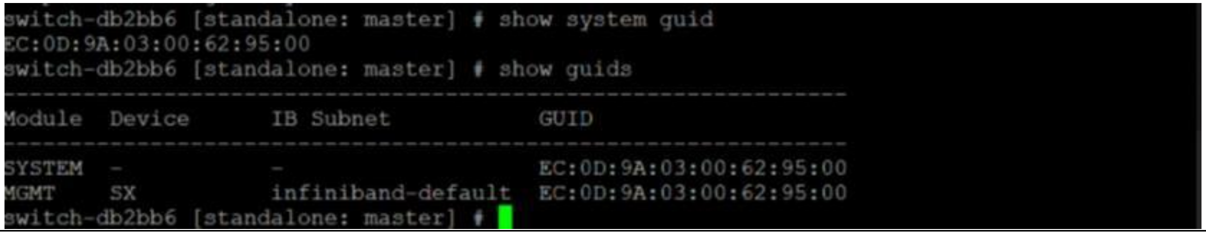
Test Procedure	1. Remove the antenna from the EUT and then connect a low attention attenuation RF cable (Cable loss =1.0dB) from the antenna port to the spectrum. 2. Set the RBW≥DTS bandwidth 3. Set the VBW ≥ 3 x RBW 4. Set the span ≥ 3 x RBW. 5. Detector = peak. 6. Sweep time = auto couple. 7. Trace mode = max hold. 8. Use peak marker function to determine the peak amplitude level. 9. Report the worse case 10. To calculate the EIRP, add the Antenna gain to Measured power.
Expected results	As per WPC GSR 45(E)

Test No 43

Parameter Name	Bridge mode ONT test
Test Details	Non-blocking throughput test for bridge mode ONT in place of Dual stack RFC test and IPv6 RFC test.
Test instruments required	Traffic generator, Traffic simulator/analyser, OLT, ONT(DUT)
Test Setup And Test Setup	
Test Steps	(1) Run RFC 2544 test for throughput test with IPv4 data. (2) Run RFC 2544 test for throughput test with IPv6 data.
Expected Results	Verify throughput for ONT with respect to respective standard applicable on PON technology mentioned in annex-J3 and observe that no alarms or frameloss has occurred.

Test No 44

Parameter Name	Subnet Manager Functional Test Case for Infiniband Switches
Test Details	Test for Subnet Manager – Vital functionality
Test Instruments Required	Single IB Switch with cables connected in loopback communicated with Local Laptop through LAN Port.
Test Setup	
Test Procedure 1	1. Connect the tested IB switches as shown in the above test setup. 2. Check for loop-detection on EUT by executing the command: ***ip smnode "Switch Host Name" enable*** or equivalent. **Example for *"Switch Host Name":* switch-73ca44 enable** 3. Wait couple minutes until LEDs change colour from orange/yellow to green. 4. Verify if "Logical port state" is **Active** for all ports physically connected in loopback by QSFP/OSFP data cables by executing the command: ***show interfaces ib status***

Expected Results	1. Subnet Manager must be able to detect and prevent the loop 2. Attach screenshots for loop-detection and "Logical port state" activation. 3. **Example for loop-detection and "Logical port state" activation:**
	
Test Procedure 2	1. Connect the tested IB switches as shown in the above test setup. 2. Issue command **show GUIDS/show system guid.**
Expected Results	1. Switch should show System GUID and Management GUID 2. Attach screenshots of the displayed GUID's 3. Example Of GUID's in below screenshot
	
Test Procedure 3	1. Connect the tested IB switches as shown in the above test setup. 2. Issue following command **show system capabilities (or equivalent Command)** 3. **Issue command to check SM node status and priority** 4. **Check SM is enabled** 5. Issue **"Show IB nodename"**

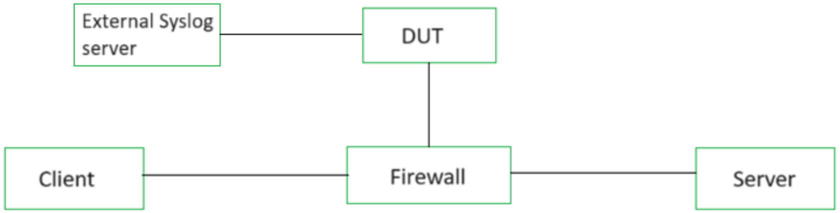
Expected Results	1. Switch should Support IB 2. Max number of Nodes supported 3. Status of the SM node should be active 4. Node name and GUID are displayed properly. **5. Example Screenshots**

	switch-db2bb6 [standalone: master] # show system capabilities
	IB: Supported, L2, Adaptive Routing
	Max SM nodes: 648
	IB Max licensed speed: FDR
	switch-db2bb6 [standalone: master] # show ib smnode switch-db2bb6 sm-running
	active
	switch-db2bb6 [standalone: master] # show ib smnode switch-db2bb6 sm-state
	enabled
	switch-db2bb6 [standalone: master] # show ib smnode switch-db2bb6 sm-priority
	0
	switch-db2bb6 [standalone: master] # show ib sm
	enable
	switch-db2bb6 [standalone: master] # show ib nodename
	GUID='EC:0D:9A:03:00:62:95:00', name='SX6036', discovered='no'
	switch-db2bb6 [standalone: master] #

Test No.45

Parameter Name	FWP Emergency Support – Call on 112
Test Details	Test for facility to dial 112 with Keypad lock, with SIM having registration on PLMN.
Test instruments required	None
Test Setup	Powered on EUT. Test SIM having registration on PLMN.
Test Procedure 1	1. Switch on the screen. If there is a screen protector (wallpaper), remove it. If there is a screen lock, invoke it to lock the screen. 2. Check if either keypad, or an icon/ link to display the keypad is visible. In case of later, click icon/ link to display keyboard. 3. Invoke emergency call by dialing 112. 4. Disconnect the call if invoked.
Expected Results	It is possible to dial the emergency number 112 even if the key pad is locked, as verified through Procedure 1.

Test No.-46

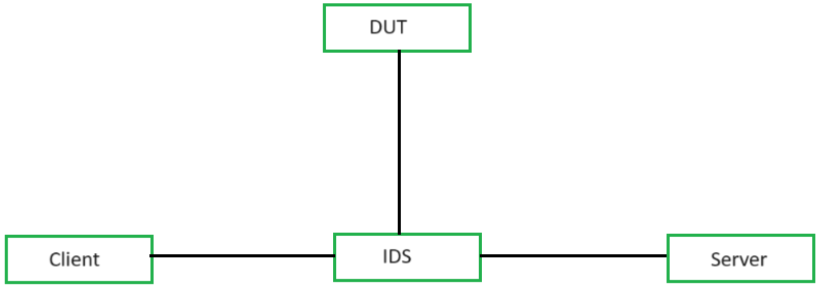
Parameter Name	Network Visibility, Monitoring and Logging	**Requirement**	The IP Security equipment should have network visibility, monitoring and logging capabilities
Objective	To verify if the IP Security equipment has visibility to the network it is protecting, able to monitor the traffic and log potential security events		
Topology			

Pre-Test Conditions

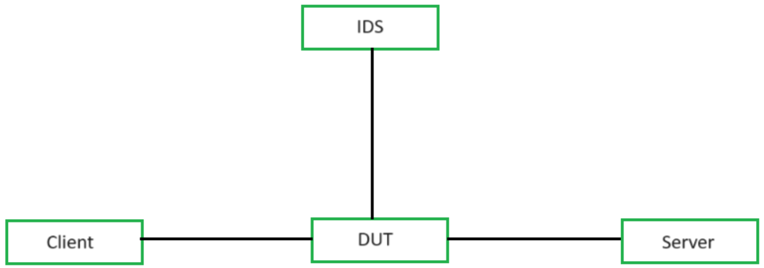
1. Configure the security monitoring profile and implement it to the firewall policy.
2. Configure the Client in trusted zone and Server in untrusted zone.
3. Configure NTP and security logging.
4. Configure the DUT to transfer logs to external Syslog server.

Test Procedure	**Expected Results**
1. Generate traffic between the Client and Server to match configured monitoring policies and verify if proper alerts are generated. 2. Navigate to network visibility dashboard of DUT and verify if real time traffic is displayed with source IP, destination IP, protocol and application used. 3. Verify the logs generated captures necessary details like source IP, destination IP, application, action taken, log levels (event, debug, trace, notice etc.,) and NTP synchronized timestamps. 4. Verify if DUT able to transfer logs to external syslog server	1. DUT must have the network visibility to live traffic. 2. DUT must generate proper alert messages based on configured monitoring policies. 3. DUT must capture necessary details in the logs with proper timestamps. 4. DUT must be able to transfer the logs to external syslog server.

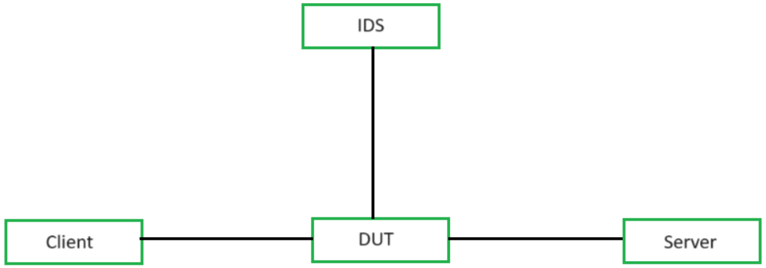
Test No.-47

Parameter Name	Encrypted traffic analysis	**Requirement**	The IP Security equipment should be able to analyze encrypted traffic
Objective	To verify if the IP Security equipment has the capability to analyze encrypted traffic for detecting and protecting against malicious files		
Topology			
Pre-Test Conditions			
1. Configure the integration between DUT and IDS device. 2. Configure the security profile for encrypted traffic analysis in DUT and push it to IDS device. 3. Implement the profile to the IP Security policy. 4. Configure the security logging.			
Test Procedure		**Expected Results**	
1. On the server run a OpenSSL server with self-signed certificate. 2. From client send a HTTPS request to server using curl tool. 3. Verify if the encrypted traffic is detected with self-signed certificate and the alerts are sent to DUT. 4. DUT must log the detected flow of encrypted traffic with all necessary information.		1. The encrypted traffic must be detected. 2. DUT must generate the logs for detected encrypted traffic.	

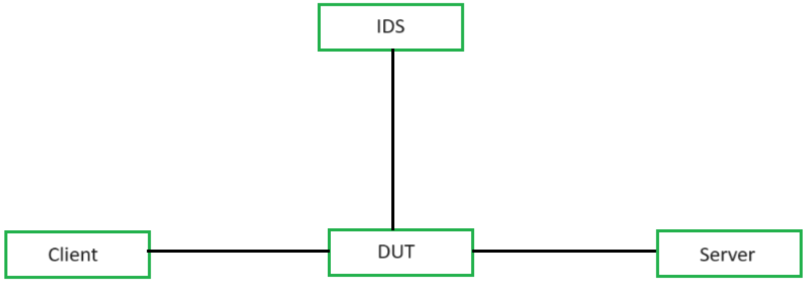
Test No.-48

<table>
<tr><td>Parameter Name</td><td>Application visibility and control</td><td>Requirement</td><td>The IP Security equipment should have visibility and control to the application traffic.</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to identify the traffic based on application and have control over the traffic</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the security profile for detecting and blocking traffic on application basis.
2. Configure Application QoS profile with specific rate limiters for various application traffic.
3. Implement the profiles to the firewall policy.
4. Generate traffic through DUT for common application services.
5. Configure the security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Generate traffic through DUT for common application services like FTP, SSH, Telnet, TFTP, HTTP, HTTPS, SMTP, IMAP, POP3, DNS, SNMP and verify if traffic is getting blocked as per configured security profile.
2. Generate application traffic between client and server and verify if the utilization lies within the configured rate limiters.</td><td colspan="2">1. DUT should detect and block the traffic based on the application.
2. DUT should limit the service quality as per configured rate limiters.
3. DUT should generate proper alert messages for blocked and over utilized traffic.</td></tr>
</table>

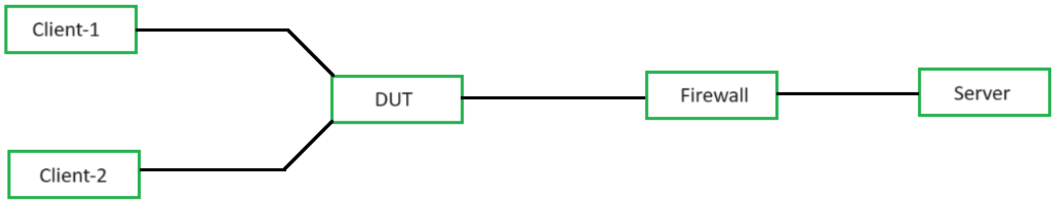
Test No.-49

<table>
<tr><td>Parameter Name</td><td>SSL Proxy</td><td>Requirement</td><td>The IP Security equipment should have the capability to act as a SSL proxy</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability decrypt, analyze and re-encrypt the SSL protected data traffic.</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Generate necessary CA certificate for SSL proxy.
2. Configure SSL forward proxy profile to perform SSL inspection in the DUT.
3. Apply the profile to IP Security policy in DUT.
4. Configure the client on internal network of DUT and server on external network of DUT
5. Configure DUT as the proxy in client.
6. Configure the security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. . Access the web page on the server with HTTPS.
2. Verify if the DUT decrypts, inspects and then forwards the packet to IDS.
3. Verify if DUT re-encrypts the packets received from IDS device before sending to Server.
4. Verify the source IP of request between the DUT and server.
5. Verify the destination IP of response between the DUT and server.</td><td colspan="2">1. DUT must decrypt, inspect and re-encrypt the packets.
2. The source IP of request between the DUT and server must be DUT’s external IP.
3. The destination IP of response between the DUT and server must be DUT’s external IP.
4. DUT must log the requests and responses with all necessary information.</td></tr>
</table>

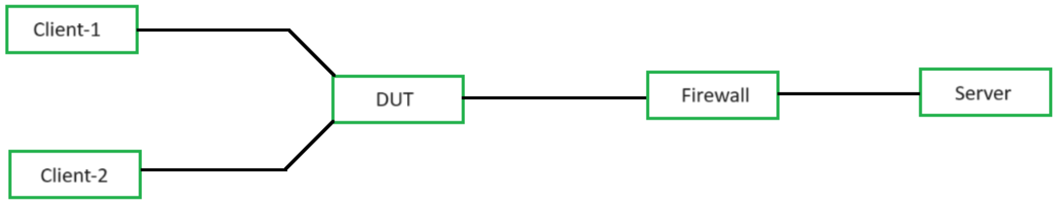
Test No.-50

<table>
<tr><td>Parameter Name</td><td>Data Loss Prevention (DLP)</td><td>Requirement</td><td>The IP Security equipment should be able to prevent data loss</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to analyze and prevent sensitive data leaving from the network.</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the DLP profile to filter network traffic and files based on various matching criteria like regular expressions, sensitive data patterns (credit card numbers), file size, type and name.
2. Configure the DLP profile to generate alerts for encrypted files transfer.
3. Apply the profile to IP Security policy
4. Configure security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Transfer a file between client and server matching the configured file size, type, name and verify if it is getting blocked.
2. Transfer an encrypted file between client and server and verify if proper alerts are being generated.
3. Verify proper logs are generated for detected files.</td><td colspan="2">1. DUT must detect and block the file matching one or more filtering criteria.
2. DUT must log the actions taken against the matching files.
3. DUT must generate alert for encrypted file transfer.</td></tr>
</table>

Test No.-51

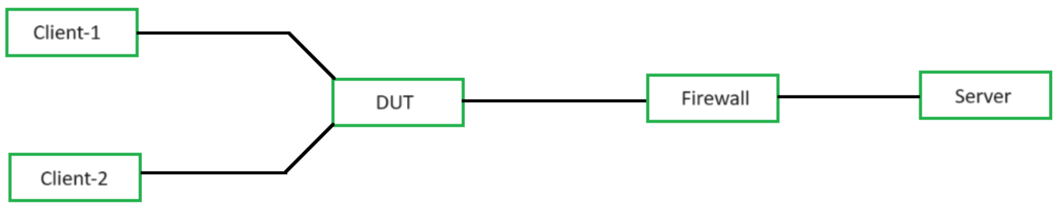
<table>
<tr><td>Parameter Name</td><td>L3 DDoS protection</td><td>Requirement</td><td colspan="2">The IP Security equipment should be able to detect and prevent L3 DDoS attacks</td></tr>
<tr><td>Objective</td><td colspan="4">To verify if the IP Security equipment has the capability to detect and prevent against Layer 3 DDoS attack.</td></tr>
<tr><td>Topology</td><td colspan="4">
</td></tr>
<tr><td colspan="5">Pre-Test Conditions</td></tr>
<tr><td colspan="5">1. Configure the DUT to be inline with the firewall.
2. Configure the client on external side of DUT and server on internal side of DUT.
3. Configure the security profile for identifying and protecting against L3 DDoS attack.
4. Apply the profile to IP Security policy.</td></tr>
<tr><td colspan="3">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="3">1. Perform normal ping from Client-1 and perform ICMP flood from Client-2.
2. Verify if the DUT can identify the flood traffic and block it.
3. Perform ICMP flood attack from Client-2 with random source IP addresses.
4. Verify if the DUT can identify the flood traffic and block it.
5. Verify the CPU usage and memory utilization on server.</td><td colspan="2">1. The DUT must identify the L3 DDoS attack and block the flood traffic.
2. Server memory and CPU utilization must stay under threshold.</td></tr>
</table>

Test No.-52

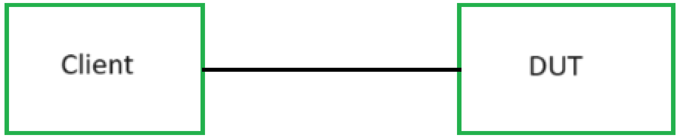
<table>
<tr><td>Parameter Name</td><td>L4 DDoS protection</td><td>Requirement</td><td>The IP Security equipment should be able to detect and prevent L4 DDoS attacks</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to detect and prevent against Layer 4 DDoS attack.</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the DUT to be inline with the firewall.
2. Configure the client on external side of DUT and server on internal side of DUT.
3. Configure the security profile for identifying and protecting against L4 DDoS attack.
4. Apply the profile to IP Security policy.</td></tr>
</table>

<table>
<tr><td>Test Procedure</td><td>Expected Results</td></tr>
<tr><td>1. Send a normal TCP-SYN from Client-1 and perform TCP SYN and UDP flood from Client-2.
2. Verify if the DUT can identify the flood traffic and block it.
3. Perform TCP SYN and UDP flood attack from Client-2 with random source IP addresses.
4. Verify if the DUT can identify the flood traffic and block it.
5. Verify the CPU usage and memory utilization on server.</td><td>1. The DUT must identify the L4 DDoS attack and block the flood traffic.
2. Server memory and CPU utilization must stay under threshold.</td></tr>
</table>

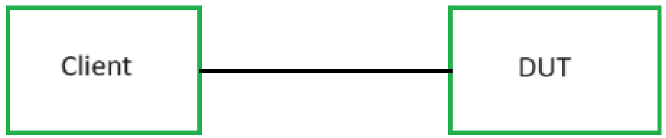
Test No.-53

<table>
<tr><td>Parameter Name</td><td>L7 DDoS protection</td><td>Requirement</td><td colspan="2">The IP Security equipment should be able to detect and prevent L7 DDoS attacks</td></tr>
<tr><td>Objective</td><td colspan="4">To verify if the IP Security equipment has the capability to detect and prevent against Layer 7 DDoS attack.</td></tr>
<tr><td>Topology</td><td colspan="4">
</td></tr>
<tr><td colspan="5">Pre-Test Conditions</td></tr>
<tr><td colspan="5">1. Configure the DUT to be inline with the firewall.
2. Configure the client on external side of DUT and server on internal side of DUT.
3. Configure the security profile for identifying and protecting against L7 DDoS attack.
4. Apply the profile to IP Security policy.</td></tr>
<tr><td colspan="3">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="3">1. Send a normal HTTP request from Client-1 and perform HTTP/HTTPS flood from Client-2.
2. Verify if the DUT can identify the flood traffic and block it.
3. Perform HTTP/HTTPS flood attack from Client-2 with random source IP addresses.
4. Verify if the DUT can identify the flood traffic and block it.</td><td colspan="2">1. The DUT must identify the L7 DDoS attack and block the flood traffic.
2. Server memory and CPU utilization must stay under threshold.</td></tr>
</table>

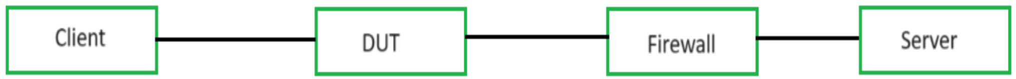
Test No.-54

Parameter Name	Static Analysis	**Requirement**	The IP Security equipment should detect and analyse malicious file statically
Objective	To verify if the IP Security equipment has the capability to detect and statically analyze the malicious file in a secured way.		
Topology			
Pre-Test Conditions			
1. Configure the security profile for performing Static analysis of potentially malicious files. 2. Apply the profile to the IP Security policy			
Test Procedure	**Expected Results**		
1. Upload the malicious file from Client to DUT. 2. Run static analysis in the DUT. 3. Verify if the DUT identifies and analyses the malicious file by matching signature of known malwares. 4. Verify if the DUT calculates and analyses the hash value of malicious file with known malware hashes. 5. Verify if the DUT scans and identifies malicious links and codes embedded the file.	1. The DUT should be able to identify the malicious file by matching the signature and hash values. 2. The DUT should be able to identify malicious links and codes embedded in the file.		

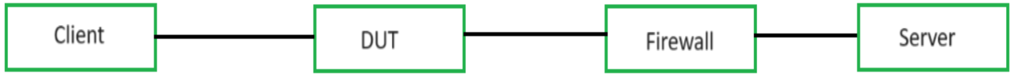
Test No.-55

<table>
<tr><td>Parameter Name</td><td>Dynamic Analysis</td><td>Requirement</td><td>The IP Security equipment should detect and analyse malicious file dynamically</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to detect and dynamically analyze the malicious file in a secured way.</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the security profile for performing Dynamic analysis of potentially malicious files.
2. Apply the profile to the IP Security policy</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Upload the malicious file from Client to DUT.
2. Run dynamic analysis in the DUT.
3. Verify if the DUT executes the malicious file in a secured way.
4. Verify if the DUT captures all the actions performed by the malicious file.
5. Verify if the DUT can identify external communications tried by the malicious file if any.</td><td colspan="2">1. The DUT must capture the actions performed by the malicious file.
2. The DUT must identify external communications the malicious file trying to establish.
3. The DUT must record and log all the actions captured during the phase of dynamic analysis.</td></tr>
</table>

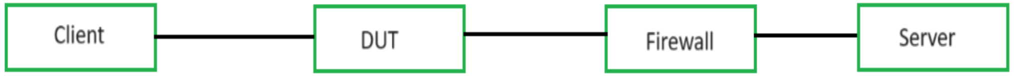
Test No.-56

<table>
<tr><td>Parameter Name</td><td colspan="2">1.1 Protection against OWASP Top 10 - SQL Injection</td><td>Requirement</td><td colspan="2">The IP Security equipment should detect and protect against common web application attacks</td></tr>
<tr><td>Objective</td><td colspan="5">To verify if the IP Security equipment has the capability to detect and block SQL injection attack</td></tr>
<tr><td>Topology</td><td colspan="5">
</td></tr>
<tr><td colspan="6">Pre-Test Conditions</td></tr>
<tr><td colspan="6">1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging.</td></tr>
<tr><td colspan="3">Test Procedure</td><td colspan="3">Expected Results</td></tr>
<tr><td colspan="3">1. Identify the point of injection in the Web application hosted on the server.
2. Send a SQL query for detecting the possibility of injection and fetching unauthorized data.
3. Verify if the DUT detects and blocks the injected queries.
4. Verify if logs are generated with all necessary information.</td><td colspan="3">1. DUT should detect and block SQL injection queries.
2. DUT should log the events properly with all necessary information.</td></tr>
</table>

Test No.-57

Parameter Name	1.2 **Protection against OWASP Top 10 - Cross Site Scripting (XSS)**	**Requirement**	The IP Security equipment should detect and protect against common web application attacks
Objective	To verify if the IP Security equipment has the capability to detect and block Cross site scripting attack		
Topology			
Pre-Test Conditions			
1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities. 2. Apply the profile to IP Security policy. 3. Configure security logging.			
Test Procedure		**Expected Results**	
1. Identify the point of injection in the Web application hosted on the server. 2. Inject a Java script for Reflected XSS and verify if the response reaches back the test tool. 3. Inject a Java script for Stored XSS and verify if it is getting stored on the Web server. 4. Verify if logs are generated properly.		1. DUT should detect and block the Cross site scripting injections. 2. DUT should log the events properly with all necessary information.	

Test No.-58

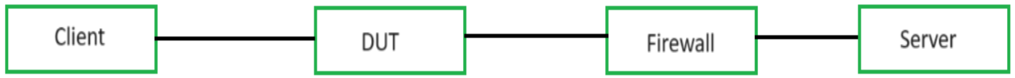
Parameter Name	1.3 **Protection against OWASP Top 10 - Protection against Brute forcing**	**Requirement**	The IP Security equipment should detect and protect against common web application attacks
Objective	To verify if the IP Security equipment has the capability to detect and block brute force attack		
Topology			

Pre-Test Conditions

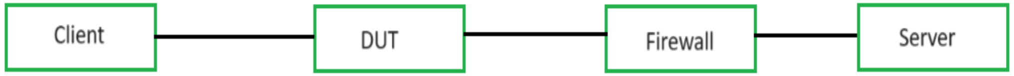
1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging.

Test Procedure	**Expected Results**
1. Identify the HTTP request of login page of the Web application hosted on the server. 2. Perform Brute force attack using a wordlist of username and password. 3. Verify if the DUT detects and blocks the attack. 4. Verify if the logs are generated properly.	1. DUT should detect and block the Brute forcing attacks. 2. DUT should log the event properly with all necessary information

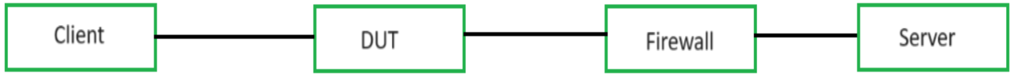
Test No.-59

<table>
<tr><td>Parameter Name</td><td>1.4 Protection against OWASP Top 10 - Server Side Request Forgery (SSRF)</td><td>Requirement</td><td>The IP Security equipment should detect and protect against common web application attacks</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to detect and block Server side request attack</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Identify HTTP request for point of injection in the Web application hosted on the server.
2. Identify the parameter in the request which carries the server side request.
3. Modify the parameter for requesting and fetching an unauthorized resource from server side.
4. Verify if the DUT detects and blocks the injected request.
5. Verify if logs are generated with all necessary information.</td><td colspan="2">1. DUT should detect and block the malicious server side requests.
2. DUT should log the event properly with all necessary information.</td></tr>
</table>

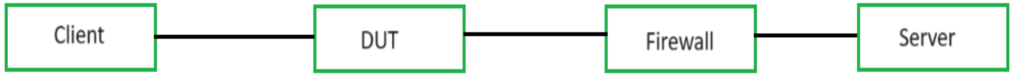
Test No.-60

<table>
<tr><td>Parameter Name</td><td>1.5 Protection against OWASP Top 10 - HTTP method validation</td><td>Requirement</td><td>The IP Security equipment should detect and protect against common web application attacks</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to detect and block the HTTP methods which are not used by the web application.</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Identify required HTTP request format and parameters for communicating with the web application hosted on the server.
2. Send the HTTP request with all possible HTTP methods and check for responses from the web application.
3. Verify if the DUT detects and blocks the adversarial HTTP methods.
4. Verify if logs are generated with all necessary information.</td><td colspan="2">1. DUT should detect and block all the adversarial HTTP methods.
2. DUT should log the event properly with all necessary information.</td></tr>
</table>

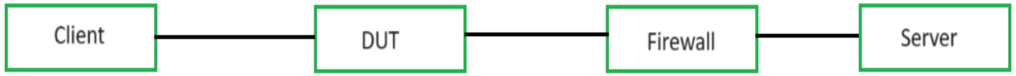
Test No.-61

<table>
<tr><td>Parameter Name</td><td>1.6 Protection against OWASP Top 10 - File inclusion attack</td><td>Requirement</td><td>The IP Security equipment should detect and protect against common web application attacks</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to detect and block File inclusion attack</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Identify the HTTP request for File fetching functionality in the Web application hosted on the server.
2. Try to fetch an unauthorized file.
3. Verify if the DUT detects and blocks the file inclusion request.
4. Verify if logs are generated with all necessary information.</td><td colspan="2">1. DUT should verify the files being returned by web application.
2. DUT should detect and block if any unauthorized file is getting fetched.
3. DUT should log the event properly with all necessary information.</td></tr>
</table>

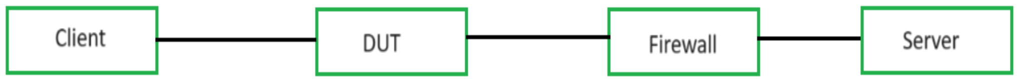
Test No.-62

<table>
<tr><td>Parameter Name</td><td>1.7 Protection against OWASP Top 10 - Command Injection</td><td>Requirement</td><td colspan="2">The IP Security equipment should detect and protect against common web application attacks</td></tr>
<tr><td>Objective</td><td colspan="4">To verify if the IP Security equipment has the capability to detect and block SQL injection attack</td></tr>
<tr><td>Topology</td><td colspan="4">
</td></tr>
<tr><td colspan="5">Pre-Test Conditions</td></tr>
<tr><td colspan="5">1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging.</td></tr>
<tr><td colspan="3">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="3">1. Identify the point of injection in the Web application hosted on the server.
2. Inject a command to perform an unauthorized action like fetching /etc/passwd file.
3. Verify if the DUT detects and blocks the injected command.
4. Verify if logs are generated with all necessary information.</td><td colspan="2">1. DUT should detect and block malicious command injections.
2. DUT should log the events properly with all necessary information.</td></tr>
</table>

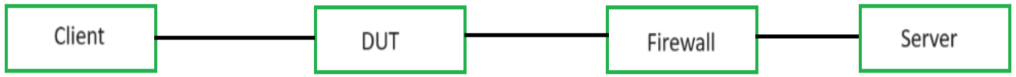
Test No.63

<table>
<tr><td>Test Case 62</td><td>Protection against OWASP Top 10 – Path traversal</td><td>Requirement</td><td>The IP Security equipment must detect and protect against common web application attacks</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to detect and block Path traversal attack</td></tr>
<tr><td>Topology</td><td colspan="3"></td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Identify the point of injection in the Web application hosted on the server.
2. Send a path traversal HTTP request for navigating to unauthorized folder and fetching a test file.
3. Verify if the DUT detects and blocks the traversal HTTP request.
4. Verify if logs are generated with all necessary information.</td><td colspan="2">1. DUT must detect and block path traversal HTTP request.
2. DUT must log the events properly with all necessary information.</td></tr>
</table>

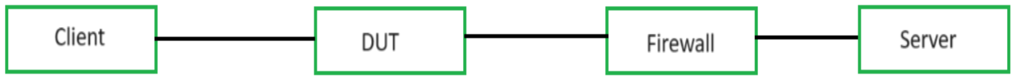
Test No. 64

<table>
<tr><td>Test Case 63</td><td>Protection against OWASP Top 10 - Client Side Request Forgery (CSRF)</td><td>Requirement</td><td>The IP Security equipment must detect and protect against common web application attacks</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to detect and block Client side request forgery attack</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Login and Identify a functionality in the application running on the server which needs an authenticated session. (Eg: Password change)
2. Craft a URL which will send a HTTP request to the application when an authenticated user clicks it.
3. From client side open the URL and it will send the HTTP request by including users session ID.
4. Verify if DUT is able to detect this unintended cross origin HTTP request and block it.
5. Verify if logs are generated with all necessary information.</td><td colspan="2">1. DUT must detect and block the unintended cross origin HTTP.
2. DUT must log the event properly with all necessary information.</td></tr>
</table>

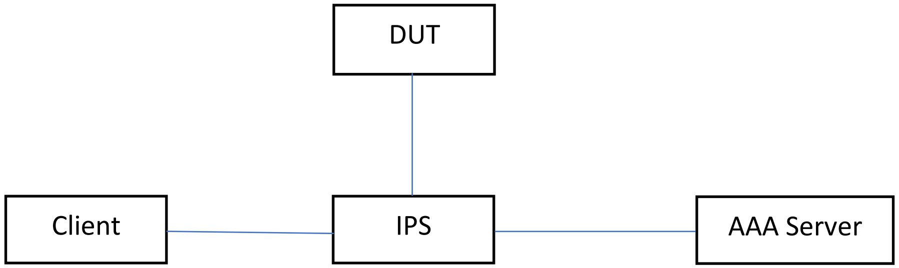
Test No. 65

<table>
<tr><td>Test Case 64</td><td>Protection against OWASP Top 10 – Monitoring & Audit event generation</td><td>Requirement</td><td>The IP Security equipment should detect and protect against common web application attacks</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability to detect and block File inclusion attack</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the IPSec profile for identifying and protecting against OWASP Top 10 vulnerabilities.
2. Apply the profile to IP Security policy.
3. Configure security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Perform various injection and other web application attacks from client.
2. Verify if the DUT monitors, detects and blocks the attacks.
3. Verify if logs are generated with all necessary information.</td><td colspan="2">1. DUT must monitor, detect and block the attacks.
2. DUT must log the event properly with all necessary information.</td></tr>
</table>

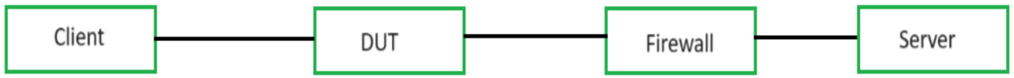
Test No. 66

<table>
<tr><td>Test Case 65</td><td>1.8 Reverse Proxy</td><td>Requirement</td><td>The IP Security equipment should have reverse proxy functionality.</td></tr>
<tr><td>Objective</td><td colspan="3">To verify if the IP Security equipment has the capability of reverse proxy and able to respond to web requests on behalf of internal web server.</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td colspan="4">Pre-Test Conditions</td></tr>
<tr><td colspan="4">1. Configure the server on LAN side and client on WAN side of the DUT
2. Configure necessary certificates in DUT and server.
3. Configure security logging.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. Try to access the web application running on the web server which protected in the LAN side of DUT from client.
2. Verify the HTTP request response flow from client to DUT and DUT to server.
3. Verify if DUT is able to intercept, decrypt and re-encrypt the packets.
4. Verify if the DUT responds to web requests on behalf of web server.
5. Verify if logs are generated with all necessary information.</td><td colspan="2">1. DUT should be able to intercept, decrypt and re-encrypt the packets.
2. DUT should respond to web requests on behalf of web server.
3. DUT should log the events properly with all necessary information.</td></tr>
</table>

Test No.-67

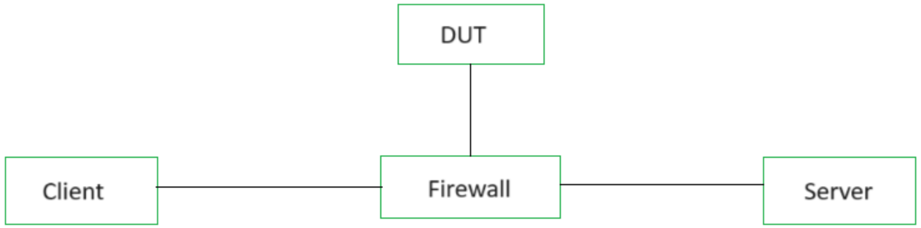
<table>
<tr><td>Test No. 66</td><td>External Authentication with AAA server</td><td>Requirement</td><td colspan="2">The IP Security equipment should securely communicate with external authentication server</td></tr>
<tr><td>Objective</td><td colspan="4">To verify if the IP Security equipment has the capability to authenticate users with external authentication server in a secured way.</td></tr>
<tr><td>Topology</td><td colspan="4">
</td></tr>
<tr><td colspan="5">Pre-Test Conditions</td></tr>
<tr><td colspan="5">1. Register the IPS device with DUT
2. Configure & integrate the FreeRadius AAA server with the IPS device
3. Configure the authentication profile in DUT and implement it on IPS device.
4. Configure a valid user credential in FreeRadius AAA server.</td></tr>
<tr><td colspan="3">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="3">1. Verify the integration between AAA server and IPS device
2. Run the Radtest command on the client by providing the valid credential for testing functionality.
3. Verify if the authentication request reaches the AAA Server through the IPS device.
4. Ensure that the FreeRadius AAA server validates the credentials and sends the response.
5. Verify if the DUT fetches and log all necessary information regarding the login attempt.</td><td colspan="2">1. DUT must be able to configure an authentication policy on the IPS device
2. The authentication request must be forwarded to FreeRadius AAA server and it shall validate the user.
3. The DUT must fetch and log all necessary information regarding the login attempt..</td></tr>
</table>

Test No.-68

Test Case 4	Manageability – Netconf with Yang	**Requirement**	The IP Security equipment must support management using Netconf with Yang data model
Objective	To verify if the IP Security equipment can be configured and managed using Netconf with Yang data model		
Topology	 		
Pre-Test Conditions			
1. Configure the IP Security equipment for Netconf with necessary parameters for manageability.			

Test Procedure	**Expected Results**
1. Configure multiple Netconf sessions with the DUT. 2. Verify proper authentication of Netconf sessions. 3. Send a <get-config> request and verify if proper configuration data is returned. 4. Send a <edit-config> request for modifying the configuration parameter. 5. Again, send a <get-config> request and verify if the modifications are reflected properly. 6. Verify hello element sent by the server and client.	1. DUT must support at least one session and must support multiple sessions. 2. Netconf sessions must be properly authenticated. 3. DUT must respond with proper configuration data upon receiving a <get-config> request. 4. DUT must make the configuration changes in accordance with the <edit-config> request parameters. 5. Hello element sent by the server must include session ID and the hello element sent by the client must not include session ID.

Test No. 69

Test Case No 68	IDS – Management & Analytic equipment	**Requirement**	The IP Security equipment must support firewall management and analysis of detected alerts
Objective	To verify if the IP Security equipment has the functionality to configure and manage policies on firewall and also can analyze the alerts generated by the firewall equipment.		
Topology			
Pre-Test Conditions			
1. Configure the IP Security equipment and firewall to establish a communication channel for configuring policies and receiving alerts for analyzing.			

Test Procedure	**Expected Results**
1. Verify the communication channel between DUT and firewall. 2. Configure policies from DUT, push it to the firewall and verify if policies are properly configured. 3. Verify if firewall sends the detected alerts to DUT. 4. Verify whether logs are properly generated and stored in DUT.	1. The communication channel between DUT and firewall must be a secured channel. 2. DUT must be successfully able to configure and push policies to the firewall. 3. DUT must securely receive alerts from the firewall. 4. DUT must properly log all the alerts and events.

Test No - 70

Parameter	FC Zone Server	**Requirement**	Create a Zoneset / Zone on a switch
Objective	To verify the creation of a Zoneset and Zone on an switch		
Topology			
Tools			

Pre-Test Condition

HOST A and Target A are the Devices/VM's broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device

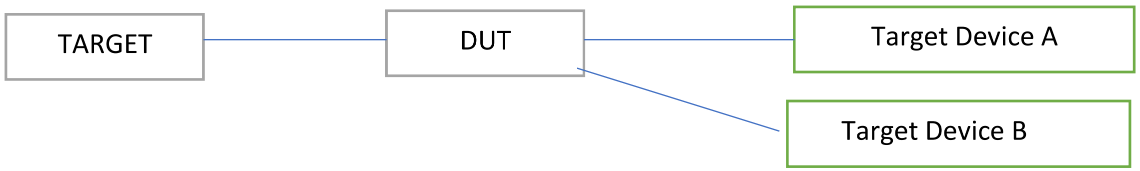
Install HBA utilities on Server(HOST) and Storage device(Target Device)

1. Ensure that the SAN switch is properly configured and operational.
2. Verify that the Fibre Channel devices (Hosts, storage, etc.) connected to the switch support IPv4 over FC.
3. Configure the necessary zoning on the SAN switch to allow communication between the IPv4-enabled devices.

Test Procedure	**Expected Results**
On FC capable SAN switch (DUT) perform the following: 1. Create a zoneset named " test-zoneset-1" on DUT; 2. Create a zone named " xyz-1" 3. Identify the WWN of a Host A and add it as a member of zone "xyz-1" 4. Identify the WWN of a Target device A and add it as a member of zone "xyz-1" 5. Add zone "xyz" to zoneset "test-zoneset-1" 6. Activate zoneset "test-zoneset-1"	1. The zoneset name can be created. 2. The zone name can be created. 3. The Host and Target WWN's are reported 4. The addition of the Host and Target WWN's to the zone causes no errors. 5. The zone can be moved to the zoneset with any errors being reported. 6. The activation of the zoneset reports no errors. 7. The Host OS now reports the attached Target. 8. The Target now reports the attached Host; if supported by Target. 9. Verify host sees all paths to LUNs

	10. Check for End Device Fabric RSCN for any one HBA.

Test No.-71

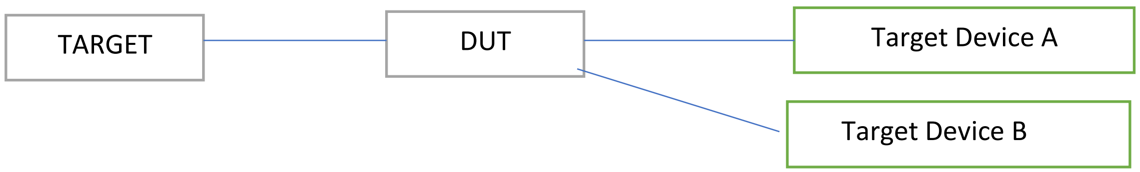
<table>
<tr><td>Parameter</td><td>FC Zone Server</td><td>Requirement</td><td>Zone server - Zone configure- Add/Remove Zones from an Active Zoneset</td></tr>
<tr><td>Objective</td><td colspan="3">To verify the validity of the zone addition and removal from the switch.</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td>Tools</td><td colspan="3"></td></tr>
<tr><td colspan="4">Pre-Test Condition</td></tr>
<tr><td colspan="4">HOST A and Target A are the Devices/VM’s broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device

Install HBA utilities on Server(HOST) and Storage device(Target Device)

1. Ensure that the SAN switch is properly configured and operational.
2. Verify that the Fibre Channel devices (Hosts, storage, etc.) connected to the switch support IPv4 over FC.
3. Configure the necessary zoning on the SAN switch to allow communication between the IPv4-enabled devices.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">On FC capable SAN switch (DUT) perform the following:

1. On DUT, Add one new zone with Target device B into a currently active zoneset.
2. Reactivate the zoneset.
3. Remove (delete) one zone from the currently active zoneset.
4. Reactivate the zoneset.</td><td colspan="2">1. The zone can be opened for editing.
2. The addition of a new zone works without any errors.
3. The reactivation of the zoneset does not generate any errors.
4. Target/LUN visible to host (all paths)
5. The removal of a zone works without any errors being reported.
6. The reactivation of the zoneset does not generate any errors.
7. Target/LUN not visible to host (all paths)
8. Check for End Device Fabric RSCN for any one HBA</td></tr>
</table>

Test No.-72

Parameter	FC Zone Server	**Requirement**	Zone server - Zone configure- Add/Remove a Zone Member to an Active Zone
Objective	To verify the validity of the zone addition and removal from the switch.		
Topology	 		
Tools			
Pre-Test Condition			
HOST A and Target A are the Devices/VM's broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device Install HBA utilities on Server(HOST) and Storage device(Target Device) 1. Ensure that the SAN switch is properly configured and operational. 2. Verify that the Fibre Channel devices (Hosts, storage, etc.) connected to the switch support IPv4 over FC. 3. Configure the necessary zoning on the SAN switch to allow communication between the IPv4-enabled devices.			

Test Procedure	Expected Results
From the SAN Switch (DUT), perform the following: 1. Open the zoneset “test-zoneset-1” and edit zone “xyz-1”. (Zone should have two or more than two targets and luns should be presented through all ports) 2. Identify the WWN of one of the targets and remove it from this zone. 3. Reactivate the zoneset. 4. Open the zoneset “test-zoneset-1” and edit zone “xyz-1” 5. Identify the WWN of one of the targets and remove it from this zone. 6. Reactivate the zoneset. 7. Open the zoneset “test-zoneset-1” and edit zone “xyz-1. 8. Identify the WWN of one of the targets that was previously removed and re-add it back to the zone. **9.** Reactivate the zoneset.	1. The zone can be opened for editing. 2. The removal of the first zone member works without any errors 3. The first reactivation of the zoneset does not generate any errors. 4. All RSCN generated properly 5. The Host no longer reports the target. 6. The Second reactivation of the zoneset does not generate any errors. 7. All RSCN generated properly 8. The Host no longer reports the target. 9. The third reactivation of the zoneset does not generate any errors. 10. All RSCN generated properly 11. The Host reports the target. 12. Check for End Device Fabric RSCN for any one HBA.

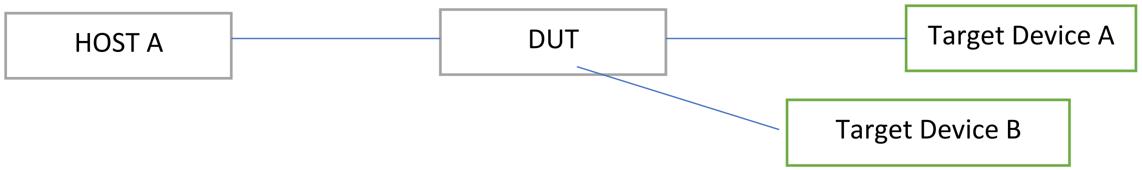
Test No-73

<table>
<tr><td>Parameter</td><td>FC Zone Server</td><td>Requirement</td><td>Zone server - Zone Configure- Zoneset Deactivation and Reactivation</td></tr>
<tr><td>Objective</td><td colspan="3">To verify that the zoneset can be Deactivation and Reactivation from the switch</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td>Tools</td><td colspan="3"></td></tr>
<tr><td colspan="4">Pre-Test Condition</td></tr>
<tr><td colspan="4">HOST A and Target A are the Devices/VM’s broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device

Install HBA utilities on Server(HOST) and Storage device(Target Device)

1. Ensure that the SAN switch is properly configured and operational.
2. Verify that the Fibre Channel devices (Hosts, storage, etc.) connected to the switch support IPv4 over FC.
3. Configure the necessary zoning on the SAN switch to allow communication between the IPv4-enabled devices.</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">On FC capable SAN switch (DUT) perform the following:

1. From the switch, perform the following:
2. Deactivate the zoneset “ test-zoneset-2”
3. Reactivate the zoneset “ test-zoneset-2”</td><td colspan="2">1. No errors are reported when the zoneset is deactivated.
2. The Host does not report any target devices
3. No errors are reported when the zoneset is reactivated
4. The Host reports the target device.
5. Verify host sees all paths to LUN
6. Check for End Device Fabric RSCN for any one HBA.</td></tr>
</table>

Parameter	FC Zone Server	Requirement	Zone server – Verify traffic from Host to Target
Objective	To verify that the zoneset can be Deactivation and Reactivation from the switch		
Topology			
Tools			
Pre-Test Condition			
HOST A and Target A are the Devices/VM's broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device			

5. Test No.-74

Install HBA utilities on Server(HOST) and Storage device(Target Device)	
Test Procedure	**Expected Results**
1. Create a zone at DUT with the below info <zone_name>: Name of the zone. <pwwn_initiator>: WWN (World Wide Name) of the initiator device HOST A <pwwn_target>: WWN of the target device Target Device A 2. Create a zone set <zoneset_name>: Name of the zone set. <zone_name>: Name of the zone created in the previous step. 3. Activate Zoneset 4. Verify connectivity between Host A to Target Device A via SAN Switch 5. Ping from Host A - sudo fcping -t 1 -c 3 -s 512 -v -H <Target Device A_WWN> 6. Add Target Device B to Zone 7. Ping from Host A - sudo fcping -t 1 -c 3 -s 512 -v -H <Target Device B_WWN> 8. Remove Target Device B from zone 9. Ping from Host A - sudo fcping -t 1 -c 3 -s 512 -v -H <Target Device B_WWN>	1. Verify zone info after step 3 2. At step 5 ping should pass 3. At step 7 ping should pass 4. At step 9 ping should fail

6. Test no-75

<table>
<tr><td>Parameter</td><td>FC Logins</td><td>Requirement</td><td>Test Fibre Channel Logins and its functionality</td></tr>
<tr><td>Objective</td><td colspan="3">To verify Fibre Channel Logins and its functionality</td></tr>
<tr><td>Topology</td><td colspan="3">
</td></tr>
<tr><td>Tools</td><td colspan="3"></td></tr>
<tr><td colspan="4">Pre-Test Condition</td></tr>
<tr><td colspan="4">HOST A and Target A are the Devices/VM’s broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device

Install HBA utilities on Server(HOST) and Storage device(Target Device)</td></tr>
<tr><td colspan="2">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="2">1. powered on HBA port, it sends a FLOGI to the connected switch, Send Fabric Login request (FLOGI), transmitting its World Wide Port Name (WWPN) to the directly connected Fibre Channel switch from Host A
2. Port Login (PLOGI) process and registration with name server
3. Query Name server for the list of devices Node port can contact with in a fabric</td><td colspan="2">1. Switch allocates a 24-bit Fibre Channel ID (FCID) to the host A and Target Device A
2. Verify Switch table that maps FCID to WWPN address or Alias
3. Verify name server data base after plogi registration success
4. Verify storage authorisation
5. Verify Name server data base</td></tr>
</table>

4. Host initiates a PLRI Process Login request to target storage 5. Storage system authorizes the host's access	

7.Test No.-76

Parameter	FC Name Server	**Requirement**	Test registration process with Fibre Channel Name Server

Objective	To verify registration process with Fibre Channel Name Server
Topology	
Tools	

Pre-Test Condition

HOST A and Target A are the Devices/VM's broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device

Install HBA utilities on Server(HOST) and Storage device(Target Device)

Test Procedure	Expected Results
1. Powered on HBA port on HAST A and TARGET DEVICE A, it sends a FLOGI to the connected switch, Send Fabric Login request (FLOGI), transmitting its World Wide Port Name (WWPN) to the directly connected Fibre Channel switch from Host A 2. Port Login (PLOGI) process and registration with name server. 3. **Fibre Channel Name Service**	1. Switch allocates a 24-bit Fibre Channel ID (FCID) to the host A 2. Verify Switch table that maps FCID to WWPN address or Alias 3. Each switch should show **World Wide Port Name (WWPN),** its corresponding **Fibre Channel ID (FCID)** 4. Port Login (PLOGI) process and registration with name server success

(FCNS) should exchange of Fabric Login (FLOGI) database information among Fibre Channel switches. .	5 Verify fcns database

8. Test No.-77

Parameter	FC RSCN	**Requirement**	Verify name server db based on RSCN (Registered State Change Notification)
Objective	To Verify name server db based on RSCN (Registered State Change Notification)		
Topology			
Tools			
Pre-Test Condition			
HOST A and Target A are the Devices/VM's broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device Install HBA utilities on Server(HOST) and Storage device(Target Device)			

Test Procedure	Expected Results
1. Powered on HBA port, it sends a FLOGI to the connected switch, Send Fabric Login request (FLOGI), transmitting its World Wide Port Name (WWPN) to the directly connected Fibre Channel switch from Host A 2. Port Login (PLOGI) process and registration with name server. 3. Host initiates a RSCN to SAN switch 4. Remove Host A and check the RSCN messages received for change	1. Switch allocates a 24-bit Fibre Channel ID (FCID) to the HOST A and Target Device A 2. Verify Switch table that maps FCID to WWPN address or Alias 3. Verify name server data base after plogi registration success 4. Host should receive a RSCN ACK from SAN switch 5. After Removing Hist A RSCN message received and HOST A removed from Name server Database

<table>
<tr><td>Parameter</td><td>FC Management</td><td>Requirement</td><td colspan="2">FC Management</td></tr>
<tr><td>Objective</td><td colspan="4">To Verify MIBs response to ensure that they return accurate and relevant data</td></tr>
<tr><td>Topology</td><td colspan="4">
</td></tr>
<tr><td>Tools</td><td colspan="4"></td></tr>
<tr><td colspan="5">Pre-Test Condition</td></tr>
<tr><td colspan="5">HOST A and Target A are the Devices/VM’s broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device

Install HBA utilities on Server(HOST) and Storage device(Target Device)</td></tr>
<tr><td colspan="3">Test Procedure</td><td colspan="2">Expected Results</td></tr>
</table>

9. Test No.-78

1. SNMP is enabled on DUT and configure Configure DUT switch(config)# snmp-server community public ro switch(config)# snmp-server 192.168.1.100 version 2c public switch(config)# snmp-server enable traps switch(config)# snmp-server system-shutdown 2. Do snmp 1. fcmInstanceBasicGroup Group 2. fcmSwitchBasicGroup Group 3. fcmPortBasicGroup Group 4. fcmPortStatsGroup Group 5. fcmPortClass23StatsGroup Group 6. fcmPortLcStatsGroup Group 7. fcmPortClassFStatsGroup Group 8. fcmPortErrorsGroup Group 9. fcmSwitchPortGroup Group 10. fcmSwitchLoginGroup Group 11. fcmLinkBasicGroup Group 3. MIBs to ensure that they return accurate and relevant data	1. Verify MIBs response to ensure that they return accurate and relevant data

10. Test No.79

Parameter	FC Frame Encapsulation	**Requirement**	FC encapsulation host
Objective	To Verify FC encapsulation		
Topology			
Tools			

Pre-Test Condition

HOST A and Target A are the Devices/VM's broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device.

Install HBA utilities on Server(HOST) and Storage device(Target Device)

4. Ensure that the SAN switch is properly configured and operational.
5. Verify that the Fibre Channel devices (Hosts, storage, etc.) connected to the switch support IPv4 over FC.
6. Configure the necessary zoning on the SAN switch to allow communication between the IPv4-enabled devices.

Test Procedure	Expected Results
1. Configure Hosts: Ensure that Host A and Target Device A are configured with IPv4 addresses and are capable of sending and receiving IP packets over Fibre Channel. 2. Create Zones:	1. Verify the zoning configuration to ensure that the source and destination devices are in the same zone 2. Ping should success and no packet loss seen 3. Verify Frame content header + Payload

Configure zoning on the SAN switch to include Host A and Target Device A in the same zone. 3. Ensure that the zone includes the Fibre Channel ports connecting Host A and Target Device A, as well as any necessary SAN switch ports. 4. Activate the Zone Set: Activate the zone set to apply the zoning configuration. 5. Verify Connectivity: Ensure that Host A can ping Target Device A using IPv4 addresses. 6. Ping to verify connectivity between the hosts. 7. Capture and Analyze Traffic: Use a Fibre Channel analyzer or monitoring tool to capture and analyze the Fibre Channel frames exchanged between Host A and Target Device A. 8. Verify that the captured frames contain IPv4 packets and that the SAN switch properly encapsulates and forwards the IP traffic.	4. On PCAP verify IPv4 over FC encapsulating IPv4 and Address Resolution Protocol (ARP) packets over FC [IP address to WW_PN] 5. Verify FC Address Resolution Protocol(FARP) for associating World Wide Port Names (MAC addresses) and FC Port identifiers [WW_PN to FC Port Identifiers (Port_ID)]

11. Test No.- 80

<table>
<tr><td>Parameter</td><td>FC Packet Forwarding</td><td>Requirement</td><td colspan="2">FC Packet Forwarding</td></tr>
<tr><td>Objective</td><td colspan="4">To veriy that FC frames are correctly forwarded between Host server and storage device via DUT(SAN Switch)</td></tr>
<tr><td>Topology</td><td colspan="4">
</td></tr>
<tr><td>Tools</td><td colspan="4"></td></tr>
<tr><td colspan="5">Pre-Test Condition</td></tr>
<tr><td colspan="5">HOST A and Target A are the Devices/VM’s broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device

Install HBA utilities on Server(HOST) and Storage device(Target Device)</td></tr>
<tr><td colspan="3">Test Procedure</td><td colspan="2">Expected Results</td></tr>
<tr><td colspan="3">1. Verify connectivity between Host A to Target Device A via SAN Switch
2. sudo fcping -t 1 -c 3 -s 512 -v -H <Device_A_WWN>
3. Initiate FTP transfer from Target Device A to Host A.
4. Monitor traffic on the SAN Switch to</td><td colspan="2">1. Verify the zoning configuration to ensure that the source and destination devices are in the same zone
2. Ping should success and no packet loss seen
3. File download should be success in bidirectional.
4. The switch forwards the frame to the</td></tr>
</table>

ensure FTP packets are forwarded correctly. 5. Check bidirectional FTP communication Use a Fibre Channel analyzer or monitoring tool to capture the FC frame as it traverses the fabric	appropriate port based on the destination WW-PN 5. Frames are forwarded promptly and without loss or corruption

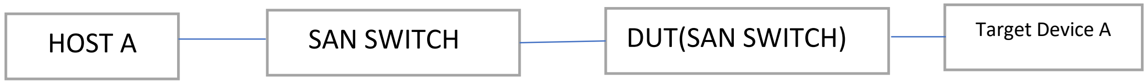
12. test No.-
81

Parameter	SNMP V3	**Requirement**	Manageability SNMPV3
Objective	To verify SNMPV3 Manageability		
Topology			
Tools			
Pre-Test Condition			
HOST A and Target A are the Devices/VM’s broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device Install HBA utilities on Server(HOST) and Storage device(Target Device)			
Test Procedure		**Expected Results**	
1. Configure the agent on DUT and SNMP manager on SNMP Test Tool to use SNMPv3 with security level setting to AuthPriv. 2. Set Authentication to SHA and Privacy (encryption) to DES. 3. The NMS uses SNMPv3 to monitor and manage the agent 4. The agent automatically sends notifications to report events to the NMS. 5. The NMS and the agent perform		1. Use correct authentication credentials to access the agent. 2. Attach traces for successful encrypted authentication with correct credentials 3. Use incorrect authentication credentials to access the agent 4. Attach traces for failed authentication with incorrect credentials	

authentication when they establish an SNMP session. The authentication algorithm is SHA and the authentication key is xxxxxx. 6. The NMS and the agent also encrypt the SNMP packets between them by using the DES algorithm and encryption key yyyyyy	

13. Test No.-82

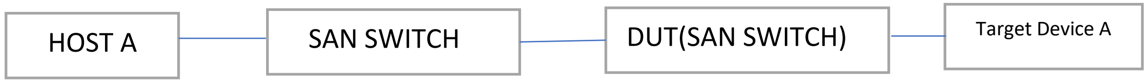
Parameter	FC Static Routing	**Requirement**	Static Routing

Objective	To veriy that FC frames are correctly forwarded between Host server and storage device via DUT(SAN Switch)
Topology	
Tools	
Pre-Test Condition	
HOST A and Target A are the Devices/VM's broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device Install HBA utilities on Server(HOST) and Storage device(Target Device)	
Test Procedure	**Expected Results**
1. Ensure that the FC interfaces on all devices are properly connected and configured. 2. Use the Fibre Channel IDs (FCIDs) of the SAN switch and the router and update the configurations accordingly. 3. Add the static routes on all devices 4. Send traffic from Target Device A to Host A # Enable Fibre Channel routing switch(config)# fcrouting enable	1. Verify the zoning configuration to ensure that the source and destination devices are in the same zone 2. FC frames are correctly forwarded from source devices to destination devices within the Fibre Channel fabric. 3. The switch forwards the frame to the appropriate port based on the destination WW-PN 4. Frames are forwarded promptly and without loss or corruption

# Create static route switch(config)# fcroute domain <domain_ID> ip <destination_IP> 0x<hop_count> fc <FCID_of_next_hop> # Example: # fcroute domain 10 ip 192.168.1.2 0x1 fc 0x5006048cffffb588	

14. Test No-83

Parameter	FC Dynamic Routing	**Requirement**	Dynamic Routing

<table>
<tr><td>Objective</td><td colspan="2">To veriy Dynamic Routing</td></tr>
<tr><td>Topology</td><td colspan="2">
</td></tr>
<tr><td>Tools</td><td colspan="2"></td></tr>
<tr><td colspan="3">Pre-Test Condition</td></tr>
<tr><td colspan="3">HOST A and Target A are the Devices/VM’s broughtup having HBA adapters. HBA/CNA at HPE/DELL or any device

Install HBA utilities on Server(HOST) and Storage device(Target Device)</td></tr>
<tr><td colspan="2">Test Procedure</td><td>Expected Results</td></tr>
<tr><td colspan="2">1. Ensure that the FC interfaces on all devices are properly connected and configured.
2. Configure FSPF Router C/SAN SW and DUT
3. Send traffic from Host A to Target Device A

Enable Fibre Channel routing

switch(config)# fcrouting enable

Enable FSPF routing

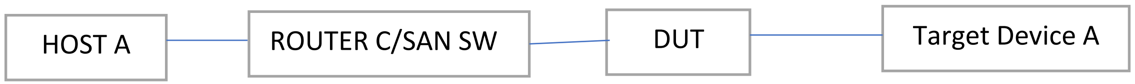
switch(config)# fspf enable

Advertise the FC interface

switch(config)# fspf advertise interface fc0</td><td>1. Verify the zoning configuration to ensure that the source and destination devices are in the same zone
2. Verify FSPF dynamic routing tables on DUT in the Fibre Channel fabric.
3. FSPF will dynamically determine the shortest path between Host A and Target Device A through the SAN switch.
4. FC frames are correctly forwarded from source devices to destination devices within the Fibre Channel fabric.
5. The switch forwards the frame to the appropriate port based on the destination WW-PN
6. Frames are forwarded promptly and without</td></tr>
</table>

	loss or corruption

15. Test No-84

Parameter	FC Security Protocol	**Requirement**	Security Protocols
Objective	To verify the functionality and effectiveness of Fibre-Channel Security Protocols (FC-SP) and DHCHAP authentication on a SAN switch.		
Topology			
Tools			
Pre-Test Condition			
SAN switch is properly configured and operational.			

<table>
<tr><td colspan="2">FC-SP is enabled and configured on the SAN switch.

Fibre Channel devices (Hosts, storage, etc.) support FC-SP and are connected to the SAN switch.

Zoning is configured to allow communication between the test devices.</td></tr>
<tr><td>Test Procedure</td><td>Expected Results</td></tr>
<tr><td>Mutual Authentication Test(DHCHAP):

Test Procedure:

1. Initiate a Fibre Channel login (PLOGI) from Host A to the SAN switch
2. Configure the Host and DUT

2.Integrity Check Test:

Test Procedure:

1. Send Fibre Channel frames with known data from Host A to Target Device A through the SAN switch.

3.Confidentiality Test:

Test Procedure:

1. Configure ikev2 between SAN switch/Router C and DUT
2. Send encrypted Fibre Channel frames from Host A to Target Device A through the SAN switch.</td><td>1. SAN switch performs mutual authentication with Host A using FC-SP.
2. Verify in the SAN switch logs that Host A and the switch mutually authenticate each other successfully.

1. SAN switch performs integrity checking on the received frames using FC-SP.

2. Capture the frames using a protocol analyzer and verify that the integrity of the frames is maintained (CRC Validated)

1. Ikev2 should up both sides
2. Verify that IKEv2 has established Security Associations (SAs) between the Router and the SAN switch FC
3. SAN switch encrypts the frames using FC-SP to ensure confidentiality.
4. Capture the frames using an analyzer and verify that the contents are encrypted and cannot be read without decryption.</td></tr>
</table>

Appendix-III

Test Setup and Test Procedures

The Appendix consist Lists of parameters to be tested under Protocol test of ER on PON

A. Test Setup:

Equipment List:

Active Components:

OLT Emulator or equivalent : The OLT Emulator is a piece of equipment, which must be included in the ODN during conformance or interoperability testing to capture and analyze the Standard managed Entities (ME) present on that network. The GPON Analyzer will not alter, correct, or otherwise disturb any of the traffic present on the ODN.

Optical Distribution Network: The optical distribution network (ODN) is required to create the real time FTTH network to ensure each optical receiver is operating in roughly the mid-point of its dynamic range; ensuring the receiver is not operating is a stressed mode, which could cause bit errors.

Ethernet Traffic Generator: A traffic generator creates traffic, or packets, that machines on a network consume. A network traffic generator is built to resemble an actual machine on the network from the perspective of the target machines. These hardware or software tools provide visibility into the impact of traffic on network resources.

-OLT: Optical Line Terminal

-PON SFP(C++): Passive Optical Network Interface

-ONT: Optical Network Terminal

- OLT Emulator or equivalent

-Traffic Generator

- PPPOE /IPOE Server

- LCT/ Console

- NMS /EMS

Server

(Optional)

Optical Power

meter

Passive Components:

-1*N Splitter

-Patch Cord

-Rack

-Fiber Distribution Box

B. Interoperability Test Setup:

When an ONU/ONT and OLT pair is being tested for interoperability, below figure-1 defines the basic test setup for interoperability testing.

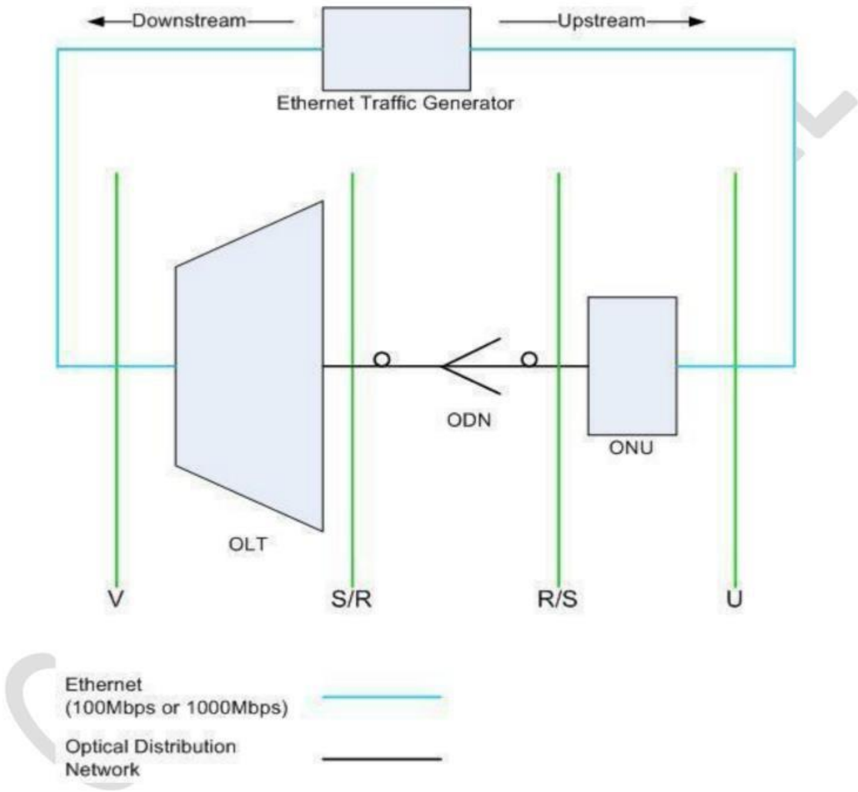


Figure.B.1: Basic setup for interoperability testing

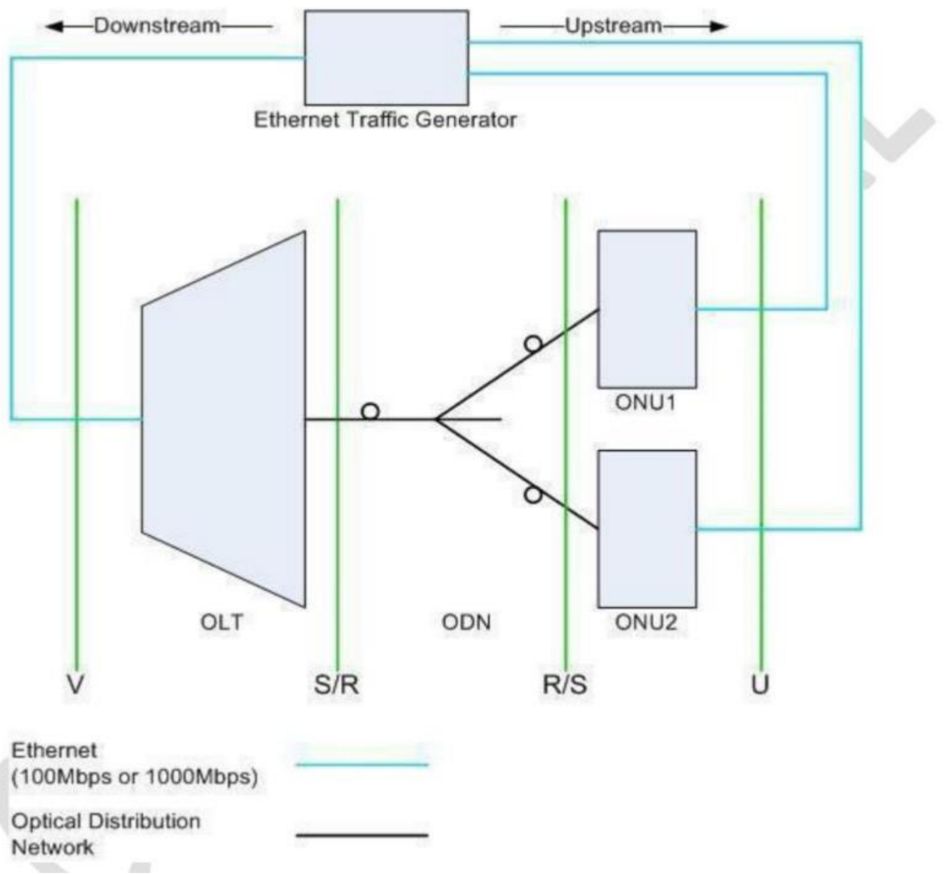


Figure. B.2 : Setup for interoperability tests requiring multiple ONUs/ONTs

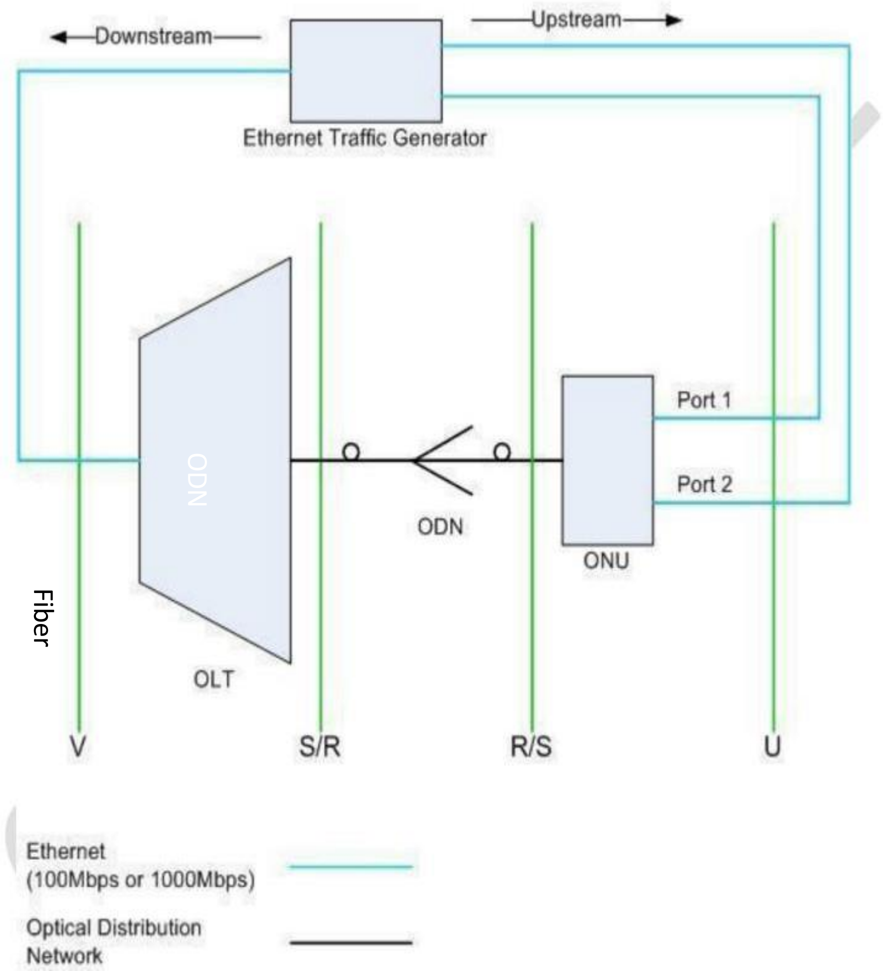
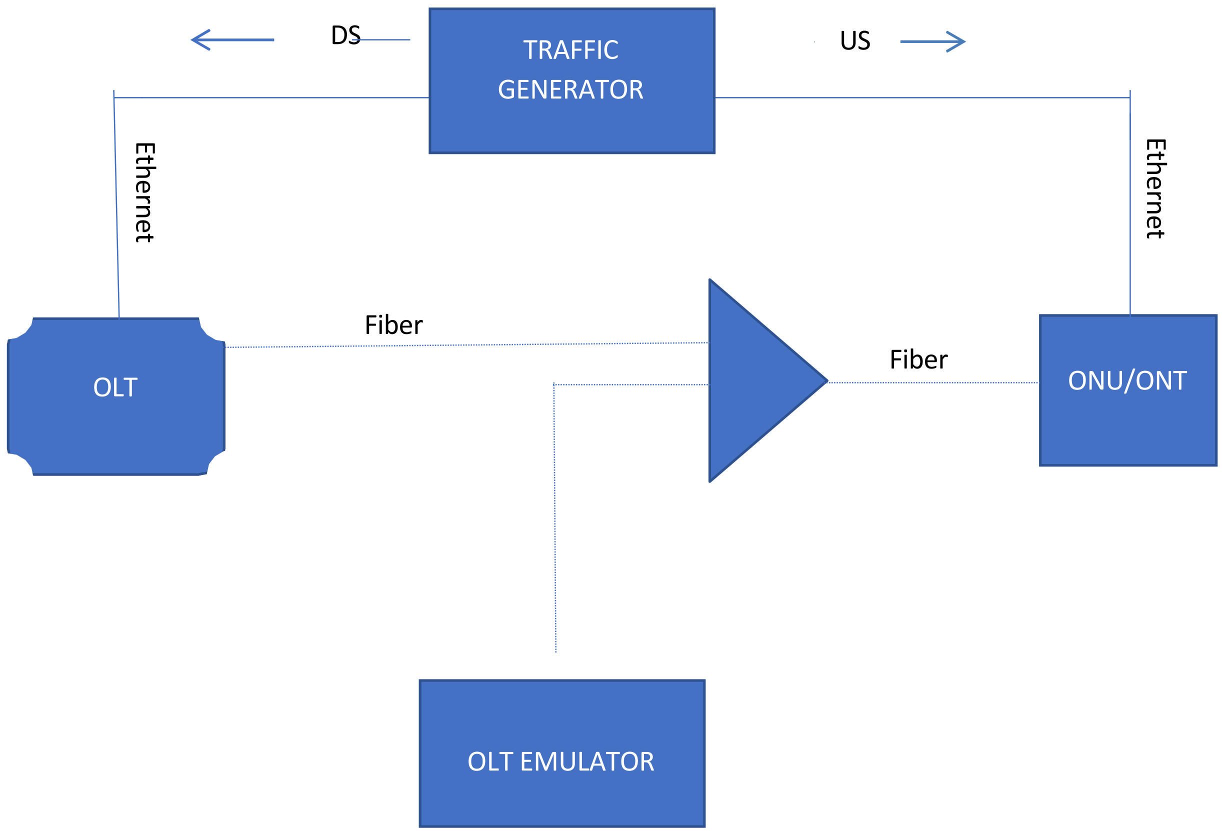


Figure. B.3: Setup for interoperability tests with ONU/ONT supporting multiple U interfaces



ODN: Optical Distribution Network

Figure.B.4: OLT Emulator Test Setup for interoperability tests with OLT and ONU/ONT

List-1(GPON-Protocol test)

List-1(GPON-Protocol test)

Table .1

Sl No	Parameter	Details mentioned under Clauses
1	Security	1.0
2	Network degradation check	2.0
3	Activation method	3.0

1.0 Security

This clause discusses the data security issues in PON. It discusses the threat model that the security is intended to counter. It then discusses the basic key exchange and activation method. The basic concern in PON is that the downstream data is broadcasted to all ONUs attached to the PON. If a malicious user were to re-programme his ONU, then the malicious user could listen to all the downstream data of all the users. It is this 'eavesdropping threat' that the PON security system is intended to counter.

Specification

The following conformance parameters are described in this clause:

Sl No	Parameter	Reference in G.984.3	Value/Comment	Remark
1	Encryption system	12.2	Meet the requirement of Cl 12.2	Tested by protocol analyser or simulated on CLI of ONU
2	Data encryption key exchange	12.3	Meet the requirement of Cl 12.3	
3	Data encryption key switch-over	12.4	Meet the requirement of Cl 12.4	

2.0 Network degradation check

List-1(GPON-Protocol test)

Following parameters encompasses mechanisms to check that any telecom equipment does not degrade performance of existing network to which it is connected..

2.1 Items detected at OLT

The following conformance parameters are described in this clause

Sl No	Type	Description	Reference in G.984.3	Value/Comment	Remark
1.	LOSi	Loss of signal for ONUi	11.1.1	Meet the requirement of Cl 11.1.1	Tested by protocol analyser or Simulated by removing fibre from ONU or turning off ONU
2.	LOS	Loss of signal	11.1.1	Meet the requirement of Cl 11.1.1	
3.	LOFi	Loss of frame of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
4.	DGi	Receive dying-gasp of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
5.	LOAMi	Loss of PLOAM for ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
6.	SDi	Signal degraded of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
7.	SFi	Signal fail of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
8.	DOWi	Drift of window of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
9.	LCDGi	Loss of GEM channel delineation	11.1.1	Meet the requirement of Cl 11.1.1	
10.	RDIi	Remote defect indication of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	

11.	TF	Transmitter failure	11.1.1	Meet the requirement of Cl 11.1.1	
12.	SUFi	Start-up failure of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
13.	DFi	Deactivate failure of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
14.	LOAi	Loss of acknowledge with ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
15.	MEMi	Message_Error message from ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
16.	PEEi	Physical equipment error of ONUi	11.1.1	Meet the requirement of Cl 11.1.1	
17.	TIWi	Transmission interference warning	11.1.1	Meet the requirement of Cl 11.1.1	
18.	LOKi	Loss of key synch with ONUi	11.1.1	Meet the requirement of Cl 11.1.1	

2.2 Items detected at ONU

The following conformance parameters are described in this clause

Sl No	Type	Description	Reference in G.984.3	Value/Comment	Remark
1.	LOS	Loss of signal	11.1.2	Meet the requirement of Cl 11.1.2	Tested by protocol analyser or Simulated by removing fibre from ONU or turning off ONU
2.	LOF	Loss of frame	11.1.2	Meet the requirement of Cl 11.1.2	Tested by protocol analyser or Simulated by removing fibre from ONU or turning off ONU
3.	DACT	Deactivate ONU-ID	11.1.2	Meet the requirement of Cl 11.1.2	Tested by protocol analyser or simulated by command
4.	DIS	Disabled ONU	11.1.2	Meet the requirement of Cl 11.1.2	Tested by protocol analyser or simulated by command

5.	SF	Signal failed	11.1.2	Meet the requirement of Cl 11.1.2	Tested by protocol analyser Or Undertaking/Self declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter.
6.	SD	Signal degraded	11.1.2	Meet the requirement of Cl 11.1.2	
7.	LCDG	Loss of GEM channel delineation	11.1.2	Meet the requirement of Cl 11.1.2	
8.	TF	Transmitter failure	11.1.2	Meet the requirement of Cl 11.1.2	
9.	SUF	Start-up failure	11.1.2	Meet the requirement of Cl 11.1.2	
10.	MEM	Message error message	11.1.2	Meet the requirement of Cl 11.1.2	
11.	MIS	Link mismatching	11.1.2	Meet the requirement of Cl 11.1.2	
12.	PEE	Physical equipment error	11.1.2	Meet the requirement of Cl 11.1.2	
13.	RDI	Remote defect indication in ONU	11.1.2	Meet the requirement of Cl 11.1.2	

3.0 Activation method

The term "activation process" refers to the set of distributed procedures allowing an inactive ONU to join or resume operations on the PON.

The activation process includes three phases: parameter learning, serial number acquisition and ranging.

The following conformance parameters are described in this clause

Sl No	Parameters	Reference in G.984.3	Value/Comment	Remarks
	ONU activation states, timers and counters	10.2.1	Meet the requirement of Cl 10.2.1	Tested by protocol analyser or Console
	ONU state specification	10.2.2	Meet the requirement of Cl 10.2.2	
	ONU state diagram	10.2.3	Meet the requirement of Cl 10.2.3	Tested by protocol analyser Or

	ONU functional transitions	10.2.4	Meet the requirement of Cl 10.2.4	Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.

List-1(GPON-Protocol test)

Sl No	Parameters	Reference in G.984.3	Value/Comment	Remarks
	ONU events	10.2.5	Meet the requirement of Cl 10.2.5	Tested by protocol analyser or Console
	OLT common part	10.3.1	Meet the requirement of Cl 10.3.1	
	ONU-specific part	10.3.2	Meet the requirement of Cl 10.3.2	
	Quiet window creation	10.3.3	Meet the requirement of Cl 10.3.3	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
	Activation process failure detection	10.3.4	Meet the requirement of Cl 10.3.4	
	Phase monitoring and updating equalization delay	10.3.5	Meet the requirement of Cl 10.3.5	
	Fibre distance measurement	10.3.6	Meet the requirement of Cl 10.3.6	Tested by protocol analyser or Console
	Timing relationships during serial number acquisition	10.4.2	Meet the requirement of Cl 10.4.2	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
	Size of the quiet window during serial number acquisition	10.4.2.2	Meet the requirement of Cl 10.4.2.2	

List-2(XGPON-Protocol test)

List-2(XGPON-Protocol test)

Sl No	Parameter	Clause in standard
1	ONU Activation	1.0
2	Security	2.0
3	Network degradation check	3.0

1.0 ONU activation

The term "activation process" refers to the set of distributed procedures allowing an inactive ONU to join or resume operations on the PON. The activation process includes three phases: synchronization, serial number acquisition, and ranging. The following conformance parameters are described in this clause

Sl No	Parameter	Reference in G.987.3	Value/ Reference	Remark
1.	Power up	12.2.4	Meet the requirement of 12.2.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
2.	Downstream synchronization attained(LODS cleared)	12.2.4	Meet the requirement of 12.2.4	**Tested by protocol analyser or ONT debug console**
3.	Loss of downstream synchronization(LODS)	12.2.4	Meet the requirement of 12.2.4	
4.	Receive broadcast Profile PLOAM	12.2.4	Meet the requirement of 12.2.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
5.	Receive unicast Profile PLOAM	12.2.4	Meet the requirement of 12.2.4	
6.	Receive broadcast Serial Number grant	12.2.4	Meet the requirement of 12.2.4	
7.	Receive Assign ONU ID PLOAM (SN match)	12.2.4	Meet the requirement of 12.2.4	Tested by protocol analyser or ONT debug console
8.	Receive directed Ranging time	12.2.4	Meet the requirement of	

	PLOAM		12.2.4	
9.	Receive Ranging grant	12.2.4	Meet the requirement of 12.2.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
10.	Receive broadcast Ranging time PLOAM	12.2.4	Meet the requirement of 12.2.4	
11.	TO1 expired	12.2.4	Meet the requirement of 12.2.4	
12.	Receive directed Deactivate ONU ID PLOAM	12.2.4	Meet the requirement of 12.2.4	
13.	Receive broadcast Deactivate ONU ID PLOAM	12.2.4	Meet the requirement of 12.2.4	
14.	Receive Disable PLOAM – Disable specific SN option (SN match)	12.2.4	Meet the requirement of 12.2.4	Tested by protocol analyser or ONT debug console
15.	Receive Disable PLOAM – Enable specific SN option(SN match)	12.2.4	Meet the requirement of 12.2.4	
16.	TO2 expired	12.2.4	Meet the requirement of 12.2.4	
17.	Receive bandwidth grant with data allocation	12.2.4	Meet the requirement of 12.2.4	
18.	Receive Disable PLOAM – Disable All option	12.2.4	Meet the requirement of 12.2.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
19.	Receive Disable PLOAM – Enable All option	12.2.4	Meet the requirement of 12.2.4	
20.	Receive directed PLOAM grant	12.2.4	Meet the requirement of 12.2.4	
21.	Receive Request_ Registration PLOAM	12.2.4	Meet the requirement of 12.2.4	
22.	Receive Assign Alloc ID PLOAM	12.2.4	Meet the requirement of 12.2.4	Tested by protocol analyser or ONT debug console
23.	Receive Key Control PLOAM	12.2.4	Meet the requirement of 12.2.4	
24.	Receive Sleep Allow PLOAM	12.2.4	Meet the requirement of	

			12.2.4	

1.1 OLT and ONU timing relationships

The following conformance parameters are described in this clause

Sl No	Parameter	Reference in G.987.3	Value/ Reference	Remark
1.	Timing of ONU upstream transmissions	13.1.1	Meet the requirement of 13.1.1	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
2.	Timing relationships and quiet window during serial number acquisition	13.1.2	Meet the requirement of 13.1.2	
3.	Timing relationships and quiet window during ranging	13.1.3	Meet the requirement of 13.1.3	

2.0 Security

This clause discusses threat models characteristic for the XG-PON operating environment, and specifies authentication, data integrity, and privacy protection aspects of the system.

XG-PON security is intended to protect against the following threats:

a) Since downstream data is broadcast to all ONUs attached to the XG-PON OLT, a malicious user capable of replacing or re-programming an ONU would be capable of receiving all downstream data intended for all connected users.

b) Since upstream data received by the optical line terminal (OLT) can originate from any ONU attached to the XG-PON optical distribution network (ODN), a malicious user capable of replacing or re-programming an ONU could forge packets so as to impersonate a different ONU (i.e., theft of service).

c) An attacker could connect a malicious device at various points on the infrastructure (e.g., by tampering with street cabinets, spare ports, or fibre cables). Such a device could intercept and/or generate traffic. Depending on the location of such a device, it could impersonate an OLT or alternatively it could impersonate an ONU.

d) A malicious user in any of the above scenarios could record packets transmitted on the passive optical network (PON) and replay them back onto the PON later, or conduct bit-flipping attacks.

The following conformance parameters are described in this clause

List-2(XGPON-Protocol test)

Sl No	Parameter	Reference in G.987.3	Value/ Reference	Remark
1.	Threat model for XG-PON	15.1	Meet the requirement of 15.1	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
2.	XGEM payload encryption system	15.4	Meet the requirement of 15.4	
3.	Integrity protection and data origin verification for PLOAM	15.6	Meet the requirement of 15.6	
4.	Authentication	15.2	Meet the requirement of 15.2	Tested by protocol analyser or ONT debug console or ONT log.
5.	Key derivation	15.3	Meet the requirement of 15.3	
6.	Data encryption key exchange and activation mechanism	15.5	Meet the requirement of 15.5	
7.	Integrity protection and data origin verification for OMCI	15.7	Meet the requirement of 15.7	
8.	Integrity and data origin verification key switching	15.8	Meet the requirement of 15.8	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
9.	XG-PON systems with reduced data encryption strength	15.9	Meet the requirement of 15.9	

3.0 Network degradation check:
Following parameters encompasses mechanisms to check that any telecom equipment does not degrade performance of existing network to which it is connected.

3.1 Items detected at OLT:
The following conformance parameters are described in this clause

Sl No	Parameter	Reference in G.987.3	Value/ Reference	Remark

1.	Loss of burst for ONU *i*	14.2.1	Meet the requirement of 14.2.1	**Tested by protocol analyser or LCT.**
2.	Loss of signal	14.2.1		
3.	Transmission interference warning for ONU *i*	14.2.1		Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
4.	Start-up failure of ONU *i*	14.2.1		
5.	Disable failure of ONU *i*.	14.2.1		
6.	Loss of PLOAM channel with ONU *i*	14.2.1		
7.	Loss of OMCI channel with ONU *i*	14.2.1		

3.2 Items detected at ONU

The following conformance parameters are described in this clause

Sl No	Parameter	Reference in G.987.3	Value/ Reference	Remark
1	Loss of downstream synchro-nization.	14.2.2		Tested by protocol analyser or ONT console

List-3(XGS-PON-Protocol test)

Sl No	Parameter	Clause in standard
1	ONU Activation	1.0
2	Security	2.0
3	Network degradation check	3.0

1.0 ONU activation

The term "activation process" refers to the set of distributed procedures allowing an inactive ONU to join or resume operations on the PON. The activation process includes three phases: synchronization, serial number acquisition, and ranging. The following conformance parameters are described in this clause

Sl No	Parameter	Reference in G.9807.1	Value/ Reference	Remark
1.	Power up	Table C.12.4	Meet the requirement of Table C.12.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
2.	Downstream synchronization attained DSYNC	Table C.12.4	Meet the requirement of Table C.12.4	
3.	Loss of downstream synchronization LODS	Table C.12.4	Meet the requirement of Table C.12.4	Tested by protocol analyser or ONT debug console
4.	Initial Profile Acquired	Table C.12.4	Meet the requirement of Table C.12.4	
5.	Timer TO2 expires	Table C.12.4	Meet the requirement of Table C.12.4	
6.	ONU-ID assignment	Table C.12.4	Meet the requirement of Table C.12.4	
7.	EqD assignment	Table C.12.4	Meet the requirement of Table C.12.4	
8.	Enable SN request	Table C.12.4	Meet the requirement of Table C.12.4	
9.	Assign_Alloc-ID	Table C.12.4	Meet the requirement of Table C.12.4	

List-3(XGSPON-Protocol test)

10.	Key_Control	Table C.12.4	Meet the requirement of Table C.12.4	
11.	Timer TO1 expires	Table C.12.4	Meet the requirement of Table C.12.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
12.	SN grant	Table C.12.4	Meet the requirement of Table C.12.4	
13.	Directed PLOAM grant	Table C.12.4	Meet the requirement of Table C.12.4	
14.	Data grant	Table C.12.4	Meet the requirement of Table C.12.4	
15.	Directed deactivate	Table C.12.4	Meet the requirement of Table C.12.4	
16.	ONU-ID request	Table C.12.4	Meet the requirement of Table C.12.4	
17.	Broadcast deactivate	Table C.12.4	Meet the requirement of Table C.12.4	
18.	Burst_Profile	Table C.12.4	Meet the requirement of Table C.12.4	
19.	Ranging_Time (relative adjustment)	Table C.12.4	Meet the requirement of Table C.12.4	
20.	Request_Registration	Table C.12.4	Meet the requirement of Table C.12.4	
21.	Sleep_Allow	Table C.12.4	Meet the requirement of Table C.12.4	

List-3(XGSPON-Protocol test)

1.1 OLT and ONU timing relationships

The following conformance parameters are described in this clause

Sl No	Parameter	Reference in G.9807.1	Value/ Reference	Remark
1.	Timing of ONU upstream transmissions	C.13.1.1	Meet the requirement of C.13.1.1	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
2.	Timing relationships and quiet window during serial number acquisition	C.13.1.2	Meet the requirement of C.13.1.2	
3.	Timing relationships and quiet window during ranging	C.13.1.3	Meet the requirement of C.13.1.3	

2.0 Security

This clause discusses threat models characteristic for the XGS-PON operating environment, and specifies authentication, data integrity, and privacy protection aspects of the system.

XGS-PON security is intended to protect against the following threats:

- Since downstream data is broadcast to all ONUs attached to the OLT, a malicious user capable of replacing or re-programming an ONU would be capable of receiving all downstream data intended for all connected users.
- Since upstream data received by the OLT can originate from any ONU attached to the XGS-PON optical distribution network (ODN), a malicious user capable of replacing or re-programming an ONU could forge packets so as to impersonate a different ONU (i.e., theft of service).
- An attacker could connect a malicious device at various points on the infrastructure (e.g., by tampering with street cabinets, spare ports or fibre cables). Such a device could intercept and/or generate traffic. Depending on the location of such a device, it could impersonate an OLT or alternatively it could impersonate an ONU.
- A malicious user in any of the above scenarios could record packets transmitted on the PON and replay them back onto the PON later, or conduct bit-flipping attacks.

The following conformance parameters are described in this clause

List-3(XGSPON-Protocol test)

Sl No	Parameter	Reference in G.9807.1	Value/ Reference	Remark
1.	Threat model	C.15.1	Meet the requirement of C.15.1	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
2.	XGEM payload encryption system	C.15.4	Meet the requirement of C.15.4	
3.	Integrity protection and data origin verification for PLOAM	C.15.6	Meet the requirement of C.15.6	
4.	Integrity and data origin verification key switching	C.15.8	Meet the requirement of C.15.8	
5.	XGS-PON systems with reduced data encryption strength	C.15.9	Meet the requirement of C.15.9	
6.	Authentication	C.15.2	Meet the requirement of C.15.2	Tested by protocol analyser or ONT debug console or ONT console or ONT log.
7.	Key derivation	C.15.3	Meet the requirement of C.15.3	
8.	Data encryption key exchange and activation mechanism	C.15.5	Meet the requirement of C.15.5	
9.	Integrity protection and data origin verification for OMCI	C.15.7	Meet the requirement of C.15.7	

3.0 Network degradation check
Following parameters encompasses mechanisms to check that any telecom equipment does not degrade performance of existing network to which it is connected.

3.1 Items detected at OLT:
The following conformance parameters are described in this clause

List-3(XGSPON-Protocol test)

Sl No	Parameter	Reference in G.9807.1	Value/ Reference	Remark
1.	Loss of burst for ONUi	C.14.2	Meet the requirement of C.14.2	Tested by protocol analyser or LCT
2.	Loss of signal	C.14.2		
3.	Transmission interference warning for ONU i	C.14.2		Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
4.	Start-up failure of ONUi.	C.14.2		
5.	Disable failure of ONUi.	C.14.2		
6.	Loss of PLOAM channel with ONUi.	C.14.2		
7.	Loss of OMCC channel with ONUi	C.14.2		

List-3(XGSPON-Protocol test)

3.2 Items detected at ONU

The following conformance parameters are described in this clause

Sl No	Parameter	Reference in G.9807.1	Value/ Reference	Remark
1	Loss of downstream synchronization.	C.14.3	Meet the requirement of C.14.3	Tested by protocol analyser or ONT console

List-4(NGPON2-Protocol test)

List 4 (NGPON2-Protocol test)

Sl No	Parameter	Clause in standard
1	ONU activation	1.0
2	Security	2.0
3	Network degradation check	3.0

1.0 ONU activation

The activation proper includes three phases: downstream synchronization, serial number acquisition (ONU discovery), and ranging.

1.1 TWDM PON ONU activation cycle

This clause specifies the TC layer behaviour of a TWDM PON ONU using a state machine. As a matter of convenience, the ONU activation cycle state machine can be partitioned into two blocks: (1) activation proper, and (2) operation and tuning.
The following conformance parameters are described in this clause

Sl No	Parameters	Reference in G.989.3	Value/ References	Remark
1.	**ONU activation cycle states**	Table 12-1	Meet the requirement of Table 12-1	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
2.	Initial state	12.1.4	Meet the requirement of 12.1.4	
3.	O1/Off-Sync ≡ O1.1	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser or ONT console
4.	O1/Profile Learning ≡ O1.2	12.1.4	Meet the requirement of 12.1.4	
5.	Serial Number state	12.1.4	Meet the requirement of 12.1.4	
6.	Ranging state	12.1.4	Meet the requirement of 12.1.4	
7.	Operation state	12.1.4	Meet the requirement of 12.1.4	
8.	O5/Associated ≡ O5.1	12.1.4	Meet the requirement of 12.1.4	

9.	O5/Pending ≡ O5.2	12.1.4	Meet the requirement of 12.1.4	
10.	Intermittent LODS state	12.1.4	Meet the requirement of 12.1.4	
11.	Emergency Stop state	12.1.4	Meet the requirement of 12.1.4	
12.	Downstream Tuning state	12.1.4	Meet the requirement of 12.1.4	
13.	O8/Off-Sync ≡ O8.1	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
14.	O8/Profile Learning ≡ O8.2	12.1.4	Meet the requirement of 12.1.4	
15.	Upstream Tuning state	12.1.4	Meet the requirement of 12.1.4	
16.	ONU activation cycle state machine timers	Table 12-2	Meet the requirement of Table 12-2	
17.	Discovery timer	12.1.4	Meet the requirement of 12.1.4	
18.	Ranging timer	12.1.4	Meet the requirement of 12.1.4	
19.	Loss of downstream synchronization (LODS) timer.	12.1.4	Meet the requirement of 12.1.4	
20.	LODS protection timer	12.1.4	Meet the requirement of 12.1.4	
21.	Downstream tuning timer	12.1.4	Meet the requirement of 12.1.4	
22.	Upstream tuning timer	12.1.4	Meet the requirement of 12.1.4	
23.	ONU activation cycle state machine inputs	Table 12-3	Meet the requirement of Table 12-3	
24.	DSYNC	12.1.4	Meet the requirement of 12.1.4	
25.	LODS	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser or ONT console
26.	SFC match	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser Or

List-4(NGPON2-Protocol test)

27.	DWLCH ok to work	12.1.4	Meet the requirement of 12.1.4	Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
28.	DWLCH not appropriate	12.1.4	Meet the requirement of 12.1.4	
29.	TOZ expires	12.1.4	Meet the requirement of 12.1.4	
30.	TO1 expires	12.1.4	Meet the requirement of 12.1.4	
31.	TO2 expires	12.1.4	Meet the requirement of 12.1.4	
32.	TO3 expires	12.1.4	Meet the requirement of 12.1.4	
33.	TO4 expires	12.1.4	Meet the requirement of 12.1.4	
34.	TO5 expires	12.1.4	Meet the requirement of 12.1.4	
35.	SN grant	12.1.4	Meet the requirement of 12.1.4	
36.	Directed PLOAM grant	12.1.4	Meet the requirement of 12.1.4	
37.	Data grant	12.1.4	Meet the requirement of 12.1.4	
38.	ONU-ID Assignment	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser or ONT console
39.	EqD Assignment	12.1.4	Meet the requirement of 12.1.4	
40.	Deactivate ONU-ID request	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
41.	Disable SN request	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser or ONT console
42.	Enable SN request	12.1.4	Meet the requirement of 12.1.4	
43.	Calibration request	12.1.4	Meet the requirement of	Tested by protocol analyser

			12.1.4	Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
44.	Tuning request	12.1.4	Meet the requirement of 12.1.4	
45.	US Tuning confirmation	12.1.4	Meet the requirement of 12.1.4	
46.	System_Profile	12.1.4	Meet the requirement of 12.1.4	
47.	Channel_Profile	12.1.4	Meet the requirement of 12.1.4	
48.	Burst_Profile	12.1.4	Meet the requirement of 12.1.4	
49.	Ranging_Time (relative adjustment)	12.1.4	Meet the requirement of 12.1.4	
50.	Request_Registration	12.1.4	Meet the requirement of 12.1.4	
51.	Assign_Alloc-ID	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser or ONT console
52.	Key_Control	12.1.4	Meet the requirement of 12.1.4	
53.	Sleep_Allow	12.1.4	Meet the requirement of 12.1.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
54.	Adust_Tx_Wavelength	12.1.4	Meet the requirement of 12.1.4	
55.	Protection_Control	12.1.4	Meet the requirement of 12.1.4	
56.	OLT support of the TWDM ONU activation	12.1.5	Meet the requirement of 12.1.5	
57.	ONU power levelling	12.1.6	Meet the requirement of 12.1.6	

1.2 PtP WDM ONU activation cycle state machine

The following conformance parameters are described in this clause

Sl No	Parameters	Reference in G.989.3	Value/ References	Remark

List-4(NGPON2-Protocol test)

1.	**ONU activation cycle states**	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
2.	Initial state	12.2.2	Meet the requirement of 12.2.2	
3.	O1/Off-Sync ≡ O1.1	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser or ONT console
4.	O1/Profile Learning ≡ O1.2	12.2.2	Meet the requirement of 12.2.2	
5.	Serial Number state	12.2.2	Meet the requirement of 12.2.2	
6.	Operation state	12.2.2	Meet the requirement of 12.2.2	
7.	Intermittent LODS state	12.2.2	Meet the requirement of 12.2.2	
8.	Emergency Stop state	12.2.2	Meet the requirement of 12.2.2	
9.	Downstream Tuning state	12.2.2	Meet the requirement of 12.2.2	
10.	O8/Off-Sync ≡ O8.1	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
11.	O8/Profile Learning ≡ O8.2	12.2.2	Meet the requirement of 12.2.2	
12.	Upstream Tuning state	12.2.2	Meet the requirement of 12.2.2	
13.	**ONU activation cycle state machine timers**	12.2.2	Meet the requirement of 12.2.2	
14.	Discovery timer	12.2.2	Meet the requirement of 12.2.2	
15.	Loss of downstream synchronization (LODS) timer.	12.2.2	Meet the requirement of 12.2.2	
16.	LODS Protection timer	12.2.2	Meet the requirement of 12.2.2	
17.	Downstream Tuning timer	12.2.2	Meet the requirement of 12.2.2	
18.	Upstream tuning timer	12.2.2	Meet the requirement of	

			12.2.2	
19.	**ONU activation cycle state machine inputs**	12.2.2	Meet the requirement of 12.2.2	
20.	DSYNC	12.2.2	Meet the requirement of 12.2.2	
21.	LODS	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser or ONT console
22.	SFC match	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
23.	DWLCH ok to work	12.2.2	Meet the requirement of 12.2.2	
24.	DWLCH not appropriate	12.2.2	Meet the requirement of 12.2.2	
25.	TOZ expires	12.2.2	Meet the requirement of 12.2.2	
26.	TO2 expires	12.2.2	Meet the requirement of 12.2.2	
27.	TO3 expires	12.2.2	Meet the requirement of 12.2.2	
28.	TO4 expires	12.2.2	Meet the requirement of 12.2.2	
29.	TO5 expires	12.2.2	Meet the requirement of 12.2.2	
30.	ONU-ID Assignment	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser or ONT console
31.	Deactivate ONU-ID request	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser or ONT console
32.	Disable SN request	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser or ONT console
33.	Enable SN request	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser or ONT console
34.	Tuning request	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to
35.	US Tuning confirmation	12.2.2	Meet the requirement of 12.2.2	
36.	System_Profile	12.2.2	Meet the requirement of	

			12.2.2	test this parameter.
37.	Channel_Profile	12.2.2	Meet the requirement of 12.2.2	
38.	Burst_Profile	12.2.2	Meet the requirement of 12.2.2	
39.	Key_Control	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser or ONT console
40.	Sleep_Allow	12.2.2	Meet the requirement of 12.2.2	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
41.	Adust_Tx_Wavelength	12.2.2	Meet the requirement of 12.2.2	
42.	Protection_Control	12.2.2	Meet the requirement of 12.2.2	
43.	Rate_Control	12.2.2	Meet the requirement of 12.2.2	

1.3 NG-PON2 OLT and ONU timing relationships

The following conformance parameters are described in this clause

Sl No	Parameters	Reference in G.989.3	Value/ References	Remark
	Timing of ONU upstream transmissions	13.1.1	Meet the requirement of 13.1.1	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
	Timing relationships and quiet window during serial number acquisition	13.1.2	Meet the requirement of 13.1.2	
	Timing relationships and quiet window during ranging	13.1.3	Meet the requirement of 13.1.3	

List-4(NGPON2-Protocol test)

2.0 Security

This clause discusses threat models characteristic for the NG-PON2 operating environment, and specifies authentication, data integrity and privacy protection aspects of the system. NG-PON2 security is intended to protect against the following threats:

1) Since downstream data is broadcast to all ONUs attached to the NG-PON2 OLT CT, a malicious user capable of replacing or re-programming an ONU would be capable of receiving all downstream data intended for all connected users.
2) Since upstream data received by the OLT CT can originate from any ONU attached to the NG-PON2 optical distribution network (ODN), a malicious user capable of replacing or re-programming an ONU could forge packets so as to impersonate a different ONU (i.e., theft of service).
3) An attacker could connect a malicious device at various points on the infrastructure (e.g., by tampering with street cabinets, spare ports or fibre cables). Such a device could intercept and/or generate traffic. Depending on the location of such a device, it could impersonate an OLT CT or alternatively it could impersonate an ONU.
4) A malicious user in any of the above scenarios could record packets transmitted on the passive optical network (PON) and replay them back onto the PON later, or conduct bit-flipping attacks.

The following conformance parameters are described in this clause

Sl No	Parameter	Reference in G.989.3	Value/ References	Remark
1.	Authentication	15.2	Meet the requirement of 15.2	Tested by protocol analyser or ONT debug console
2.	Key derivation	15.3	Meet the requirement of 15.3	
3.	XGEM payload encryption system	15.4	Meet the requirement of 15.4	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
4.	Data encryption key exchange and activation mechanism	15.5	Meet the requirement of 15.5	Tested by protocol analyser or ONT debug console
5.	Integrity protection and data origin verification for PLOAM	15.6	Meet the requirement of 15.6	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till

				accredited/designated Lab is equipped to test this parameter.
6.	Integrity protection and data origin verification for OMCI	15.7	Meet the requirement of 15.7	Tested by protocol analyser or ONT debug console
7.	Integrity and data origin verification key switching	15.8	Meet the requirement of 15.8	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this parameter till accredited/designated Lab is equipped to test this parameter.
8.	NG-PON2 systems with reduced data encryption strength	15.9	Meet the requirement of 15.9	

3.0 Network degradation check

Following parameters encompasses mechanisms to check that any telecom equipment does not degrade performance of existing network to which it is connected..

This clause captures the required actions that are performed in the TC layer, as opposed to those left to the discretion of an implementer. In particular, the effects of repeated defects of the same type are an implementation matter.

3.1 Items detected at OLT channel termination

The following conformance parameters are described in this clause

Sl No	Type	Description	Reference in G.989.3	Value/ References	Remark
1.	LOS	Loss of signal	14.2.1	Meet the requirement of 14.2.1	Tested by protocol analyser or LCT
2.	TIWi	Transmission interference warning for ONU i	14.2.1	Meet the requirement of 14.2.1	Tested by protocol analyser Or Self-declaration of conformity (SDoC) along with corroboration with datasheet/test report from chip vendor may be accepted against this
3.	SUFi	Start-up failure of ONU_i.	14.2.1	Meet the requirement of 14.2.1	
4.	DFi	Disable failure of ONU_i.	14.2.1	Meet the requirement of 14.2.1	
5.	LOPCi	Loss of PLOAM channel with ONU_i.	14.2.1	Meet the requirement of 14.2.1	
6.	LOOCi	Loss of OMCC channel with ONU_i	14.2.1	Meet the requirement of 14.2.1	
7.	DOTXi	Drift of transmitter wavelength warning	14.2.1	Meet the requirement of 14.2.1	
8.	ALRFi	Attenuation level request failure	14.2.1	Meet the requirement of 14.2.1	

					parameter till accredited/designated Lab is equipped to test this parameter.

3.2 Items detected at ONU

The following conformance parameters are described in this clause

Sl No	**Type**	**Description**	**Reference in G.989.3**	**Value/ Reference**	**Remark**
1	LODS	Loss of downstream synchro-nization.	14.2.2	Meet the requirement of 14.2.2	**Tested by protocol analyser or ONT debug console**

List 5(1G/10G EPON- Protocol test)

(Note: Tested by protocol analyser or ONT)

5.4 Security

In scenarios where the Operator cannot rely on security functions provided by the CPE, the network may be exposed to various attacks (spoofing attacks, DoS attacks, etc.). The following Requirements address this situation.

R-109 The ONU SHOULD be able to provide services to users with duplicate MAC addresses.

R-110 The ONU SHOULD be able to deny service to users with duplicate MAC addresses.

R-111 The ONU SHOULD inspect upstream and downstream DHCP packets in order to discover the mapping of IP address to MAC address and populate an ARP table associating these addresses with their respective U-interface and VLAN.

R-112 The ONU SHOULD ensure that downstream broadcast ARP requests are not sent on U-interfaces that do not have the requested IP address.

R-113 The ONU SHOULD provide mechanisms to prevent user IP address spoofing, by discarding upstream IP packets received from U-interfaces that do not match the configured or DHCP discovered source IP address.

R-114 The ONU SHOULD be configurable with a list of IP address associated with user port and VLAN, to be used for users having static IP configuration.

R-115 In order to prevent source MAC flooding attacks, the ONU SHOULD be able to limit the number of source MAC addresses learned and forwarded from each user port. This limit SHOULD be configurable per user port.

R-116 The OLT SHOULD be able to provide services to users with duplicate MAC addresses (aligns with R-89/TR-101).

R-117 The OLT SHOULD be able to deny service to users with duplicate MAC addresses.

R-118 The OLT SHOULD provide a mechanism to prevent Broadband Network Gateway MAC address spoofing.

R-119 The OLT SHOULD inspect upstream and downstream DHCP packets in order to discover the mapping of IP address to MAC address and populate an ARP table associating these addresses with the appropriate ONU and VLAN.

R-120 The OLT SHOULD ensure that downstream broadcast ARP requests are not forwarded to ONUs that do not have the requested IP address.

R-121 The OLT SHOULD provide mechanisms to prevent user IP address spoofing, by discarding upstream IP packets received from ONUs that do not match the configured or DHCP-discovered source IP address.

R-122 The OLT SHOULD be configurable with a list of IP addresses associated with ONUs and VLANs, to be used for subscribers with static IP configurations.

R-123 In order to prevent source MAC flooding attacks, the OLT SHOULD be able to limit the number of source MAC addresses learned and forwarded from each ONU. This limit MUST be configurable per ONU.

5.5 Filtering

R-124 The OLT and ONU SHOULD allow configuring and applying the following filters. The OLT MUST apply any configured filters in the downstream direction, and the ONU MUST apply any configured filters in the upstream direction.

1. Source MAC address filter. This filter MAY be used in one of the following ways:
   i. Allowing access from a specific MAC address,
   ii. Denying access from a specific MAC address.

2. Destination MAC address filter. This filter MAY be used in one of the following ways:
   i. Allowing access to specific destinations,
   ii. Denying access to specific destinations.

R-125 The ONU SHOULD allow configuration of an EtherType filter, and applying it per U-interface in the upstream direction. This filter MAY be used in one of the following ways:
i. Allowing a specific EtherType frame access (e.g. IPoE, PPPoE),
ii. Denying a specific EtherType frame access (e.g. IPoE, PPPoE).

R-126 The OLT and ONU SHOULD be able to filter reserved group MAC destination addresses (in the 01:80:C2 range – See R-95/TR-101).

8.2 Initial Provisioning of ONUs

8.2.1 Introduction

Authentication for the ONUs attached to the EPON system is used by a service provider to control access to the network. Only authenticated ONUs are allowed to complete the initialization process and gain access the network.

The OLT authenticates attached ONUs using one or more of the following methods:

- Physical ID-based authentication
- Logical ID-based authentication
- Hybrid authentication

R-175 The OLT MUST support configuring the ONU authentication mode to be physical ID-based authentication, logical ID-based authentication, or hybrid authentication.

R-176 The OLT MUST prevent an illegal (authentication failed) ONU from accessing the network.

8.2.2 Physical ID-Based Authentication

If the OLT is configured for physical ID-based authentication, it uses the MAC address of an ONU as the physical ID for authentication. The MAC address of an ONU is reported to the OLT in the MPCP discovery process as defined in IEEE 802.3. In the OLT, a table of the legal MAC addresses is maintained for authentication.

R-177 The OLT MUST support MAC address-based ONU authentication.

8.2.3 Logical ID-Based Authentication

If the OLT is configured for logical ID-based authentication, the OLT authenticates the ONU based on the ONU Logical Identifier (LOID) and possibly a password (PW). The LOID/LOID+PW is a series of configurable characters in the ONU, hence logical ID-based authentication is more flexible than physical ID-based authentication.

Following successful completion of the MPCP discovery process and OAM discovery process, the OLT requests a LOID/LOID+PW from the target ONU in order to authenticate it. If the logical authentication process fails, the OLT deregisters the given ONU and denies it to access the EPON system.

Figure 29 depicts the process of successful logical ID-based authentication.

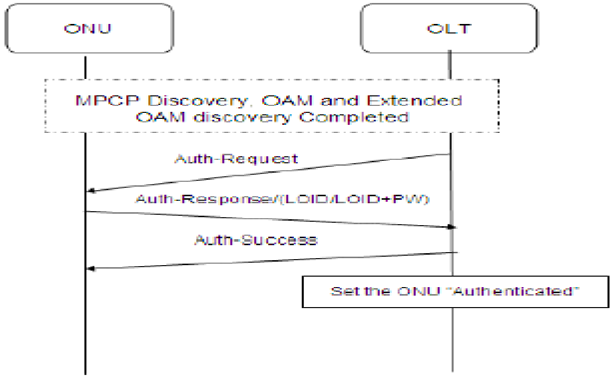


Figure 29 Successful logical ID based-authentication

Following is a brief description of the logical ID-based authentication process:

1. Once the MPCP and OAM discovery processes are completed, the OLT sends the extended OAM message ‘Auth_Request’ to the ONU to start the authentication process.
2. The ONU receives the message ‘Auth_Request’ and replies with the extended OAM message ‘Auth_Response’, which contains the logical ID information (LOID/LOID+PW).
3. Once the OLT receives the response from the target ONU, it verifies the ONU’s LOID/LOID+PW.
4. If the verification check completes successfully, the OLT sets the state of the ONU to ‘authenticated’.
5. If the verification check fails, the OLT sends the extended OAM message ‘Auth_Failure’ to the ONU and sets its state to ‘unauthenticated’. Next, the OLT sends a MPCP DU REGISTER (with Flag = 0x02: deregister set) to deregister the ONU.

The process of unsuccessful logical ID-based authentication is shown in Figure 30.

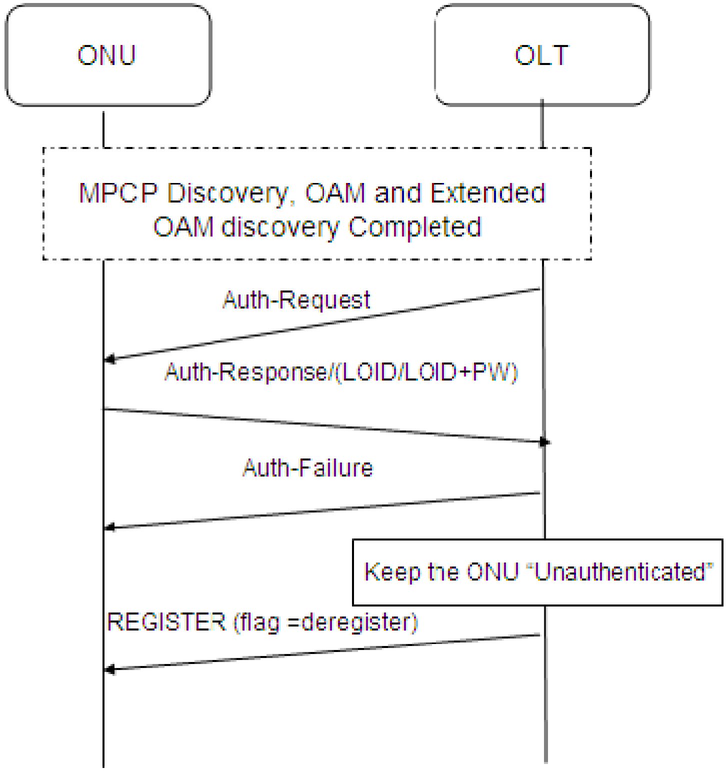


Figure 30 Unsuccessful logical ID based authentication by the OLT

R-178 The OLT MUST support ONU authentication based on LOID.

R-179 The OLT MUST support ONU authentication based on LOID+PW.

R-180 The OLT MUST support the pre-provisioning of PWs and their associated LOIDs.

R-181 The OLT MUST allow selection between LOID-based and LOID+PW-based ONU authentication.

R-182 The ONU MUST support local configuration of LOID/LOID+PW.

R-183 The ONU MUST retain the provisioned LOID/LOID+PW values indefinitely, or until the LOID/LOID+PW is re-provisioned."

If the logical ID is modified, in order to make the new logical ID effective the ONU has to go through the discovery and authentication process again.

As an example, a 24-character field can be used to hold the LOID value, and a 12-character field can be used to hold the Password value.

8.2.4 Hybrid Authentication

An OLT configured for hybrid authentication simultaneously supports both physical ID-based and logical ID-based authentication.

The OLT maintains a table of legal ONU MAC addresses. If an ONU has been successfully authenticated based on its MAC address, the OLT sets its state to 'authenticated.' Otherwise, the ONU is marked as 'unauthenticated.'

For an ONU that fails the authentication process based on its MAC address, the OLT will initiate the authentication process based on the logical ID, after finishing the MPCP discovery process and OAM discovery process.

If both the physical ID- and logical ID-based authentication processes fail, the OLT will deregister the given ONU.

R-184 The OLT MUST support hybrid authentication for the attached ONUs.

Attachment to Annexure-K

Table 5a/G.691 – Parameters specified for STM-64 optical interfaces

Application code (Table 1)	Unit	I-64.1r	I-64.1	I-64.2r	I-64.2	I-64.3	I-64.5
Transmitter at reference point MPI-S		Parameters given in G.693 as code VSR600-2R1	Parameters given in G.693 as code VSR2000-2R1	Parameters given in G.693 as code VSR2000-2L2	Parameters given in G.959.1 as code P1I1-2D2	Parameters given in G.959.1 as code P1I1-2D3	Parameters given in G.959.1 as code P1I1-2D5
Source type							
Operating wavelength range	nm						
Mean launched power							
– maximum	dBm						
– minimum	dBm						
Spectral characteristics							
– maximum RMS width (σ)	nm						
– maximum –20 dB width	nm						
– chirp parameter, α	rad						
– maximum spectral power density	mW/ 10 MHz						
– minimum SMSR	dB						
Minimum EX	dB						
Main optical path, MPI-S to MPI-R							
Attenuation range							
– maximum	dB						
– minimum	dB						
Chromatic dispersion							
– maximum	ps/nm						
– minimum	ps/nm						
Passive dispersion compensation							
– maximum	ps/nm						
– minimum	ps/nm						
Maximum DGD	ps						
Min ORL of cable plant at MPI-S, including any connectors	dB						
Maximum discrete reflectance between MPI-S and MPI-R	dB						
Receiver at reference point MPI-R							
Minimum sensitivity (BER of 1×10^{-12})	dBm						
Minimum overload	dBm						
Maximum optical path penalty	dB						
Maximum reflectance of receiver, measured at MPI-R	dB						
NOTE – All applications in this Recommendation use single-longitudinal mode (SLM) lasers as sources except the I-64.1r application that uses multi-longitudinal mode (MLM) lasers.							

Table 5b/G.691 – Parameters specified for STM-64 optical interfaces

Application code (Table 1)	Unit	S-64.1	S-64.2a	S-64.2b	S-64.3a	S-64.3b	S-64.5a	S-64.5b
Transmitter at reference point MPI-S		Parameters given in G.959.1 as code P1S1-2D1	Parameters given in G.959.1 as code P1S1-2D2a	Parameters given in G.959.1 as code P1S1-2D2b	Parameters given in G.959.1 as code P1S1-2D3a	Parameters given in G.959.1 as code P1S1-2D3b	Parameters given in G.959.1 as code P1S1-2D5a	Parameters given in G.959.1 as code P1S1-2D5b
Operating wavelength range	nm							
Mean launched power								
– maximum	dBm							
– minimum	dBm							
Spectral characteristics								
– maximum –20 dB width	nm							
– chirp parameter, α	rad							
– maximum spectral power density	mW/ 10 MHz							
– minimum SMSR	dB							
Minimum EX	dB							
Main optical path, MPI-S to MPI-R								
Attenuation range								
– maximum	dB							
– minimum	dB							
Chromatic dispersion								
– maximum	ps/nm							
– minimum	ps/nm							
Passive dispersion compensation								
– maximum	ps/nm							
– minimum	ps/nm							
Maximum DGD	ps							
Min ORL of cable plant at MPI-S, including any connectors	dB							
Maximum discrete reflectance between MPI-S and MPI-R	dB							
Receiver at reference point MPI-R								
Minimum sensitivity (BER of 1×10^{-12})	dBm							
Minimum overload	dBm							
Maximum optical path penalty	dB							
Maximum reflectance of receiver, measured at MPI-R	dB							

NOTE – S-64.2a, 3a, and 5a have transmitter power levels appropriate for APD receivers; S-64.2b, 3b, and 5b have transmitter power levels appropriate for PIN receivers.

Table 5c/G.691 – Parameters specified for STM-64 optical interfaces

Application code (Table 1)	Unit	L-64.1	L-64.2a	L-64.2b	L-64.2c	L-64.3
			(Notes 1, 2)	(Note 1)	(Note 1)	
Transmitter at reference point MPI-S		Parameters given in G.959.1 as code P1L1-2D1				
Operating wavelength range	nm	Parameters given in G.959.1 as code P1L1-2D1	1530-1565	1530-1565	1530-1565	1530-1565
Mean launched power		Parameters given in G.959.1 as code P1L1-2D1				
– maximum	dBm	Parameters given in G.959.1 as code P1L1-2D1	+2	13	+2	13
– minimum	dBm	Parameters given in G.959.1 as code P1L1-2D1	–2	10	–2	10
Spectral characteristics		Parameters given in G.959.1 as code P1L1-2D1				
– maximum –20 dB width	nm	Parameters given in G.959.1 as code P1L1-2D1	ffs	ffs	ffs	ffs
– chirp parameter, α	rad	Parameters given in G.959.1 as code P1L1-2D1	ffs	ffs	ffs	ffs
– maximum spectral power density	mW/10MHz	Parameters given in G.959.1 as code P1L1-2D1	ffs	ffs	ffs	ffs
– minimum SMSR	dB	Parameters given in G.959.1 as code P1L1-2D1	ffs	ffs	ffs	ffs
Minimum EX	dB	Parameters given in G.959.1 as code P1L1-2D1	10	8.2	10	8.2
Main optical path, MPI-S to MPI-R		Parameters given in G.959.1 as code P1L1-2D1				
Attenuation range		Parameters given in G.959.1 as code P1L1-2D1				
– maximum	dB	Parameters given in G.959.1 as code P1L1-2D1	22	22	22	22
– minimum	dB	Parameters given in G.959.1 as code P1L1-2D1	11	16	11	16
Chromatic dispersion		Parameters given in G.959.1 as code P1L1-2D1				
– maximum	ps/nm	Parameters given in G.959.1 as code P1L1-2D1	1600	1600	1600	260
– minimum	ps/nm	Parameters given in G.959.1 as code P1L1-2D1	ffs	ffs	ffs	NA
Passive dispersion compensation		Parameters given in G.959.1 as code P1L1-2D1				
– maximum	ps/nm	Parameters given in G.959.1 as code P1L1-2D1	ffs	NA	NA	NA
– minimum	ps/nm	Parameters given in G.959.1 as code P1L1-2D1	ffs	NA	NA	NA
Maximum DGD	ps	Parameters given in G.959.1 as code P1L1-2D1	30	30	30	30
Min ORL of cable plant at MPI-S, including any connectors	dB	Parameters given in G.959.1 as code P1L1-2D1	24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	Parameters given in G.959.1 as code P1L1-2D1	–27	–27	–27	–27
Receiver at reference point MPI-R		Parameters given in G.959.1 as code P1L1-2D1				
Minimum sensitivity (BER of 1×10^{-12})	dBm	Parameters given in G.959.1 as code P1L1-2D1	–26	–14	–26	–13
Minimum overload	dBm	Parameters given in G.959.1 as code P1L1-2D1	–9	–3	–9	–3
Maximum optical path penalty	dB	Parameters given in G.959.1 as code P1L1-2D1	2	2	2	1
Maximum reflectance of receiver, measured at MPI-R	dB	Parameters given in G.959.1 as code P1L1-2D1	–27	–27	–27	–27

NOTE 1 – L-64.2a uses PDC as DA, L-64.2b uses SPM as DA, and L-64.2c uses prechirp as DA.

NOTE 2 – See 8.3.2 on the values and placement of the PDC.

Table 5d/G.691 – Parameters specified for STM-64 optical interfaces

Application code (Table 1)	Unit	V-64.2a	V-64.2b	V-64.3
		(Notes 1, 2)	(Note 2)	
Transmitter at reference point MPI-S				
Operating wavelength range	nm	1530-1565	1530-1565	1530-1565
Mean launched power				
– maximum	dBm	13	15	13
– minimum	dBm	10	12	10
Spectral characteristics				
– maximum –20 dB width	nm	ffs	ffs	ffs
– chirp parameter, α	rad	ffs	ffs	ffs
– maximum spectral power density	mW/ 10 MHz	ffs	ffs	ffs
– minimum SMSR	dB	ffs	ffs	ffs
Minimum EX	dB	10	8.2	8.2
Main optical path, MPI-S to MPI-R				
Attenuation range				
– maximum	dB	33	33	33
– minimum	dB	22	22	22
Chromatic dispersion				
– maximum	ps/nm	2400	2400	400
– minimum	ps/nm	ffs	ffs	NA
Passive dispersion compensation				
– maximum	ps/nm	ffs	ffs	NA
– minimum	ps/nm	ffs	ffs	NA
Maximum DGD	ps	30	30	30
Min ORL of cable plant at MPI-S, including any connectors	dB	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Receiver at reference point MPI-R				
Minimum sensitivity (BER of 1×10^{-12})	dBm	–25	–23	–24
Minimum overload	dBm	–9	–7	–9
Maximum optical path penalty	dBm	2	2	1
Maximum reflectance of receiver, measured at MPI-R	dB	–27	–27	–27
NOTE 1 – See 8.3.2 on the values and placement of the PDC.				
NOTE 2 – V-64.2a uses PDC as DA and V-64.2b uses a combination of SPM and PDC as DA.				

8 Optical engineering approach

8.1 Design assumptions

This clause discusses the design aspects introduced in this Recommendation due to, e.g., optical amplifiers and dispersion accommodation. A general discussion on worst-case and statistical design approaches can be found in ITU-T Rec. G.957.

Attachment to Annexure-L

Table 8-1 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 2.5G short-haul applications

Parameter (Note)	Units	P16S1-1D2 P16S1-1D5	P32S1-1D2 P32S1-1D5
General information			
Maximum number of channels	–	16	32
Bit rate/line coding of optical tributary signals	–	NRZ 2.5G	NRZ 2.5G
Maximum bit error ratio	–	10^{-12}	10^{-12}
Fibre type	–	ITU-T G.652, ITU-T G.655	ITU-T G.652, ITU-T G.655
Interface at point MPI-S_M			
Maximum mean channel output power	dBm	−4	−4
Minimum mean channel output power	dBm	−10	−10
Maximum mean total output power	dBm	+8	+11
Central frequency	THz	192.1 + 0.2m, m = 0 to 15	192.1 + 0.1m, m = 0 to 31
Channel spacing	GHz	200	100
Maximum spectral excursion	GHz	40	20
Minimum channel extinction ratio	dB	8.2	8.2
Eye mask	–	NRZ 2.5G	NRZ 2.5G
Optical path (single span) from point MPI-S_M to MPI-R_M			
Maximum attenuation	dB	11	11
Minimum attenuation	dB	2	2
Maximum chromatic dispersion at upper wavelength limit	ps/nm	800 for [ITU-T G.652], 420 for [ITU-T G.655]	800 for [ITU-T G.652], 420 for [ITU-T G.655]
Maximum chromatic dispersion at lower wavelength limit	ps/nm	800 for [ITU-T G.652], 420 for [ITU-T G.655]	800 for [ITU-T G.652], 420 for [ITU-T G.655]
Minimum optical return loss at MPI-S_M	dB	24	24
Maximum discrete reflectance between MPI-S_M and MPI-R_M	dB	−27	−27
Maximum differential group delay	ps	120	120
Interface at point MPI-R_M			
Maximum mean channel input power	dBm	−6	−6
Minimum mean channel input power	dBm	−21	−21
Maximum mean total input power	dBm	+6	+9
Maximum channel power difference	dB	NA	NA

Table 8-1 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 2.5G short-haul applications

Parameter (Note)	Units	P16S1-1D2 P16S1-1D5	P32S1-1D2 P32S1-1D5
Maximum optical path penalty	dB	1	1
Minimum equivalent sensitivity	dBm	−22	−22
Maximum reflectance of optical network element	dB	−27	−27
NOTE – The parameter values in this table may not be applicable to future systems that use line amplifiers or to intra-domain interfaces (IaDIs).			

Table 8-2 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 10G intra-office applications

Parameter (Note 1)	Units	P16I1-2D2 P16I1-2D3 (Note 2) P16I1-2D5	P32I1-2D2 P32I1-2D5
General information			
Maximum number of channels	–	16	32
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ 10G
Maximum bit error ratio	–	10^{-12}	10^{-12}
Fibre type	–	ITU-T G.652, ITU-T G.653, ITU-T G.655	ITU-T G.652, ITU-T G.655
Interface at point MPI-S_M			
Maximum mean channel output power	dBm	−3	−3
Minimum mean channel output power	dBm	−6	−6
Maximum mean total output power	dBm	+9	+12
Central frequency	THz	$192.1 + 0.2m$, $m = 0$ to 15	$192.1 + 0.1m$, $m = 0$ to 31
Channel spacing	GHz	200	100
Maximum spectral excursion	GHz	40	20
Minimum channel extinction ratio	dB	8.2	8.2
Eye mask	–	NRZ 10G amplified	NRZ 10G amplified
Optical path (single span) from point MPI-S_M to MPI-R_M			
Maximum attenuation	dB	6 (Note 2)	6
Minimum attenuation	dB	0	0

Table 8-2 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 10G intra-office applications

Parameter (Note 1)	Units	P16I1-2D2 P16I1-2D3 (Note 2) P16I1-2D5	P32I1-2D2 P32I1-2D5
Maximum chromatic dispersion at upper wavelength limit	ps/nm	400 for ITU-T G.652, ±70 for ITU-T G.653, 210 for ITU-T G.655	400 for ITU-T G.652, 210 for ITU-T G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	400 for ITU-T G.652, ±70 for ITU-T G.653, 210 for ITU-T G.655	400 for ITU-T G.652, 210 for ITU-T G.655
Minimum optical return loss at MPI-S_M	dB	24	24
Maximum discrete reflectance between MPI-S_M and MPI-R_M	dB	−27	−27
Maximum differential group delay	ps	30	30
Interface at point MPI-R_M			
Maximum mean channel input power	dBm	−3	−3
Minimum mean channel input power	dBm	−12	−12
Maximum mean total input power	dBm	+9	+12
Maximum channel power difference	dB	NA	NA
Maximum optical path penalty	dB	2 for ITU-T G.652, 1 for ITU-T G.653 (Note 2),1 for ITU-T G.655	2 for ITU-T G.652, 1 for ITU-T G.655
Minimum equivalent sensitivity	dBm	−14 for ITU-T G.652, −13 for ITU-T G.653, −13 for ITU-T G.655	−14 for ITU-T G.652, −13 for ITU-T G.655
Maximum reflectance of optical network element	dB	−27	−27

NOTE 1 – The parameter values in this table may not be applicable to future systems that use line amplifiers or to intra-domain interfaces (IaDIs).

NOTE 2 – For an optical path penalty of 1 dB, the transmission distance of multichannel intra-office interfaces on ITU-T G.653 fibres is recommended to be within 2 km due to fibre non-linearity. If this distance is longer than 2 km, a further penalty (in addition to the 1 dB optical path penalty) may be observed. Alternatively, unequally spaced channel central frequencies may be used via joint engineering.

Table 8-3 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications

Parameter (Note)	Units	P16S1-2B2 P16S1-2B5	P16S1-2C2 P16S1-2C3 P16S1-2C5	P32S1-2B2 P32S1-2B5	P32S1-2C2 P32S1-2C5
General information					
Maximum number of channels	–	16	16	32	32
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ 10G	NRZ 10G	NRZ 10G
Maximum bit error ratio	–	10^{-12}	10^{-12}	10^{-12}	10^{-12}
Fibre type	–	ITU-T G.652, ITU-T G.655	ITU-T G.652, ITU-T G.653, ITU-T G.655	ITU-T G.652, ITU-T G.655	ITU-T G.652, ITU-T G.655
Interface at point MPI-S_M					
Maximum mean channel output power	dBm	+3	−7	+3	−7
Minimum mean channel output power	dBm	0	−11	0	−11
Maximum mean total output power	dBm	+15	+5	+18	+8
Central frequency	THz	192.1 + 0.2m, m = 0 to 15	192.1 + 0.2m, m = 0 to 15	192.1 + 0.1m, m = 0 to 31	192.1 + 0.1m, m = 0 to 31
Channel spacing	GHz	200	200	100	100
Maximum spectral excursion	GHz	40	40	20	20
Minimum channel extinction ratio	dB	8.2	8.2	8.2	8.2
Eye mask	–	NRZ 10G amplified	NRZ 10G amplified	NRZ 10G amplified	NRZ 10G amplified
Optical path (single span) from point MPI-S_M to MPI-R_M					
Maximum attenuation	dB	11	11	11	11
Minimum attenuation	dB	0	0	0	0

Table 8-3 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications

Parameter (Note)	Units	P16S1-2B2 P16S1-2B5	P16S1-2C2 P16S1-2C3 P16S1-2C5	P32S1-2B2 P32S1-2B5	P32S1-2C2 P32S1-2C5
Maximum chromatic dispersion at upper wavelength limit	ps/nm	800 for ITU-T G.652, 420 for ITU-T G.655	800 for ITU-T G.652, ±130 for ITU-T G.653, 420 for ITU-T G.655	800 for ITU-T G.652, 420 for ITU-T G.655	800 for ITU-T G.652, 420 for ITU-T G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	800 for ITU-T G.652, 420 for ITU-T G.655	800 for ITU-T G.652, ±130 for ITU-T G.653, 420 for ITU-T G.655	800 for ITU-T G.652, 420 for ITU-T G.655	800 for ITU-T G.652, 420 for ITU-T G.655
Minimum optical return loss at MPI-S_M	dB	24	24	24	24
Maximum discrete reflectance between MPI-S_M and MPI-R_M	dB	–27	–27	–27	–27
Maximum differential group delay	ps	30	30	30	30
Interface at point MPI-R_M					
Maximum mean channel input power	dBm	+3	–7	+3	–7
Minimum mean channel input power	dBm	–11	–22	–11	–22
Maximum mean total input power	dBm	+15	+5	+18	+8
Maximum channel power difference	dB	NA	2	NA	2
Maximum optical path penalty	dB	2 for ITU-T G.652, 1 for ITU-T G.655	2 for ITU-T G.652, 1 for ITU-T G.653, 1 for ITU-T G.655	2 for ITU-T G.652, 1 for ITU-T G.655	2 for ITU-T G.652, 1 for ITU-T G.655

Table 8-3 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications

Parameter (Note)	Units	P16S1-2B2 P16S1-2B5	P16S1-2C2 P16S1-2C3 P16S1-2C5	P32S1-2B2 P32S1-2B5	P32S1-2C2 P32S1-2C5
Minimum equivalent sensitivity	dBm	–13 for ITU-T G.652, –12 for ITU-T G.655	–24 for ITU-T G.652, –23 for ITU-T G.653, –23 for ITU-T G.655	–13 for ITU-T G.652, –12 for ITU-T G.655	–24 for ITU-T G.652, –23 for ITU-T G.655
Maximum reflectance of optical network element	dB	–27	–27	–27	–27
NOTE – The parameter values in this table may not be applicable to future systems that use line amplifiers or to intra-domain interfaces (IaDIs).					

Table 8-4 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 2.5G and NRZ 10G long-haul applications

Parameter (Note)	Units	P16L1-1A2 P16L1-1A5	P16L1-2A2 P16L1-2A5
General information			
Maximum number of channels	–	16	16
Bit rate/line coding of optical tributary signals	–	NRZ 2.5G	NRZ 10G
Maximum bit error ratio	–	10^{-12}	10^{-12}
Fibre type	–	ITU-T G.652, ITU-T G.655	ITU-T G.652, ITU-T G.655
Interface at point MPI-S_M			
Maximum mean channel output power	dBm	+5	+5
Minimum mean channel output power	dBm	+2	0
Maximum mean total output power	dBm	+17	+17
Central frequency	THz	$192.1 + 0.2m$, $m = 0$ to 15	$192.1 + 0.2m$, $m = 0$ to 15
Channel spacing	GHz	200	200
Maximum spectral excursion	GHz	40	40
Minimum channel extinction ratio	dB	8.2	8.2
Eye mask	–	NRZ 2.5G	NRZ 10G amplified
Optical path (single span) from point MPI-S_M to MPI-R_M			
Maximum attenuation	dB	22	22
Minimum attenuation	dB	11	11

Table 8-4 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 2.5G and NRZ 10G long-haul applications

Parameter (Note)	Units	P16L1-1A2 P16L1-1A5	P16L1-2A2 P16L1-2A5
Maximum chromatic dispersion at upper wavelength limit	ps/nm	1 600 for ITU-T G.652, 840 for ITU-T G.655	1 600 for ITU-T G.652, 840 for ITU-T G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	1 600 for ITU-T G.652, 840 for ITU-T G.655	1 600 for ITU-T G.652, 840 for ITU-T G.655
Minimum optical return loss at MPI-S_M	dB	24	24
Maximum discrete reflectance between MPI-S_M and MPI-R_M	dB	–27	–27
Maximum differential group delay	ps	120	30
Interface at point MPI-R_M			
Maximum mean channel input power	dBm	–6	–6
Minimum mean channel input power	dBm	–20	–22
Maximum mean total input power	dBm	+6	+6
Maximum channel power difference	dB	3	3
Maximum optical path penalty	dB	2 for ITU-T G.652, 1 for ITU-T G.655	2 for ITU-T G.652, 1 for ITU-T G.655
Minimum equivalent sensitivity	dBm	–22 for ITU-T G.652, –21 for ITU-T G.655	–24 for ITU-T G.652, –23 for ITU-T G.655
Maximum reflectance of optical network element	dB	–27	–27
NOTE – The parameter values in this table may not be applicable to future systems that use line amplifiers or to intra-domain interfaces (IaDIs).			

Table 8-5 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 25G applications

<table>
<tr><th>Parameter</th><th>Units</th><th colspan="2">4I1-9D1F</th><th>4L1-9C1F</th><th>4L1-9D1F</th></tr>
<tr><td>General information</td><td></td><td colspan="2"></td><td></td><td></td></tr>
<tr><td>Maximum number of channels</td><td>–</td><td colspan="2">4</td><td>4</td><td>4</td></tr>
<tr><td>Bit rate/line coding of optical tributary signals</td><td>–</td><td colspan="2">OTL4.4 or FOIC1.4-RS</td><td>OTL4.4 or FOIC1.4-RS</td><td>OTL4.4 or FOIC1.4-RS</td></tr>
<tr><td>Maximum bit error ratio</td><td>–</td><td colspan="2">10^{-12} (Note 1)</td><td>10^{-12} (Note 1)</td><td>10^{-12} (Note 1)</td></tr>
<tr><td>Fibre type</td><td>–</td><td colspan="2">ITU-T G.652</td><td>ITU-T G.652</td><td>ITU-T G.652</td></tr>
<tr><td>Interface at point MPI-S_M</td><td></td><td colspan="2"></td><td></td><td></td></tr>
<tr><td>Maximum mean channel output power</td><td>dBm</td><td>4</td><td>2.9</td><td>2.9</td><td>5.1</td></tr>
</table>

Table 8-5 – Multichannel IrDI parameters and values for optical tributary signal class NRZ 25G applications

Parameter	Units	4I1-9D1F		4L1-9C1F	4L1-9D1F
Minimum channel extinction ratio (Note 2)	dB	4	7	8	7
Maximum channel extinction ratio (Note 2)	dB	7	–	–	–
Minimum mean channel output power (Note 2)	dBm	−0.6	−2.5	−2.7	0.6
Maximum mean total output power	dBm	10	8.9	8.9	11.1
Maximum channel power difference	dB	5		3.6	3.6
Central frequency	THz	229.0 + 0.8m, m = 0 to 3		229.0 + 0.8m, m = 0 to 3	229.0 + 0.8m, m = 0 to 3
Channel spacing	GHz	800		800	800
Maximum spectral excursion	GHz	±184		±184	±184
Eye mask	–	NRZ 25G Ratio		NRZ 25G Ratio	NRZ 25G Ratio
Optical path (single span) from point MPI-S_M to MPI-R_M					
Maximum attenuation	dB	6.3		18	18
Minimum attenuation	dB	0		0	10
Maximum chromatic dispersion at upper wavelength limit	ps/nm	−28.5 to +9.5		−114 to +38	−114 to +38
Maximum chromatic dispersion at lower wavelength limit	ps/nm	−28.5 to +9.5		−114 to +38	−114 to +38
Minimum optical return loss at MPI-S_M	dB	20		20	20
Maximum discrete reflectance between MPI-S_M and MPI-R_M	dB	−26		−26	−26
Maximum differential group delay	ps	8		10.3	10.3
Interface at point MPI-R_M					
Maximum mean channel input power	dBm	4	2.9	4.5	−4.9
Minimum mean channel input power (Note 2)	dBm	−6.9	–8.8	−20.7	−17.4
Maximum mean total input power	dBm	10	8.9	10.5	1.1
Maximum channel power difference	dB	5.5		4.5	4.5
Maximum optical path penalty	dB	1.5		2.5	1.5
Minimum equivalent sensitivity (Note 2)	dBm	−8.4	–10.3	−23.2	−18.9
Maximum reflectance of optical network element	dB	−26		−26	−26

NOTE 1 – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}.

NOTE 2 – The parameters for 4I1-9D1F allow two options for the transmitter (shown via a split in the column) with different values for maximum and minimum mean channel output power, maximum and minimum channel extinction ratio and maximum mean total output power. The two sets of transmitter parameter values provide different values for maximum and minimum mean channel input power, maximum mean total input power and minimum equivalent sensitivity for the same physical receiver as indicated by the split values for these parameters. The transmitter must meet the specifications in one of the two columns and the receiver must meet the specifications in both columns.

Table 8-6 – Multichannel IrDI parameters and values for optical tributary signal class PAM4 50G applications

<table>
<tr><th>Parameter</th><th>Units</th><th colspan="2">8R1-4D1F</th><th colspan="2">4I1-4D1F</th><th colspan="2">8I1-4D1F</th></tr>
<tr><td>General information</td><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Maximum number of channels</td><td>–</td><td colspan="2">8</td><td colspan="2">4</td><td colspan="2">8</td></tr>
<tr><td>Bit rate/line coding of optical tributary signals</td><td>–</td><td colspan="2">FOIC4.8
PAM4</td><td colspan="2">FOIC2.4
PAM4</td><td colspan="2">FOIC4.8
PAM4</td></tr>
<tr><td>Maximum bit error ratio</td><td>–</td><td colspan="2">10^{-13} (Note 1)</td><td colspan="2">10^{-13} (Note 1)</td><td colspan="2">10^{-13} (Note 1)</td></tr>
<tr><td>Fibre type</td><td>–</td><td colspan="2">ITU-T G.652</td><td colspan="2">ITU-T G.652</td><td colspan="2">ITU-T G.652</td></tr>
<tr><td>Interface at point MPI-S_M</td><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Maximum mean channel output power</td><td>dBm</td><td colspan="2">+5.3 (Note 2)</td><td colspan="2">+5.3</td><td colspan="2">+5.3 (Note 2)</td></tr>
<tr><td>Minimum mean channel output power</td><td>dBm</td><td colspan="2">−3.5</td><td colspan="2">−3.4</td><td colspan="2">−2.8</td></tr>
<tr><td>Maximum mean total output power</td><td>dBm</td><td colspan="2">+13.2</td><td colspan="2">+11.3</td><td colspan="2">+13.2</td></tr>
<tr><td>Minimum channel extinction ratio (Note 3)</td><td>dB</td><td>3.5</td><td>4.5</td><td>3.5</td><td>4.5</td><td>3.5</td><td>4.5</td></tr>
<tr><td>Maximum channel extinction ratio (Note 3)</td><td>dB</td><td>4.5</td><td>–</td><td>4.5</td><td>–</td><td>4.5</td><td>–</td></tr>
<tr><td>Maximum channel output OMA_{outer}</td><td>dBm</td><td colspan="2">+5.5</td><td colspan="2">+5.1</td><td colspan="2">+5.7</td></tr>
<tr><td>Minimum channel output OMA_{outer}</td><td>dBm</td><td colspan="2">−0.5</td><td colspan="2">−0.4</td><td colspan="2">+0.2</td></tr>
<tr><td>Maximum TDECQ</td><td>dB</td><td colspan="2">3.1</td><td colspan="2">3.4</td><td colspan="2">3.3</td></tr>
<tr><td>Maximum channel power difference</td><td>dB</td><td colspan="2">4</td><td colspan="2">4</td><td colspan="2">4</td></tr>
<tr><td>Minimum channel OMA_{outer} minus TDECQ (Note 3)</td><td>dBm</td><td>−1.8</td><td>−1.9</td><td>−1.7</td><td>−1.8</td><td>−1.1</td><td>−1.2</td></tr>
<tr><td>Central frequency</td><td>THz</td><td colspan="2">229.0 + 0.8 m,
m = 0 to 3
and 5 to 8</td><td colspan="2">229.0 + 0.8 m,
m = 0 to 3</td><td colspan="2">229.0 + 0.8 m,
m = 0 to 3
and 5 to 8</td></tr>
<tr><td>Channel spacing</td><td>GHz</td><td colspan="2">800</td><td colspan="2">800</td><td colspan="2">800</td></tr>
<tr><td>Maximum spectral excursion</td><td>GHz</td><td colspan="2">±184</td><td colspan="2">±184</td><td colspan="2">±184</td></tr>
<tr><td>Optical path (single span)
from point MPI-S_M to MPI-R_M</td><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Maximum attenuation</td><td>dB</td><td colspan="2">4</td><td colspan="2">6.3</td><td colspan="2">6.3</td></tr>
<tr><td>Minimum attenuation</td><td>dB</td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td>Maximum chromatic dispersion at upper wavelength limit</td><td>ps/nm</td><td colspan="2">−10.2 to +1.9</td><td colspan="2">−28.4 to +9.5</td><td colspan="2">−50.8 to +9.5</td></tr>
<tr><td>Maximum chromatic dispersion at lower wavelength limit</td><td>ps/nm</td><td colspan="2">−10.2 to +1.9</td><td colspan="2">−28.4 to +9.5</td><td colspan="2">−50.8 to +9.5</td></tr>
<tr><td>Minimum optical return loss at MPI-S_M</td><td>dB</td><td colspan="2">16.5</td><td colspan="2">15.1</td><td colspan="2">15.1</td></tr>
<tr><td>Maximum discrete reflectance between MPI-S_M and MPI-R_M</td><td>dB</td><td colspan="2">See clause 7.2.3.6</td><td colspan="2">See clause 7.2.3.6</td><td colspan="2">See clause 7.2.3.6</td></tr>
<tr><td>Maximum differential group delay</td><td>ps</td><td colspan="2">3</td><td colspan="2">8</td><td colspan="2">8</td></tr>
<tr><td>Interface at point MPI-R_M</td><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Maximum mean channel input power</td><td>dBm</td><td colspan="2">+5.3</td><td colspan="2">+5.3</td><td colspan="2">+5.3</td></tr>
<tr><td>Minimum mean channel input power</td><td>dBm</td><td colspan="2">−7.5</td><td colspan="2">−9.7</td><td colspan="2">−9.1</td></tr>
<tr><td>Maximum mean total input power</td><td>dBm</td><td colspan="2">+13.2</td><td colspan="2">+11.3</td><td colspan="2">+13.2</td></tr>
</table>

Table 8-6 – Multichannel IrDI parameters and values for optical tributary signal class PAM4 50G applications

Parameter	Units	8R1-4D1F		4I1-4D1F		8I1-4D1F	
Maximum channel input OMA_{outer}	dBm	+5.7		+5.1		+5.7	
Minimum channel input OMA_{outer}	dBm	−4.5		−6.7		−6.1	
Maximum channel power difference	dB	4.1		4.2		4.5	
Maximum multi-path interference penalty allowance (Note 3)	dB	0.4	0.3	0.6	0.4	0.3	0.6
Minimum equivalent sensitivity (OMA_{outer} minus SECQ)	dBm	−6.2		−8.6		−8	
Maximum reflectance of optical network element	dB	−26		−26		−26	

NOTE 1 – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-13}.

NOTE 2 – As the Maximum mean total output power limit has to be met, not all of the lanes can operate at the Maximum mean channel output power.

NOTE 3 – The parameters for these applications allow two options for the transmitter (shown via a split in the column) with different values for minimum and maximum channel extinction ratio and minimum channel OMA_{outer} minus TDECQ. The two sets of transmitter parameter values provide different values for the maximum multi-path interference penalty allowance for the same physical receiver as indicated by the split values for this parameter. The transmitter must meet the specifications in one of the two columns and the receiver must meet the specifications in both columns.

8.2 Single-channel IrDI

The physical layer parameters and values for single-channel inter-domain interfaces are given in Tables 8-7 to 8-18.

Table 8-7 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 2.5G intra-office and short-haul applications

Parameter	Units	P1I1-1D1	P1S1-1D1	P1S1-1D2
General information		Note	Note	Note
Maximum number of channels	–	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 2.5G	NRZ 2.5G	NRZ 2.5G
Maximum bit error ratio	–	10^{-12}	10^{-12}	10^{-12}
Fibre type	–	ITU-T G.652	ITU-T G.652	ITU-T G.652
Interface at point MPI-S				
Operating wavelength range	nm	1 266–1 360	1 260–1 360	1 530–1 565
Source type		MLM	SLM	SLM
Maximum RMS width (σ)	nm	3.4	NA	NA
Maximum –20 dB width	nm	NA	1	< 1
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	NA	30	30

Table 8-7 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 2.5G intra-office and short-haul applications

Parameter	Units	P1I1-1D1	P1S1-1D1	P1S1-1D2
Maximum mean output power	dBm	–3	0	0
Minimum mean output power	dBm	–10	–5	–5
Minimum extinction ratio	dB	8.2	8.2	8.2
Eye mask	–	NRZ 2.5G	NRZ 2.5G	NRZ 2.5G
Optical path from point MPI-S to MPI-R				
Maximum attenuation	dB	6	11	11
Minimum attenuation	dB	0	0	0
Maximum chromatic dispersion at upper wavelength limit	ps/nm	±12	±140	800
Maximum chromatic dispersion at lower wavelength limit	ps/nm	±12	±140	715
Minimum optical return loss at MPI-S	dB	14	14	14
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Maximum differential group delay	ps	120	120	120
Interface at point MPI-R				
Maximum mean input power	dBm	–3	0	0
Minimum sensitivity	dBm	–17	–17	–17
Maximum optical path penalty	dB	1	1	1
Maximum reflectance of optical network element	dB	–14	–14	–14
NOTE – Parameter values for these application codes are largely based on [ITU-T G.957].				

Table 8-8 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 2.5G long-haul applications

Parameter	Units	P1L1-1D1	P1L1-1D2	1L1-1D2F
General information		Note 1	Note 1	
Maximum number of channels	–	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 2.5G	NRZ 2.5G	NRZ OTU1 FEC enabled
Maximum bit error ratio	–	10^{-12}	10^{-12}	10^{-12} (Note 2)
Fibre type	–	ITU-T G.652	ITU-T G.652	ITU-T G.652
Interface at point MPI-S				
Operating wavelength range	nm	1 280–1 335	1 530–1 565	1 530–1 565
Source type		SLM	SLM	SLM
Maximum RMS width (σ)	nm	NA	NA	NA
Maximum –20 dB width	nm	1	1	1

Table 8-8 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 2.5G long-haul applications

Parameter	Units	P1L1-1D1	P1L1-1D2	1L1-1D2F
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	30	30	30
Maximum mean output power	dBm	+3	+3	+3
Minimum mean output power	dBm	–2	–2	–2
Minimum extinction ratio	dB	8.2	8.2	8.2
Eye mask	–	NRZ 2.5G	NRZ 2.5G	NRZ 2.5G
Optical path from point MPI-S to MPI-R				
Maximum attenuation	dB	22	22	24
Minimum attenuation	dB	12	12	12
Maximum chromatic dispersion at upper wavelength limit	ps/nm	±180	1 600	1 600
Maximum chromatic dispersion at lower wavelength limit	ps/nm	±180	1430	1430
Minimum optical return loss at MPI-S	dB	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Maximum differential group delay	ps	120	120	120
Interface at point MPI-R				
Maximum mean input power	dBm	–9	–9	–9
Minimum sensitivity	dBm	–25	–26	–28
Maximum optical path penalty	dB	1	2	2
Maximum reflectance of optical network element	dB	–27	–27	–27
NOTE 1 – Parameter values for these application codes are largely based on [ITU-T G.957]. NOTE 2 – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}.				

Table 8-9 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 2.5G ultra-long-haul applications

Parameter	Units	P1U1-1A2	P1U1-1A3	P1U1-1A5	1U1-1B2F 1U1-1B5F	1U1-1B3F
[ITU-T G.691] application code		U-16.2	U-16.3	–	–	–
General information		(Note 1)	(Note 1)			
Maximum number of channels	–	1	1	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 2.5G	NRZ 2.5G	NRZ 2.5G	NRZ OTU1 FEC enabled	NRZ OTU1 FEC enabled
Maximum bit error ratio	–	10^{-12}	10^{-12}	10^{-12}	10^{-12} (Note 2)	10^{-12} (Note 2)
Fibre type	–	ITU-T G.652	ITU-T G.653	ITU-T G.655	ITU-T G.652, ITU-T G.655	ITU-T G.653
Interface at point MPI-S						
Operating wavelength range	nm	1 530–1 565	1 530–1 565	1 530–1 565	1 530–1 565	1 530–1 565
Source type		SLM	SLM	SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	30	30	30	30	30
Maximum mean output power	dBm	+15	+15	+15	+18	+18
Minimum mean output power	dBm	+12	+12	+12	+15	+15
Minimum extinction ratio	dB	8.2	8.2	8.2	8.2	8.2
Eye mask	–	NRZ 2.5G	NRZ 2.5G	NRZ 2.5G	NRZ 2.5G	NRZ 2.5G
Optical path from point MPI-S to MPI-R						
Maximum attenuation	dB	44	44	44	44	44
Minimum attenuation	dB	33	33	33	27	27

Table 8-9 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 2.5G ultra-long-haul applications

Parameter	Units	P1U1-1A2	P1U1-1A3	P1U1-1A5	1U1-1B2F 1U1-1B5F	1U1-1B3F
Maximum chromatic dispersion at upper wavelength limit	ps/nm	3 200	±550	1 700	3 200 ITU-T G.652, 1 700 ITU-T G.655	±550 (Note 3)
Maximum chromatic dispersion at lower wavelength limit	ps/nm	2 860	±550	1 390	2 860 ITU-T G.652, 1390 ITU-T G.655	±550 (Note 3)
Minimum optical return loss at MPI-S	dB	24	24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27	–27	–27
Maximum differential group delay	ps	120	120	120	120	120
Interface at point MPI-R						
Maximum mean input power	dBm	–18	–18	–18	–9	–9
Minimum sensitivity	dBm	–34	–33	–34	–31	–30
Maximum optical path penalty	dB	2	1	2	2	1
Maximum reflectance of optical network element	dB	–27	–27	–27	–27	–27

NOTE 1 – Parameter values for these application codes are largely based on [ITU-T G.691].

NOTE 2 – The BER for this application code is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}.

NOTE 3 – For ITU-T G.653 fibre, some combinations of transmitter wavelength and fibre zero dispersion wavelength can result in negative link dispersion. Adequate operation in this regime has not been verified at the power levels required for this application. In this situation, joint engineering may be necessary between the link provider and the system vendor to avoid this condition.

Table 8-10 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G intra-office applications

Parameter	Units	P1I1-2D2	P1I1-2D3	P1I1-2D5
ITU-T G.691 application code		I-64.2	I-64.3	I-64.5
General information				
Maximum number of channels	–	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ 10G	NRZ 10G
Maximum bit error ratio	–	10^{-12}	10^{-12}	10^{-12}
Fibre type	–	ITU-T G.652	ITU-T G.653	ITU-T G.655
Interface at point MPI-S				
Operating wavelength range	nm	1 500–1 565	1 500–1 565	1 500–1 565
Source type		SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	30	30	30
Maximum mean output power	dBm	–1	–1	–1
Minimum mean output power	dBm	–5	–5	–5
Minimum extinction ratio	dB	8.2	8.2	8.2
Eye mask	–	NRZ 10G 1 550 nm region	NRZ 10G 1 550 nm region	NRZ 10G 1 550 nm region
Optical path from point MPI-S to MPI-R				
Maximum attenuation	dB	7	7	7
Minimum attenuation	dB	0	0	0
Maximum chromatic dispersion at upper wavelength limit	ps/nm	500	±150	270
Maximum chromatic dispersion at lower wavelength limit	ps/nm	400	±150	180
Minimum optical return loss at MPI-S	dB	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Maximum differential group delay	ps	30	30	30
Interface at point MPI-R				
Maximum mean input power	dBm	–1	–1	–1
Minimum sensitivity	dBm	–14	–13	–13
Maximum optical path penalty	dB	2	1	1
Maximum reflectance of optical network element	dB	–27	–27	–27

Table 8-11 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications for ITU-T G.652 fibre

Parameter	Units	P1S1-2D1	P1S1-2D2a	P1S1-2D2b	1S1-2D2bF
ITU-T G.691 application code (Note 1)		S-64.1	S-64.2a	S-64.2b	
General information					
Maximum number of channels	–	1	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ 10G	NRZ 10G	NRZ OTU2 FEC enabled
Maximum bit error ratio	–	10^{-12}	10^{-12}	10^{-12}	10^{-12} (Note 2)
Fibre type	–	ITU-T G.652	ITU-T G.652	ITU-T G.652	ITU-T G.652
Interface at point MPI-S					
Operating wavelength range	nm	1 290–1 330	1 530–1 565	1 530–1 565	1 530–1 565
Source type	–		SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	30	30	30	30
Maximum mean output power	dBm	+5	–1	+2	+2
Minimum mean output power	dBm	+1	–5	–1	–2
Minimum extinction ratio	dB	6	8.2	8.2	8.2
Eye mask	–	NRZ 10G 1 310 nm region	NRZ 10G 1 550 nm region	NRZ 10G 1 550 nm region	NRZ 10G 1 550 nm region
Optical path from point MPI-S to MPI-R					
Maximum attenuation	dB	11	11	11	12
Minimum attenuation	dB	6	7	3	3
Maximum chromatic dispersion at upper wavelength limit	ps/nm	±70	800	800	800
Maximum chromatic dispersion at lower wavelength limit	ps/nm	±70	720	720	720
Minimum optical return loss at MPI-S	dB	14	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27	–27
Maximum differential group delay	ps	30	30	30	30
Interface at point MPI-R					
Maximum mean input power	dBm	–1	–8	–1	–1

Table 8-11 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications for ITU-T G.652 fibre

Parameter	Units	P1S1-2D1	P1S1-2D2a	P1S1-2D2b	1S1-2D2bF
Minimum sensitivity	dBm	–11	–18	–14	–16
Maximum optical path penalty	dB	1	2	2	2
Maximum reflectance of optical network element	dB	–14	–27	–27	–27
NOTE 1 – Application codes with a suffix "a" have transmitter power levels appropriate to APD receivers; application codes with the suffix "b" have transmitter power levels appropriate to PIN receivers. NOTE 2 – The BER for this application code is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than $10^{–12}$.					

Table 8-12 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications for ITU-T G.653 and ITU-T G.655 fibres

Parameter	Units	P1S1-2D3a P1S1-2D5a	P1S1-2D3b P1S1-2D5b	1S1-2D3bF 1S1-2D5bF
ITU-T G.691 application code (Note 1)		S-64.3a S-64.5a	S-64.3b S-64.5b	
General information				
Maximum number of channels	–	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ 10G	NRZ OTU2 FEC enabled
Maximum bit error ratio	–	$10^{–12}$	$10^{–12}$	$10^{–12}$ (Note 2)
Fibre type	–	ITU-T G.653, ITU-T G.655	ITU-T G.653, ITU-T G.655	ITU-T G.653, ITU-T G.655
Interface at point MPI-S				
Operating wavelength range	nm	1 530–1 565	1 530–1 565	1 530–1 565
Source type	–	SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	30	30	30
Maximum mean output power	dBm	–1	+2	+2
Minimum mean output power	dBm	–5	–1	–2
Minimum extinction ratio	dB	8.2	8.2	8.2
Eye mask	–	NRZ 10G 1 550 nm region	NRZ 10G 1 550 nm region	NRZ 10G 1 550 nm region

Table 8-12 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications for ITU-T G.653 and ITU-T G.655 fibres

Parameter	Units	P1S1-2D3a P1S1-2D5a	P1S1-2D3b P1S1-2D5b	1S1-2D3bF 1S1-2D5bF
Optical path from point MPI-S to MPI-R				
Maximum attenuation	dB	11	11	12
Minimum attenuation	dB	7	3	3
Maximum chromatic dispersion at upper wavelength limit	ps/nm	±140 ITU-T G.653, 430 ITU-T G.655	±140 ITU-T G.653, 430 ITU-T G.655	±140 ITU-T G.653, 430 ITU-T G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	±140 ITU-T G.653, 350 ITU-T G.655	±140 ITU-T G.653, 350 ITU-T G.655	±140 ITU-T G.653, 350 ITU-T G.655
Minimum optical return loss at MPI-S	dB	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Maximum differential group delay	ps	30	30	30
Interface at point MPI-R				
Maximum mean input power	dBm	–8	–1	–1
Minimum sensitivity	dBm	–17	–13	–15
Maximum optical path penalty	dB	1	1	1
Maximum reflectance of optical network element	dB	–27	–27	–27

NOTE 1 – Application codes with a suffix "a" have transmitter power levels appropriate to APD receivers; application codes with the suffix "b" have transmitter power levels appropriate to PIN receivers.

NOTE 2 – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}.

Table 8-13 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G long-haul applications

Parameter	Units	P1L1-2D1	P1L1-2D2	1L1-2D2F
ITU-T G.691 application code		L-64.1	–	–
General information				
Maximum number of channels	–	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ 10G	NRZ OTU2 FEC enabled
Maximum bit error ratio	–	10^{-12}	10^{-12}	10^{-12} (Note)
Fibre type	–	ITU-T G.652	ITU-T G.652	ITU-T G.652

Table 8-13 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G long-haul applications

Parameter	Units	P1L1-2D1	P1L1-2D2	1L1-2D2F
Interface at point MPI-S				
Operating wavelength range	nm	1 290–1 320	1 530–1 565	1 530–1 565
Source type	–	SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	30	30	30
Maximum mean output power	dBm	+7	+4	+4
Minimum mean output power	dBm	+3	0	–1
Minimum extinction ratio	dB	6	9	8.2
Eye mask	–	NRZ 10G 1 310 nm region	NRZ 10G 1 550 nm region	NRZ 10G 1 550 nm region
Optical path from point MPI-S to MPI-R				
Maximum attenuation	dB	22	22	22
Minimum attenuation	dB	16	11	11
Maximum chromatic dispersion at upper wavelength limit	ps/nm	±140	1 600	1 600
Maximum chromatic dispersion at lower wavelength limit	ps/nm	±140	1 430	1 430
Minimum optical return loss at MPI-S	dB	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Maximum differential group delay	ps	30	30	30
Interface at point MPI-R				
Maximum mean input power	dBm	–9	–7	–7
Minimum sensitivity	dBm	–20	–24	–25
Maximum optical path penalty	dB	1	2	2
Maximum reflectance of optical network element	dB	–27	–27	–27
NOTE – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}.				

Table 8-14 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G very long-haul applications

Parameter	Units	P1V1-2C2	1V1-2C2F	P1V1-2B5	1V1-2B5F
General information					
Maximum number of channels	–	1	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ OTU2 FEC enabled	NRZ 10G	NRZ OTU2 FEC enabled
Maximum bit error ratio	–	10^{-12}	10^{-12} (Note 1)	10^{-12}	10^{-12} (Note 1)
Fibre type	–	ITU-T G.652	ITU-T G.652	ITU-T G.655	ITU-T G.655
Interface at point MPI-S					
Operating wavelength range	nm	–	–	1 530–1 565	1 530–1 565
Central frequency	THz	192.1	192.1	–	–
Maximum spectral excursion	GHz	40	40	–	–
Source type	–	SLM	SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	30	30	30	30
Maximum mean output power	dBm	+7	+7	+13	+13
Minimum mean output power	dBm	+4	+3	+10	+10
Minimum extinction ratio	dB	9 (Note 2)	9 (Note 2)	9	8.2
Eye mask	–	NRZ 10G amplified	NRZ 10G amplified	NRZ 10G 1 550 nm region	NRZ 10G 1 550 nm region
Optical path from point MPI-S to MPI-R					
Maximum attenuation	dB	33	33	33	33
Minimum attenuation	dB	21	21	20	20
Maximum chromatic dispersion at upper wavelength limit	ps/nm	2 400	2 400	1 280	1 280
Maximum chromatic dispersion at lower wavelength limit	ps/nm	2 400	2 400	1 050	1 050
Minimum optical return loss at MPI-S	dB	24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27	–27
Maximum differential group delay	ps	30	30	30	30
Interface at point MPI-R					
Maximum mean input power	dBm	–14	–14	–7	–7
Minimum sensitivity	dBm	–30	–31	–24	–24

Table 8-14 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G very long-haul applications

Parameter	Units	P1V1-2C2	1V1-2C2F	P1V1-2B5	1V1-2B5F
Maximum optical path penalty	dB	1	1	1	1
Maximum reflectance of optical network element	dB	–27	–27	–27	–27
NOTE 1 – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}. NOTE 2 – The extinction ratio of these application codes is not required to be met in the presence of a fourth-order Bessel-Thompson filter.					

Table 8-15 – Single-channel IrDI parameters for optical tributary signal class NRZ 10G long- and very long-haul applications using electronic dispersion compensation

Parameter	Units	P1L1-2D2E	1L1-2D2FE	P1V1-2B2E	1V1-2B2FE
General information		(Note 1)	(Note 1)	(Note 1)	(Note 1)
Maximum number of channels	–	1	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ OTU2 FEC enabled	NRZ 10G	NRZ OTU2 FEC enabled
Maximum bit error ratio	–	10^{-12}	10^{-12} (Note 2)	10^{-12}	10^{-12} (Note 2)
Fibre type	–	ITU-T G.652	ITU-T G.652	ITU-T G.652	ITU-T G.652
Interface at point MPI-S					
Operating wavelength range	nm	FFS	FFS	FFS	FFS
Source type	–	SLM	SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	FFS	FFS	FFS	FFS
Maximum mean output power	dBm	FFS	FFS	FFS	FFS
Minimum mean output power	dBm	FFS	FFS	FFS	FFS
Minimum extinction ratio	dB	FFS	FFS	FFS	FFS
Eye mask	–	FFS	FFS	FFS	FFS
Optical path from point MPI-S to MPI-R					
Maximum attenuation	dB	22	22	33	33
Minimum attenuation	dB	FFS	FFS	FFS	FFS

Table 8-15 – Single-channel IrDI parameters for optical tributary signal class NRZ 10G long- and very long-haul applications using electronic dispersion compensation

Parameter	Units	P1L1-2D2E	1L1-2D2FE	P1V1-2B2E	1V1-2B2FE
Maximum chromatic dispersion at upper wavelength limit	ps/nm	FFS	FFS	FFS	FFS
Maximum chromatic dispersion at lower wavelength limit	ps/nm	FFS	FFS	FFS	FFS
Minimum optical return loss at MPI-S	dB	FFS	FFS	FFS	FFS
Maximum discrete reflectance between MPI-S and MPI-R	dB	FFS	FFS	FFS	FFS
Maximum differential group delay	ps	30	30	30	30
Interface at point MPI-R					
Maximum mean input power	dBm	FFS	FFS	FFS	FFS
Minimum sensitivity	dBm	FFS	FFS	FFS	FFS
Maximum optical path penalty	dB	FFS	FFS	FFS	FFS
Maximum reflectance of optical network element	dB	FFS	FFS	FFS	FFS
NOTE 1 – These application codes require an additional parameter to ensure that the transmitter spectral characteristics are adequate. This parameter is under study. An initial set of values for the parameters above can be found in Appendix VII. NOTE 2 – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}.					

Table 8-16 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 40G intra-office applications

Parameter	Units	P1I1-3D1	1I1-3D1F	P1I1-3D3	P1I1-3D5
General information					
Maximum number of channels	–	1	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 40G	NRZ OTU3 FEC enabled	NRZ 40G	NRZ 40G
Maximum bit error ratio	–	10–12	10–12 (Note 1)	10–12	10–12
Fibre type	–	ITU-T G.652	ITU-T G.652	ITU-T G.653	ITU-T G.655.D (Note 2)
Interface at point MPI-S					
Operating wavelength range	nm	1 307–1 317	1 307–1 317	1 530–1 565	1 530–1 565

Table 8-16 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 40G intra-office applications

Parameter	Units	P1I1-3D1	1I1-3D1F	P1I1-3D3	P1I1-3D5
Source type	–	SLM	SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	35	35	35	35
Maximum mean output power	dBm	+4	+4	+3	+3
Minimum mean output power	dBm	0	0	0	0
Minimum extinction ratio	dB	8.2	8.2	8.2	8.2
Eye mask	–	NRZ 40G	NRZ 40G	NRZ 40G	NRZ 40G
Optical path from point MPI-S to MPI-R					
Maximum attenuation	dB	6	6	5	4
Minimum attenuation	dB	0	0	0	0
Maximum chromatic dispersion at upper wavelength limit	ps/nm	±16	±16	±33	33
Maximum chromatic dispersion at lower wavelength limit	ps/nm	±16	±16	±33	33
Minimum optical return loss at MPI-S	dB	24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27	–27
Maximum differential group delay	ps	7.5	7.5	7.5	7.5
Interface at point MPI-R					
Maximum mean input power	dBm	+4	+4	+3	+3
Minimum sensitivity	dBm	–7	–7	–7	–6
Maximum optical path penalty	dB	1	1	2	2
Maximum reflectance of optical network element	dB	–27	–27	–27	–27
NOTE 1 – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}. NOTE 2 – If ITU-T G.655.E fibre is used then the target distance is reduced.					

Table 8-17 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 40G short and long-haul applications in the 1 300 nm region

Parameter	Units	P1S1-3D1	1S1-3D1F	P1L1-3C1	1L1-3C1F
General information					
Maximum number of channels	–	1	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 40G	NRZ OTU3 FEC enabled	NRZ 40G	NRZ OTU3 FEC enabled
Maximum bit error ratio	–	10^{-12}	10^{-12} (Note)	10^{-12}	10^{-12} (Note)
Fibre type	–	ITU-T G.652	ITU-T G.652	ITU-T G.652	ITU-T G.652
Interface at point MPI-S					
Operating wavelength range	nm	1 310–1 314	1 310–1 314	1 310–1 314	1 310–1 314
Source type	–	SLM	SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	35	35	35	35
Maximum mean output power	dBm	+7	+4	+7	+4
Minimum mean output power	dBm	+4	+1	+4	+1
Minimum extinction ratio	dB	8.2	8.2	8.2	8.2
Eye mask	–	NRZ 40G	NRZ 40G	NRZ 40G	NRZ 40G
Optical path from point MPI-S to MPI-R					
Maximum attenuation	dB	10.5	10.5	20	20
Minimum attenuation	dB	3	0	9	6
Maximum chromatic dispersion at upper wavelength limit	ps/nm	±27	±27	±53	±53
Maximum chromatic dispersion at lower wavelength limit	ps/nm	±27	±27	±53	±53
Minimum optical return loss at MPI-S	dB	24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27	–27
Maximum differential group delay	ps	7.5	7.5	7.5	7.5
Interface at point MPI-R					
Maximum mean input power	dBm	+4	+4	–2	–2
Minimum sensitivity	dBm	–7.5	–10.5	–18	–21
Maximum optical path penalty	dB	1	1	2	2
Maximum reflectance of optical network element	dB	–27	–27	–27	–27
NOTE – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10^{-12}.					

Table 8-18 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 40G short and long-haul applications in the 1 550 nm region

Parameter	Units	P1S1-3C2 P1S1-3C3 P1S1-3C5	P1L1-3A2 P1L1-3A3 P1L1-3A5	1L1-3C2FD 1L1-3C3FD 1L1-3C5FD	1L1-3C2F 1L1-3C3F 1L1-3C5F
General information					
Maximum number of channels	–	1	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 40G	NRZ 40G	NRZ OTU3 FEC enabled	NRZ OTU3 FEC enabled
Maximum bit error ratio	–	10–12	10–12	10–12 (Note 3)	10–12 (Note 3)
Fibre type	–	ITU-T G.652, ITU-T G.653, ITU-T G.655	ITU-T G.652, ITU-T G.653, ITU-T G.655	ITU-T G.652, ITU-T G.653, ITU-T G.655	ITU-T G.652, ITU-T G.653, ITU-T G.655
Interface at point MPI-S					
Central frequency	THz	192.1	192.1	192.1	192.1
Maximum spectral excursion	GHz	40	40	40	40
Source type	–	SLM	SLM	SLM	SLM
Maximum spectral power density	mW/ 10 MHz	FFS	FFS	FFS	FFS
Minimum side mode suppression ratio	dB	35	35	35	35
Maximum mean output power	dBm	+3	+8	+5	+5
Minimum mean output power	dBm	–3	+5	+2	+2
Minimum extinction ratio	dB	8.2	10	10	10
Eye mask	–	NRZ 40G	NRZ 40G	NRZ 40G	NRZ 40G
Optical path from point MPI-S to MPI-R					
Maximum attenuation	dB	11	22	22	22
Minimum attenuation	dB	0	11	11	11
Maximum chromatic dispersion at upper wavelength limit	ps/nm	800 for ITU-T G.652, ±120 for ITU-T G.653, 420 for ITU-T G.655	1 600 for ITU-T G.652, ±240 for ITU-T G.653, 840 for ITU-T G.655	1 600 for ITU-T G.652, ±240 for ITU-T G.653, 840 for ITU-T G.655	1 600 for ITU-T G.652, ±240 for ITU-T G.653, 840 for ITU-T G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	800 for ITU-T G.652, ±120 for ITU-T G.653, 420 for ITU-T G.655	1 600 for ITU-T G.652, ±240 for ITU-T G.653, 840 for ITU-T G.655	1 600 for ITU-T G.652, ±240 for ITU-T G.653, 840 for ITU-T G.655	1 600 for ITU-T G.652, ±240 for ITU-T G.653, 840 for ITU-T G.655

Table 8-18 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 40G short and long-haul applications in the 1 550 nm region

Parameter	Units	P1S1-3C2 P1S1-3C3 P1S1-3C5	P1L1-3A2 P1L1-3A3 P1L1-3A5	1L1-3C2FD 1L1-3C3FD 1L1-3C5FD	1L1-3C2F 1L1-3C3F 1L1-3C5F
Maximum chromatic dispersion deviation	ps/nm	(Note 2)	(Note 2)	±80	(Note 2)
Minimum optical return loss at MPI-S	dB	24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	−27	−27	−27	−27
Maximum differential group delay	ps	7.5 (Note 1)	7.5 (Note 1)	7.5 (Note 1)	7.5 (Note 1)
Interface at point MPI-R					
Maximum mean input power	dBm	+3	−3	−6	−6
Minimum sensitivity	dBm	−17	−20	−22	−23
Maximum optical path penalty	dB	3	3	2	3
Maximum reflectance of optical network element	dB	−27	−27	−27	−27
NOTE 1 – Some categories of ITU-T G.652, ITU-T G.653 and ITU-T G.655 fibre have too high a PMD coefficient to guarantee this value of DGD. NOTE 2 – This value must be agreed by joint engineering between the link provider and the system vendor. NOTE 3 – The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than 10−12.					

9 Optical safety considerations

See [ITU-T G.664] for optical safety considerations.

NOTE – For the optical power levels specified in this version of this Recommendation, automatic power reduction (APR) is not necessary according to [ITU-T G.664], [IEC 60825-1] and [IEC 60825-2]. Future versions of this Recommendation may, however, contain power levels exceeding the safe levels. In this case, for non-OTN applications, the ALS procedure defined in [ITU-T G.664] shall be applied on individual synchronous digital hierarchy (SDH) client signal interfaces only.

10 Power level management

For further study.

The average value of the random dispersion penalties due to PMD is included in the allowed path penalty. In this respect, the transmitter/receiver combination is required to tolerate an actual DGD of 0.3 bit period with a maximum sensitivity degradation of 1 dB (with 50% of optical power in each principal state of polarization). For a well-designed receiver, this corresponds to a penalty of 0.1-0.2 dB for a DGD of 0.1 bit period. The actual DGD that may be encountered in operation is a randomly varying fibre/cable property, and cannot be specified in this Recommendation. This subject is further discussed in Appendix I of [ITU-T G.691].

Any additional sensitivity degradation due to optical crosstalk (e.g., caused by non-ideal switching) is assumed to be small enough to be included within the path penalty value. Cases where this is not true are for further study. Optical crosstalk penalty is further discussed in Appendix I.

7 Optical parameter values

Optical parameter values for applications shown in Tables 1 and 2 are given in Tables 3 to 6. Except for application codes requiring FEC bytes to be transmitted (i.e., having a code with a suffix of F), systems which comply with these values should not require forward error correction in order to satisfy BER objectives. In the case of application codes requiring FEC bytes to be transmitted, the BER is required to be met only after the correction (if used) has been applied.

Tables 3 to 6 include columns in which more than one application code is shown in the heading. Where the row entries in these columns contain a single value, it applies to all of the application codes. Where the row contains multiple entries, the values apply to the application codes in the same order as they appear in the column heading.

For those applications which were previously specified in [ITU-T G.691] or [ITU-T G.959.1], any differences between ITU-T G.693 parameter values and the values in the superseded [ITU-T G.691] and [ITU-T G.959.1] application codes are given in Appendix III.

Table 3 – Optical interface parameters specified for applications with 0.6 km target distance

Application code	Unit	VSR600-2R1	VSR600-2M1	VSR600-2M2 VSR600-2M3 VSR600-2M5
ITU-T G.691 application code		I-64.1r		
ITU-T G.959.1 application code		P1I1-2D1r		
Target distance	m	600	600	600
Bit rate/line coding of optical signals	–	NRZ 10G	NRZ 10G	NRZ 10G
Fibre type	–	G.652	G.652	G.652 G.653 G.655
Transmitter at reference point MPI-S				
Source type		MLM	MLM	SLM
Operating wavelength range	nm	1268-1360	1268-1360	1530-1565
Maximum mean output power	dBm	–1	+5	+2
Minimum mean output power	dBm	–6	+2	–1
Spectral characteristics:				
– maximum RMS width (σ)	nm	3	3	NA
– maximum –20 dB width	nm	NA	NA	ffs
– minimum SMSR	dB	NA	NA	30

Table 3 – Optical interface parameters specified for applications with 0.6 km target distance

Application code	Unit	VSR600-2R1	VSR600-2M1	VSR600-2M2 VSR600-2M3 VSR600-2M5
Minimum EX	dB	6	6	8.2
Main optical path, MPI-S to MPI-R				
Maximum attenuation	dB	4	12	12
Minimum attenuation	dB	0	6[a)]	3[a)]
Maximum chromatic dispersion at upper wavelength limit[b)]	ps/nm	±3.4	±3.4	11.3 for G.652[c)] ±2 for G.653 +6.1 for G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	±3.4	±3.4	10.1 for G.652[c)] ±2 for G.653 +5.0 for G.655
Maximum DGD	ps	30	30	30
Minimum ORL of cable plant at MPI-S, including any connectors	dB	14	14	14
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Polarization-dependent loss	dB	ffs	ffs	ffs
Receiver at reference point MPI-R				
Minimum sensitivity (BER of 1×10^{-12})	dBm	–11	–11	–14
Minimum overload	dBm	–1	–1	–1
Maximum optical path penalty	dB	1	1	1
Maximum reflectance of receiver, measured at MPI-R	dB	–14	–14	–14

a) This value of minimum attenuation is highly undesirable. A value of 0 dB is desired and should be sought as technology matures.

b) In the case that passive optical devices in the main optical path introduce additional chromatic dispersion, the achievable link distance may be reduced. Alternatively, an application with a higher chromatic dispersion tolerance may be used to overcome this restriction.

c) This application can also be used on ITU-T G.653 and ITU-T G.655 fibre.

Table 4 – Optical interface parameters specified for applications with 2 km target distance and attenuation category R

Application code	Unit	VSR2000-2R1	VSR2000-3R1[d)]	VSR2000-3R1F[d, f)]	VSR2000-3R2[e)] VSR2000-3R3[d)] VSR2000-3R5[d)]	VSR2000-3R2F[e, f)] VSR2000-3R3F[d, f)] VSR2000-3R5F[d, f)]
ITU-T G.691 application code		I-64.1				
ITU-T G.959.1 application code		P1I1-2D1				
Target distance	km	2	2	2	2	2
Bit rate/line coding of optical signals	–	NRZ 10G	NRZ 40G	NRZ OTU3 FEC enabled	NRZ 40G	NRZ OTU3 FEC enabled
Fibre type	–	G.652	G.652	G.652	G.652 G.653 G.655	G.652 G.653 G.655
Transmitter at reference point MPI-S						
Source type		SLM	SLM	SLM	SLM	SLM
Operating wavelength range	nm	1290-1330	1290-1330	1290-1330	1530-1565	1530-1565
Maximum mean output power	dBm	–1	+3	+3	+3	+3
Minimum mean output power	dBm	–6	0	0	0	0
Spectral characteristics:						
– maximum RMS width (σ)	nm	NA	NA	NA	NA	NA
– maximum –20 dB width	nm	1	ffs	ffs	ffs	ffs
– minimum SMSR	dB	30	35	35	35	35
Minimum EX	dB	6	8.2	8.2	8.2	8.2

Table 4 – Optical interface parameters specified for applications with 2 km target distance and attenuation category R

Application code	Unit	VSR2000-2R1	VSR2000-3R1[d)]	VSR2000-3R1F[d, f)]	VSR2000-3R2[e)] VSR2000-3R3[d)] VSR2000-3R5[d)]	VSR2000-3R2F[e, f)] VSR2000-3R3F[d, f)] VSR2000-3R5F[d, f)]
Main optical path, MPI-S to MPI-R						
Maximum attenuation	dB	4	4	4	4	4
Minimum attenuation	dB	0	0	0	0	0
Maximum chromatic dispersion at upper wavelength limit[a)]	ps/nm	–6.6 to +5.3	–6.6 to +5.3	–6.6 to +5.3	+38 for G.652[b)] –6.6 to +6.1 for G.653 +20.3 for G.655	+38 for G.652[b)] –6.6 to +6.1 for G.653 +20.3 for G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	–6.6 to +5.3	–6.6 to +5.3	–6.6 to +5.3	+34 for G.652[b)] –6.6 to +6.1 for G.653 +16.6 for G.655	+34 for G.652[b)] –6.6 to +6.1 for G.653 +16.6 for G.655
Maximum DGD	ps	30	7.5	7.5	7.5	7.5
Minimum ORL of cable plant at MPI-S, including any connectors	dB	14	24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27	–27	–27
Polarization-dependent loss	dB	ffs	ffs	ffs	ffs	ffs

Table 4 – Optical interface parameters specified for applications with 2 km target distance and attenuation category R

Application code	Unit	VSR2000-2R1	VSR2000-3R1[d)]	VSR2000-3R1F[d, f)]	VSR2000-3R2[e)] VSR2000-3R3[d)] VSR2000-3R5[d)]	VSR2000-3R2F[e, f)] VSR2000-3R3F[d, f)] VSR2000-3R5F[d, f)]
Receiver at reference point MPI-R						
Minimum sensitivity (BER of 1×10^{-12})	dBm	–11	–5	–5	–6 for G.652 –5 for G.653 –5 for G.655	–6 for G.652 –5 for G.653 –5 for G.655
Minimum overload	dBm	–1	+3	+3	+3	+3
Maximum optical path penalty	dB	1	1[c)]	1[c)]	2[c)] for G.652 1[c)] for G.653 1[c)] for G.655	2[c)] for G.652 1[c)] for G.653 1[c)] for G.655
Maximum reflectance of receiver, measured at MPI-R	dB	–14	–27	–27	–27	–27

a) In the case that passive optical devices in the main optical path introduce additional chromatic dispersion, the achievable link distance may be reduced. Alternatively, an application with a higher chromatic dispersion tolerance may be used to overcome this restriction.

b) This application can also be used on ITU-T G.653 and ITU-T G.655 fibre.

c) The method used to verify this penalty is for further study.

d) A receiver in compliance with this application is required to operate in any of the application codes VSR2000-3R1, VSR2000-3R3 or VSR2000-3R5. It shall, as a minimum, operate over the wavelength range of 1290-1330 nm as well as the range 1530-1565 nm.

e) A receiver in compliance with application VSR2000-3R2 will operate in either of the application codes VSR2000-3R3 or VSR2000-3R5. It will also operate in the application code VSR2000-3R1 if its operating wavelength range includes 1290-1330 nm.

f) The BER for this application is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can, therefore, be significantly higher than 10^{-12}.

Table 5 – Optical interface parameters specified for applications with 2 km target distance and attenuation category L

Application code	Unit	VSR2000-2L1F[f)]	VSR2000-2L2 VSR2000-2L3 VSR2000-2L5	VSR2000-3L1F[d, f)]	VSR2000-3L2F[e, f)] VSR2000-3L3F[d, f)] VSR2000-3L5F[d, f)]
ITU-T G.691 application code			I-64.2r		
ITU-T G.959.1 application code			P1I1-2D2r		
Target distance	km	2	2	2	2
Bit rate/line coding of optical signals	–	NRZ OTU2 FEC enabled	NRZ 10G	NRZ OTU3 FEC enabled	NRZ OTU3 FEC enabled
Fibre type	–	G.652	G.652 G.653 G.655	G.652	G.652 G.653 G.655
Transmitter at reference point MPI-S					
Source type		SLM	SLM	SLM	SLM
Operating wavelength range	nm	1290-1330	1530-1565	1290-1330	1530-1565
Maximum mean output power	dBm	–1	–1	+3	+3
Minimum mean output power	dBm	–6	–5	0	0
Spectral characteristics:					
– maximum RMS width (σ)	nm	NA	NA	NA	NA
– maximum –20 dB width	nm	1	ffs	ffs	ffs
– minimum SMSR	dB	30	30	35	35
Minimum EX	dB	6	8.2	8.2	8.2

Table 5 – Optical interface parameters specified for applications with 2 km target distance and attenuation category L

Application code	Unit	VSR2000-2L1F[f)]	VSR2000-2L2 VSR2000-2L3 VSR2000-2L5	VSR2000-3L1F[d, f)]	VSR2000-3L2F[e, f)] VSR2000-3L3F[d, f)] VSR2000-3L5F[d, f)]
Main optical path, MPI-S to MPI-R					
Maximum attenuation	dB	6	6	6	6
Minimum attenuation	dB	0	0	0	0
Maximum chromatic dispersion at upper wavelength limit[a)]	ps/nm	–6.6 to +5.3	+38 for G.652[b)] –6.6 to +6.1 for G.653 +20.3 for G.655	–6.6 to +5.3	+38 for G.652[b)] –6.6 to +6.1 for G.653 +20.3 for G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	–6.6 to +5.3	+34 for G.652[b)] –6.6 to +6.1 for G.653 +16.6 for G.655	–6.6 to +5.3	+34 for G.652[b)] –6.6 to +6.1 for G.653 +16.6 for G.655
Maximum DGD	ps	30	30	7.5	7.5
Minimum ORL of cable plant at MPI-S, including any connectors	dB	14	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27	–27
Polarization-dependent loss	dB	ffs	ffs	ffs	ffs

Table 5 – Optical interface parameters specified for applications with 2 km target distance and attenuation category L

Application code	Unit	VSR2000-2L1F[f)]	VSR2000-2L2 VSR2000-2L3 VSR2000-2L5	VSR2000-3L1F[d, f)]	VSR2000-3L2F[e, f)] VSR2000-3L3F[d, f)] VSR2000-3L5F[d, f)]
Receiver at reference point MPI-R					
Minimum sensitivity (BER of 1×10^{-12})	dBm	–13	–13	–7	–8 for G.652 –7 for G.653 –7 for G.655
Minimum overload	dBm	–1	–1	+3	+3
Maximum optical path penalty	dB	1	2	1[c)]	2[c)] for G.652 1[c)] for G.653 1[c)] for G.655
Maximum reflectance of receiver, measured at MPI-R	dB	–14	–27	–27	–27

a) In the case that passive optical devices in the main optical path introduce additional chromatic dispersion, the achievable link distance may be reduced. Alternatively, an application with a higher chromatic dispersion tolerance may be used to overcome this restriction.

b) This application can also be used on ITU-T G.653 and ITU-T G.655 fibre.

c) The method used to verify this penalty is for further study.

d) A receiver in compliance with this application is required to operate in any of the application codes VSR2000-3L1, VSR2000-3L3 or VSR2000-3L5. It shall, as a minimum, operate over the wavelength range of 1290-1330 nm as well as the range 1530-1565 nm.

e) A receiver in compliance with application VSR2000-3L2 will operate in either of the application codes VSR2000-3L3 or VSR2000-3L5. It will also operate in the application code VSR2000-3L1 if its operating wavelength range includes 1290-1330 nm.

f) The BER for this application is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can, therefore, be significantly higher than 10^{-12}.

Table 6 – Optical interface parameters specified for applications with 2 km target distance and attenuation categories M and H

Application code	Unit	VSR2000-3M1	VSR2000-3M2 VSR2000-3M3 VSR2000-3M5	VSR2000-3H2 VSR2000-3H3 VSR2000-3H5
ITU-T G.691 application code				
ITU-T G.959.1 application code				
Target distance	km	2	2	2
Bit rate/line coding of optical signals	–	NRZ 40G	NRZ 40G	NRZ 40G
Fibre type	–	G.652	G.652 G.653 G.655	G.652 G.653 G.655
Transmitter at reference point MPI-S				
Source type		SLM	SLM	SLM
Operating wavelength range	nm	1290-1330	1530-1565	1530-1565
Maximum mean output power	dBm	+10	+3	+3
Minimum mean output power	dBm	+8	0	0
Spectral characteristics:				
– maximum RMS width (σ)	nm	NA	NA	NA
– maximum –20 dB width	nm	ffs	ffs	ffs
– minimum SMSR	dB	35	35	35
Minimum EX	dB	8.2	7	7
Main optical path, MPI-S to MPI-R				
Maximum attenuation	dB	12	12	16
Minimum attenuation	dB	8[a)]	3[a)]	3
Maximum chromatic dispersion at upper wavelength limit[b)]	ps/nm	–6.6 to +5.3	+38 for G.652[c)] –6.6 to +6.1 for G.653 +20.3 for G.655	+38 for G.652[c)] –6.6 to +6.1 for G.653 +20.3 for G.655
Maximum chromatic dispersion at lower wavelength limit	ps/nm	–6.6 to +5.3	+34 for G.652[c)] –6.6 to +6.1 for G.653 +16.6 for G.655	+34 for G.652[c)] –6.6 to +6.1 for G.653 +16.6 for G.655
Maximum DGD	ps	7.5	7.5	7.5
Minimum ORL of cable plant at MPI-S, including any connectors	dB	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Polarization-dependent loss	dB	ffs	ffs	ffs

Table 6 – Optical interface parameters specified for applications with 2 km target distance and attenuation categories M and H

Application code	Unit	VSR2000-3M1	VSR2000-3M2 VSR2000-3M3 VSR2000-3M5	VSR2000-3H2 VSR2000-3H3 VSR2000-3H5
Receiver at reference point MPI-R				
Minimum sensitivity (BER of 1×10^{-12})	dBm	–5	–14 for G.652 –13 for G.653 –13 for G.655	–18 for G.652 –17 for G.653 –17 for G.655
Minimum overload	dBm	+2	0	0
Maximum optical path penalty	dB	1[d)]	2[d)] for G.652 1[d)] for G.653 1[d)] for G.655	2[d)] for G.652 1[d)] for G.653 1[d)] for G.655
Maximum reflectance of receiver, measured at MPI-R	dB	–27	–27	–27

a) This value of minimum attenuation is highly undesirable. A value of 0 dB is desired and should be sought as technology matures.

b) In the case that passive optical devices in the main optical path introduce additional chromatic dispersion, the achievable link distance may be reduced. Alternatively, an application with a higher chromatic dispersion tolerance may be used to overcome this restriction.

c) This application can also be used on ITU-T G.653 and ITU-T G.655 fibre.

d) The method used to verify this penalty is for further study.

8 Optical engineering approach

For a worst-case design approach, the relationships among maximum/minimum mean output power, maximum/minimum attenuation, minimum overload, minimum sensitivity and maximum optical path penalty are shown in Figure 3 of [ITU-T G.957].