Template for submitting comments/inputs in respect of Draft Test Guide

(Draft Test Guide No. TEC 86071:2026)

Name of Manufacturer/Stakeholder:

Organization:

Contact details:

Clause No.	Clause	Comments	Other Remarks, if any

Note: The comments/inputs on the draft Test Guide (Draft Test Guide No. TEC 86071:2026) may be provided in the above format vide email to **dirt2-tec-dot@gov.in** , **adet-tx-tec-dot@gov.in** and **ratx.tec-dot@nic.in**

परीक्षण निर्देशिका

टीईसी ८६०७१:२०२६

(पूर्व सं: टीईसी ८६०७१:२०२२)

TEST GUIDE

TEC 86071:2026

(Supersedes no. TEC 86071:2022)

Dense Wavelength Division Multiplexing (DWDM) System with Channel bit-rate of 100 to 800 Gbps and above for Core/Metro Network Applications

(मानको सं.: टीईसी ८६०७०:२०२६)

(Standard No.: TEC 86070:2026)

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

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FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This Test Guide of testing pertains to test schedule and procedure for evaluating conformance/functionality/requirements/performance of Standard for 40/80 Channel Dense Wavelength Division Multiplexing (DWDM) Equipment with channel bit-rates of 100 Gbpsto 800 Gbps and above for Metro/Core Network Applications. The Standard defines various client interfaces such as STM-64, 10GE, Fiber Channel and OTN interface such as OTU2, OTU2e, OTU3 and OTU4. The specifications of these client interfaces have been defined in the GR. The standard is aimed to cater for Metro, long haul and Very long haul DWDM networks. The standard describes the Colourless and Directionless features of ROADM, which enables the remote Administrative, Operative and Monitoring capabilities of the network.

CONTENTS

A. HISTORY SHEET

Sl. No.	*TSTP No.*	*Title*	*Remarks*
1.	TEC/TG/TX/WDM-309/01/Mar-16	Generic Requirements for DCM-Free Coherent system 40/80 Channel Dense Wavelength Division Multiplexing (DWDM) Equipmentwith channel bit-rates of100Gbps for Metro/Core Network Applications.	Release-1
2.	TEC 86071:2021	Test Guide for Standard for Generic Requirement for 40/80 Channel Dense Wavelength Division Multiplexing (DWDM) Equipmentwith channel bit-rates of 100Gbps/200Gbps for Metro/Core Network Applications.	Release-2
3.	TEC 86071:2022	Test Guide for Standard for Generic Requirement for 40/80 Channel Dense Wavelength Division Multiplexing (DWDM) Equipment with channel bit-rates of 100Gbps/200Gbps for Metro/Core Network Applications.	Release-3
4.	TEC 86071:2026	Test Guide for Standard for Generic Requirement for 40/80 Channel Dense Wavelength Division Multiplexing (DWDM) Equipment with channel bit-rates of 100Gbps/200Gbps for Metro/Core Network Applications.	Release-4

B. INTRODUCTION

This document enumerates detailed test schedule and procedure for evaluating conformance/ functionality / requirements / performance of Standard for 40/80 Channel Dense Wavelength Division Multiplexing (DWDM) Equipment with channel bit-rates of 100Gbps/200Gbps for Metro/Core Network Applications as per Standard No TEC 86070:2021.

Per channel transmission rate of this DWDM system shall be 100Gps/200Gbps in the C-band. 100G DWDM system shall use coherent Polarization Multiplexed - Quadrature PhaseShift Keying (QPSK) digital modulation technique. For 200 Gbps, DWDM system at 50 GHz Channel spacing shall use coherent Polarisation Multiplexed - mQAM digital modulation technique. Specifications for 100 Gbps/200 GbpsDWDM systems and associated client's interfaces have been given in this standard.

The document stipulates DWDM systems for Metro & Longhaul and Very Longhaul applications in the Telecom Networks. Apart from the SDH and Ethernet interfaces, OTN client interfaces have also been introduced in the document. The system shall also support Reconfigurable Optical Add Drop Multiplexer (ROADM) which shall providelot of flexibility in the network.

Note1: Though every care has been taken to cover all the parameters of the standard for product/equipment correctly in this Test guide, yet to avoid any inadvertent error/ misprint, the testing officer shall ensure that all the parameters of the standard for product/equipment have been tested & verified in accordance with the provisions of the standard for product/equipment.

Note 2: The figures mentioned in the TSTP Clause may be referred from Standard for GR for 40/80 Channel Dense Wavelength Division Multiplexing (DWDM) Equipment with channel bit-rates of 100Gbps/200Gbps for Metro/Core Network Applications as per Standard No TEC 86070:2021.

C. General information:

I. Name of the Vendor:

II. Name of the technology:

III. TAC is against: GR/PO:

IV. In case of PO, PO no:

V. Date of registration:

VI. Date of Commencement of tests:

i. Place of testing:

VII. Details of Environmental Cycle:

i. Place of environmental testing

From ---------- to ----------

VIII. Date of field trials:

i. Field trial route details:

Field trial route allotted: ----------

Terminal A :

Terminal B :

Optical Line Amplifier :

Optical Add Drop mux :

From ---------- to ----------

ii. Details of First A/T:

Please list the following details, date wise

Terminal A :

Terminal B :

Optical Line Amplifiers :

Optical Add Drop mux :

iii. Details of second A/T;

Please list the following detail, date wise

Terminal A :

Terminal B :

Optical Line Amplifier :

Optical Add Drop mux :

IX. Details of equipment:

i. Long Haul application :

a) No. of terminals

For P2P topology: 2 Nos. TEs and 7 Nos. ILAs

For Linear add drop topology: 2 Nos. TEs, 3 Nos. OADMs and 4 Nos. ILAs

For closed ring topology: 4 Nos. OADMs and 4 Nos. ILAs

For mesh topology: 5 Nos. OADMs and 4 Nos. ILAs

b) No of Subracks per terminals :

c) Details of Subracks :

- Size of the Subrack :

  Comments……
  ……..

- Type of PCB guide used: Built in embossed type PCB guides / Metallic PCB guides riveted type/ Non metallic removable PCB guides

  Comments……
  ……

- In case of Non metallic removable PCB guides, manufacturer shall give the details of material used:

  Comments……
  ……

d) Please inspect the Subrack and record the following information;

- Max. nos. of PCBs that can be loaded in the sub rack:

  Comments……

- The space between any two PCB is sufficient for the purpose of
  - Air Circulation/heat dissipation

Comments……

- Smooth flow of PCBs within the Subrack without colliding /touching the adjacent PCBs

  Comments……
- Locking arrangements of PCBs is provisioned. If yes, whether the Screwing to the body of Subrack/ Clips at the top and bottom of the PCB/Any other arrangement

  Comments……

- Are the top and bottom plates of Sub rack sufficiently strong and do not sag/bend when slightly pressed from the center of these plates, if so please indicate

  Comments……

- Whether the Subrack has got the front cover to avoid the ingress of dust.

  Comments……

- Whether care has been taken the for the EMI and EMC induction or not? If yes, what sort of arrangement has been engineered by the manufacturer?

  Comments……
  ……

- Please check and detail arrangements for fixing the Sub rack to the full/main rack (It should preferably be the screwing arrangements, with minimum four undetectable screws)

  Comments……
  ……

- Please check the material of the Subrack, in case it is mild steel, check that proper enameling has been done or not

Comments……

……

Note: Similar details to be filled in case of Very Longhaul application

d) Details of Rack:

Dimension of full size:

No of subracks, a Full Rack can accommodate:

- How many sub racks a manufacturer proposes to accommodate in a full rack:

- Please ensure that the full rack has sufficient strength, so that it does not get twisted while erecting

  Comments……

  ……

- Please ensure that the top and base plates of the Full rack are sufficiently thick and properly arranged i.e holes etc are there to mount the the rack on floor;

  Comments……

  ……

- Please ensure that there is sufficient space for running the Optical fibre cables/optical patch cord/ electrical cables etc.

  Comments……

  ……

e) No. of PCBs supported during the Type approval:

General observations regarding the PCBs

- Do PCBs have the solder mask?

  Comments……

- Do PCBs have got the designation, version and serial number etched?

Comments……

……..……

- Move the PCBs to and fro in the Sub rack and notice the lateral movement of the PCBs in the Subrack. Please check that the PCBs should have free to and fro movement and do not come out of the top and bottom PCB guides and there should not be much lateral movement

  Comments……

  ……..……

a) Optical Terminal

Terminal A

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

Note: More rows to be added as per requirement.

Terminal B

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

Note: More rows to be added as per requirement.

b) Optical Line Amplifier

Optical Line amplifier #1

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……

3) …….. ……

4) …….. ……

Optical Line amplifier # 2

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

Optical Line amplifier # 3

	Name of the PCB	Sr No
1)	……..	……
2)	…….	……
3)	……..	……

Optical Line amplifier # 4

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

Optical Line amplifier # 5

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

Optical Line amplifier # 6

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

c) Optical Add/Drop Mux:

OADM #1

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

OADM #2

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

OADM #3

	Name of the PCB	Sr No.
1)	……..	……
2)	…….	……
3)	……..	……

Ensure that the PCBs and other hardware are the same as are quoted in the bid document by the vendor.

X. Connectors:

Type of optical connectors used in the system:

Make :

Model no. :

- In the case connector used for FDF termination are other than FC/APC, ensure that the suitable adapters and same type of patch cords are provided by the manufacturer.

  Comments……

- Chromatic Dispersion of Fibre spools:

  The length of each spool measured with Chromatic Dispersion meter.

The loss of the fibre using light source and Power meter. Test wavelength of laser source shall be starting, middle and end wavelength of C band as per ITU-T grid.

Details of Dispersion Fibre spools in case of Single mode fibre							
Spool No	Spool #1	Spool #2	Spool #3	Spool #4	Spool #5	Spool #6	Spool #7
Fibre Loss/Km	=dB						
Total loss in dB							
Dispersion/Km	=ps/nmkm						
Total dispersion in ps/nm							
Spool No	Spool #8	Spool #9	Spool #10	Spool #11	Spool #12	Spool #13	Spool #14
Total loss in dB							
Total dispersion in ps/nm							
Spool No	Spool #15	Spool #16					
Total loss in dB							
Total dispersion in ps/nm							

- **Section wise details of dispersion fibre:**

  Long Haul Application:

Multiple x section No	Section #1	Section #2	Section #3	Section #4	Section #5	Section #6	Section #7	Section #8
Loss In dB								
Length								

in Km								

Very Long Haul Application:

Multiple x section No	Section #1	Section #2	Section #3	Section #4	Section #5	Section #6	Section #7	Section #8
Loss In dB								
Length in Km								

- Polarization Mode Dispersion:
    i. A-B direction:
    ii. B-A Direction:

XI. Equipment installation for evaluation

These sequences shall be taken in the way as specified below, at the time of TEC evaluation of DWDM technology

- The manufacturer shall erect the main racks and sub racks before the commencement of TEC type approval
- Install the Terminal Mux and Demux equipment and record the followings
    i) Number of transponders per sub rack
    ii) Attenuator at the output of Transponder, if yes give the details
        - Variable/Fixed …….
        - Resolution……
        - Type/make ……..
    iii) Any attenuator at the output of Mux, if yes give the detail
        - Variable/Fixed…….
        - Resolution……
        - Type/make …….

Note: No fixed external attenuator is allowed. Only soft selectable electronic variable optical attenuator allowed for the purpose of equalization/gain adjustments etc.

- Install the Optical Line amplifiers one by one after inserting the specified value of Optical Fibre in each span and record the following
  i. Attenuator at the Input/output of Booster/Line amplifier/Pre amplifier, if yes give the details
     - Variable/Fixed…….
     - Resolution…….
     - Type/make ……

  ii. Is the Pre emphasis provisioned by
     - Booster, if yes , give the details, in the term of type of Pre Emphasis, Equalisation range

       ……

  iii. Pre amplifier, if yes, give the details, in the term of type of Pre emphasis, Equalization range

       ……

- No of Optical Line amplifier supported by each subrack during the equalization

  ……..……...

- Now switch on the equipment. Feed the signal on all the channels and record the output power at the output point of each of the Booster/Pre amplifier.
  Allow the system in this state for about one hour or little more and again record the output power at each stage as stated above. This is to ensure that the system is fit for the traffic instantly or requires some time for handshaking with amplifiers etc. Also to ensure this from the SDH analyzer, map one 2488.32 Mb/s pay load onto STM-64 and feed the data to one of the transponder especially with lowest amplitude in the spectrum. On the Demux end demap the 2488.32 Mbps data and feed back to the SDH analyzer and see there should be

no error. **This test shall especially be taken during the field trial where the link shall be fully loaded with actual traffic and the remaining channels be simulated by test instruments.**

Comments……

……

- Now open the fiber and verify that the equipment restores back instantly i.e within 50 ms in case of 1+1 protection.

  Comments……

  ……..

- Now add about 1 to 2 dB attenuation in the section and ensure that the equipment does not change its performance,

  Comments……..

- Please ensure that the arrangements for mounting the subracks in the Full rack are adequate:

  Comments……

- Please attach an undertaking from the manufacturer stating that he will supply same Rack/sub rack during the supply of the equipment to BSNL/MTNL

XII. System Manuals

- Maintenance manuals:
- Installation manual:
- Repair manual:

XIII. NMS

- Software model :
- Version :
- Check sum :

Please attach an undertaking from the manufacturer stating that he will supply the same version of software with the supply of equipment and any change in the

future version to be supplied to the purchaser, shall be with the consent of TEC. In the case of type approval against tender, ensure that it is the same as quoted in the bid.

XIV. Work station /server:

Make :
Processor type and speed :
Hard disk capacity :
Key board Make :
Mouse make :
Monitor Make and size :
NMS capacity in terms of Manageability of NEs :

XV. Local craft Terminal

Make :
Processor type and speed :
Hard disk capacity :
Key board Make :
Mouse make :
Monitor Make and size :
NMS capacity in terms of Manageability of NEs :

Please attach an undertaking from the manufacturer stating that he will supply the same version of software with the supply of equipment and change in the future version to be supplied to the BSNL/MTNL shall be with the consent of TEC. In the case of type approval against tender, ensure that it is the same as quoted in the bid.

XVI. Jigs/Tools and installation materials::

Please furnish the list of jigs/Tools and installation materials required during the repair of the equipment. In case of the type approval against P.O check it and ensure that it is as per bid;

Comments……

D. Testing team: *(to be filled by testing team)*

Sno.	Name	Designation	Organization	Signature
1.				
2.				

E. List of the Test Instruments:

Sno.	Name of the test instrument	Make /Model *(to be filled by testing team)*	Validity of calibration *(to be filled by testing team)*
1	STM-64 SDH Analyzer with jitter		dd/mm/yyyy
2	OTU-2/OTU-2e OTN Analyzer		
3	OTU-4 OTN Analyzer		
4	Optical Return Loss Measuring Set		
5	WDM Analyzer/Optical Spectrum Analyser		
6	Ethernet Traffic Analyzer (10GE)		
7	Ethernet Traffic Analyzer (100G)		
8	Optical attenuator		
9	Optical Power Meter		
10	Tunable Laser Source for Insertion Loss and for simulated channels		
11	Digital Communication Analyser		

12	Optical Modulation Analyser		
13	Relevant connectors, Patch cords etc.		

F. Equipment Configuration Offered: *(to be filled by testing team)*

(a) <Equipment/product name> Configuration:

S.No.	Item	Details	Remarks

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

(b) <Other equipment name> Configuration:

S.No.	Item	Details	Remarks

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

G. Equipment/System Manuals: *(to be filled by testing team)*

Availability of Maintenance manuals, Installation manual, Repair manual & User Manual etc. (Y/N)

H. Clause-wise Test Type and Test No.:

Chapter 1

Clause No.	*Clause*	*Type of Test / Test No. etc. **
1.0	**Introduction:** 1.1 This document describes the standard for Dispersion Compensation Module Free Coherent system with a capacity of Flexible channel count with respect to spectral width used per channel in Dense Wavelength Division Multiplexing (DWDM) Optical Line System (OLS) operating at discrete wavelengths in the C-band centred around 193.1 THz frequency as per ITU-T Rec. G.694.1 grid, at fixed grid of 150/100/75/50GHz channel spacing or in flex grid DWDM network design nx6.25/12.5GHz, where "n" is the number of slices to define per channel spectral width for example if spectral width required as 87.5GHz then 7 slices of 12.5GHz required (7x12.5=87.5GHz) . 1.2 Per channel transmission rate of this DWDM system shall be 100Gps to 800G and above in the C-band. 100G and above DWDM system shall use Dual Polarization Quadrature Phase Shift Keying (DP-QPSK) and mQAM (Quadrature Amplitude Modulation) digital modulation techniques. Specifications for 100Gbps to 400G/800Gbps and above DWDM systems having standards as well as proprietary and associated client's	For 100G per channel rate, note that the 40 Chl. DWDM system supports the grid at 100GHz channel spacing and 80 Chl. DWDM system supports the grid at 50GHz channel spacing. Therefore, measure the wavelength at the line side of each transponder and muxponder with an Optical Spectrum analyzer (OSA) and ensure that the wavelengths match with the grid. Record the result in the table. For 200G, note that flexible DWDM grid shall allow a mixed bit rate or mixed modulation format transmission system to allocate frequency slots with different widths so that they can be optimized for the bandwidth requirements of the

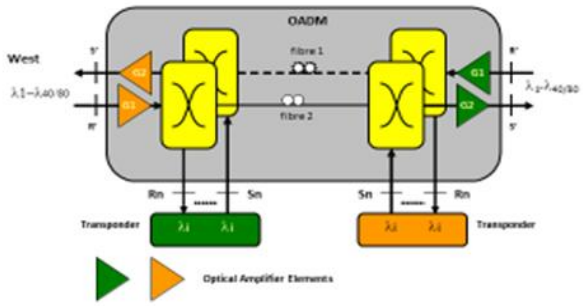
	interfaces have been given in this standard. 1.3 The document stipulates DWDM systems for Metro & Longhaul and Very Longhaul applications in the Telecom Networks. Apart from the SDH and Ethernet interfaces, Fibre channel and OTN client interfaces have also been introduced in the document. The system shall also support Reconfigurable Optical Add Drop Multiplexer (ROADM) which shall provide lot of flexibility in the network. 1.4 A flexible DWDM grid shall allow a mixed bit rate or mixed modulation format transmission system to allocate frequency slots with different widths so that they can be optimized for the bandwidth requirements of the particular bit rate and modulation scheme of the individual channels. For the flexible DWDM grid, the allowed frequency slots have a nominal central frequency (in THz) defined by: 193.1 + n × 0.00625 where n is a positive or negative integer including 0 and 0.00625 is the nominal central frequency granularity in THz and a slot width defined by: 12.5 × m where m is a positive integer and 12.5 is the slot width granularity in GHz. Any combination of frequency slots is allowed as long as no two frequency slots overlap	particular bit rate and modulation scheme of the individual channels. Record the result in the table. Note that the system supports transmission of STM-64, 10GE, OTU-2 OTU2e, OTU3, OTU4 and OTUC2 per channel. The offered interfaces shall be reflected in the test certificate.

2.0	**Description of DWDM equipment:** Following shall be the functional blocks of the DWDM system.	
2.1	**Terminal blocks:** Shall provide the following functionalities: (a)Interface from/to100Gbps to 800Gbps and above line equipment (b) Pre-emphasis of gain (c) Booster/pre-amplification (d) OSC termination (e) Performance Monitoring etc. (f) Multiplexing/De-multiplexing element: The Multiplexer of the DWDM equipment shall combine a maximum of 32/40/64/80/96/flexible count coloured DWDM channels from the Transponders/Muxponders into a multi-channel signal. Similarly, the Demux shall provide the reverse function **Notes-I**: (a) Various DWDM Mux/Demux characteristics for 'Add-out insertion loss (max.) per channel for Mux', 'Drop-in insertion loss (max.) per channel for De-Mux', are left open for implementation to manufacturer subject to conformance to parametric limits as imposed by Table 1a, 1b, 2a, 2b, 3 & 4/ Annexure-I at all relevant reference points 'RMn/SDn' and 'MPI-S/MPI-R'. (b) If desired by the purchaser, Optical Terminal Multiplexer and ILA equipment can also be upgraded to high capacity Optical	The detail testing of the TM, ILA and OADM are covered later. The purpose of this test is to take the Optical Cross talk between adjacent channel of the DWDM link with the specified section loss and dispersion, which is 22 dB. **Crosstalk measurement in case of MUX/DEMUX used:** Make the test set up as shown in figures 8 & 9. Connect the Multi wavelength power meter/OSA at the output of disturbing channel and select concerned wave length for measurement and record the level. Adjust the level from the DFB laser source so as to read 0 dBm at the output of the disturbing channel. Move the meter to two adjacent channels and two non-adjacent channels

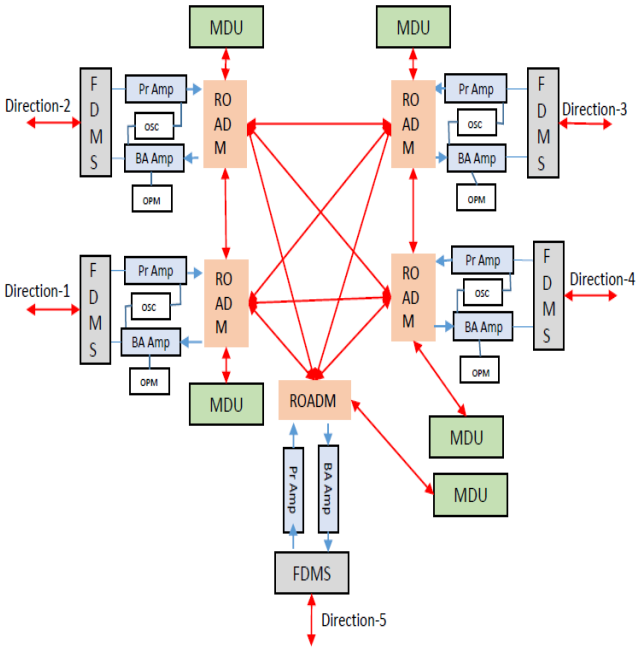
	Add/Drop Multiplex equipment with additional cards/chassis. The traffic disruption in this activity can be avoided using the appropriate protection mechanism. (c) The details of technology and characteristics (other than defined in this document) of Multiplexer/Demultiplexer are to be specified by the manufacturer. Upgrades to additional add/drop channels is required to be hitless and to be supported in field. **Note-II:** Cross-talk values - 'Maximum adjacent channel cross-talk for De-Mux', 'Minimum Isolation (for adjacent as well as non-adjacent channels) for Mux & De-Mux' shall be complied at relevant 'SDn' reference point (for the disturbed channel) at De-Mux, S' reference point on ILA/OADM and MPI-S reference point at MUX output under the following conditions: • The channel power for the disturbed channel at 'RMn' reference point at MUX is at a minimum. • The powers at other channels at respective 'RMn' reference points are at a maximum. • The optical filter characteristics in Mux/De-Mux to be such as to compensate for channel-power disparities to adhere to cross-talk specification	and record the level. Repeat by assigning the disturbing channel status to next channel and move the meter to the output of all other channels and record the reading. And so on. The spec limits for adjacent channel Cross talk is –22 dB and non-adjacent channel cross talk is -25 dB. Crosstalk measurement in case of MUX/DEMUX not used: Analyse output of Booster Amplifier/Pre-Amplifier in each direction for each ROADM at OSA. Note the readings of the signal power of the disturbing channels. The disturbing channel is then turned OFF by disconnecting the Muxponder that was adding this disturbing channel to the DWDM network. Then readings of adjacent channel cross talk and non-adjacent channel cross talk are recorded by moving

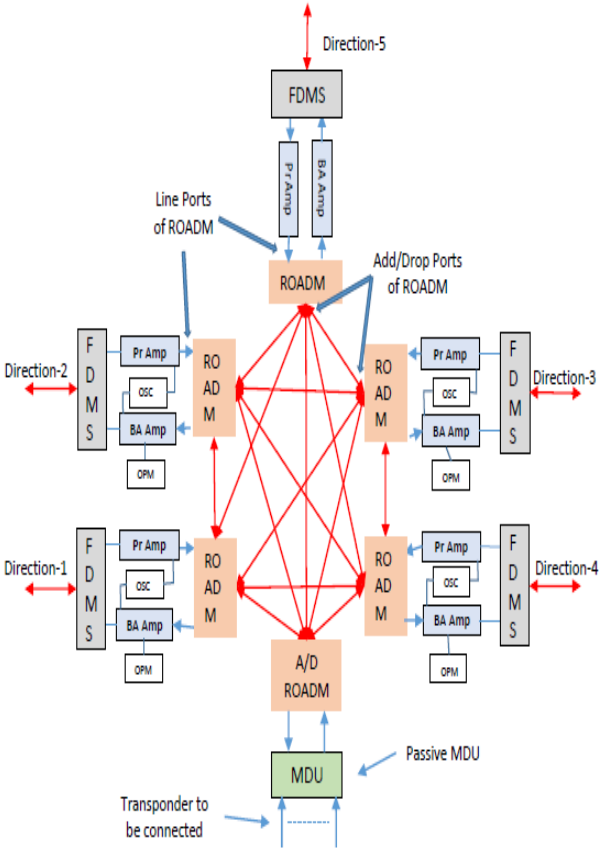
		pointer of OSA to the disturbed channels.
2.2	**In Line Amplifiers**: Provide optical line amplification and Optical Supervisory Channel termination. The DWDM system shall provide EDFA Booster Amplifiers (at Mux end), Pre-Amplifiers (at Demux end) and ILA's at enroute stations to compensate fibre-attenuation etc. The Optical In-Line Amplifier amplifies the optical signals received at the input and has the characteristics as given in the Table 1a, 1b, 2a, 2b, 3 & 4/Annexure-I. The Coherent Channel systems shall be required to compensate the dispersion occurred in the link.	The detail testing of the ILA are covered later.
2.3	**OADM module:** Optical Add/Drop Module, as the name specifies has the capability to ADD or Drop one or more channels at specified nodes, as per the need. It multiplexes/De-multiplexes for channel Add/Drop functionality. The OADM design is such that it allows unrestricted continued re-use of same channel/channels in the subsequent cascaded spans for the dropped channels. Upgrades to additional add/drop channels is hitless and is supported in field. It also provides Gain, Pre-emphasis and OSC termination. The standard envisages a common platform for Optical Add/Drop Mux and optical line amplification. OADM node provides an integrated two-stage EDFA/Raman optical amplifier to offset various losses i.e. insertion loss channel	Note down the exact number of add drop channels. Check channel power equalization and pre-emphasis feature. **a. Optical Return Loss:** The tables, test procedure and test set up is shown in Fig.1. The specs limit for Return Loss for OADM is ≥40 dB.

	add/drop and fiber-attenuation etc. Two variants of Optical Add/Drop Multiplexers shall be supported – Fixed OADM (static) and Reconfigurable OADM (ROADM).	
2.3.1	**Fixed OADM (Static):** Optical Add/Drop Multiplexer are designed to add/drop particular wavelengths (range), channel count can be 2/4/8/16 wavelengths of C-Band for add/drop traffic with the remaining optical wavelengths passed through to outgoing path via express port without 3R regeneration. However, purchaser may indicate the exact number of add/drop channels	Check the requirement as per clause. Note down the exact number of add drop channels.
2.3.1.2	**32/40/44/64/80/96 port OADM node:** Optical Add/Drop MDU of different port count can be deployed to add/drop "C-Band" with different spectral width as 50GHZ/75GHz/100GHz/150GHz. However, purchaser may indicate the exact number of add/drop channels. **New clause 1xN PSCM (Power Splitter Combiner Module) based Add/Drop structure: (Optional)** For the high line rate transmission with different baud rates ,1xN PSCM is an option to Add/Drop entire C-Band and tuning part is taken care by "Coherent Optics". OEMs can propose it as part of solution if design permits with respect to purchaser requirement.	Check the requirement as per clause. Note down the exact number of add drop channels.

	 Fig.1 OADM schematic **Note 1:** Both directions of traffic may also be implemented on two unidirectional units. Transponders for add/drop tributaries may be internal or external part of the OADM node. **Note 2:** The 'Sn' & 'Rn' and S' & R' reference points on OADM shall comply for parametric values as outlined in Table 1a, 1b, 2a, 2b, 3 & 4/Annexure-I of the standard. The parametric values refer to above are the worst-case values for all channels.	
2.3.2	**ROADM based OADM:** **Multi-Degree Reconfigurable OADM (MD-ROADM):** A Reconfigurable Optical Add-Drop Multiplexer (ROADM) is a form of optical add-drop multiplexer that adds the ability to remotely configure wavelength in OADM system. This allows individual wavelengths carrying traffic channels to be added and dropped from a transport fibre without the need to convert the signals on all of the WDM channels to electronic signals and back to	No test required. It is for information only.

	optical signals. Planning of entire bandwidth assignment need not be carried during initial deployment of a system. The configuration can be done as and when required using 1XN WSS Based ROADM. Wavelength selective switch (WSS) based on LCOS/LC or Micro-Electro-Mechanical Systems (MEMS) technology. There could be different network designs based on verity of node architectures like Coloured-Directional, Colourless-Directionless and Colourless-Directionless-Contentionless as per network owner requirement Purchaser can fulfil his requirements in any of the following combinations, however for realizing the optical layer ASON, directionless feature is must requirement.	
2.3.2.1	**Colored & Directional ROADM** ROADM sites which are Coloured & Directional, only pass-through wave direction can change on these ROADM nodes. The add/drop wave is connected to a specific direction MUX DEMUX. The add wave direction can't change without changing physical connections to other direction MUX DEMUX. The add/drop wave is connected to a specific wavelength (specific colour) port of MUX DEMUX. The add drop wavelength can't change even if the OTU is Tunable, because each port of MUX DEMUX frequency (wavelength) is fixed. Pictorial view of	No test required. It is for information only.

	Coloured and Directional ROADM is shown at Fig. 3 below(New Figure 3 proposed  **Figure 3: Pictorial View of Coloured and DirectionalROADM (New Figure 3 proposed)**	
2.3.2.2	**Colored & Directionless ROADM** ROADM sites which are Colored & directionless, not only pass-through wavelength on these ROADM nodes but also add/drop the wavelength, so it can realize optical layer reroute. To enable ASON Optical layer must use Directionless model. WSS is connected to the add/drop OTU board & makes the direction of any wavelength changeable. The add drop wavelength can't change (even the OTU is Tunable) without changing physical connections at MUX & DEMUX, because each port of Mux/Demux	No test required. It is for information only.

	frequency (wavelength) is fixed. Pictorial view of Colored and Directionless ROADM is shown at Fig. 4 below (New Figure 4 proposed)  **Figure 4: Pictorial View of Coloured and Directionless ROADM** (New Figure 4 proposed)	
2.3.2.3	**Colorless Directionless ROADMs:** To re-route around a local, nearest span failure, the direction of an add/drop port must be switchable, Directionless switching is	No test required. It is for information only.

	therefore needed for automatic restoration with a GMPLS/ASON control plane, or remote provisioning using pre-installed transponders. In colourless ROADMs ports can be tuned to arbitrary wavelengths by software command. This allows to tune the wavelengths of the transponders and the add/drop port remotely. The Colourless/Directionless-Add/Drop allows that each port of the add/drop structure access any wavelength from any direction of any degree within a node. It is therefore ideally suited for highly flexible traffic patterns. The number of local directions in directionless configuration can be in set of 1+1 for hardware redundancy purposes. The number of 1+1 sets can be more than one in case number of wavelength drop are not accommodated in one set. However, the discretion of opting for 1+1 hardware redundancy may be decided by the purchaser. Pictorial view of Colourless and Directionless ROADM is shown at Fig. 5 below(New Figure 5 proposed).	

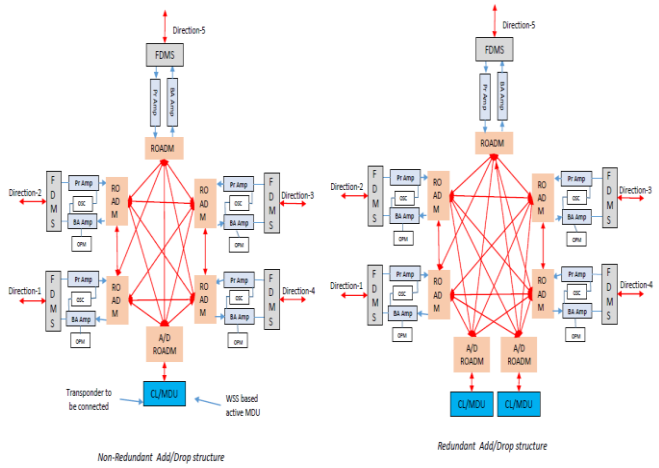


Figure 5: Pictorial View of Colourless and Directionless ROADM node with single and redundant add/drop structure

(New Figure 5 proposed)

New clause Colorless Directionless Contentionless ROADMs:

To re-route around a local, nearest span failure, the direction of an add/drop port must be switchable, Directionless switching is therefore needed for automatic restoration with a GMPLS/ASON control plane, or remote provisioning using pre-installed transponders.

In colourless ROADMs ports can be tuned to arbitrary wavelengths by software command. This allows to tune the wavelengths of the transponders and the add/drop port remotely.

In contentionless architecture transponder

sends a wavelength to the NXM ROADM, which fans it out to multiple WSS inputs. which then send them out to the correct fiber direction.

The Colourless/Directionless/Contentionless-Add/Drop allows that each port of the add/drop structure access any wavelength from any direction of any degree within a node. It is therefore ideally suited for highly flexible traffic patterns. The number of local directions in directionless configuration can be in set of 1+1 for hardware redundancy purposes. The number of 1+1 sets can be more than one in case number of wavelength drop are not accommodated in one set. However, the discretion of opting for 1+1 hardware redundancy may be decided by the purchaser. Pictorial view of Colourless and Directionless ROADM is shown in Fig. 6 below

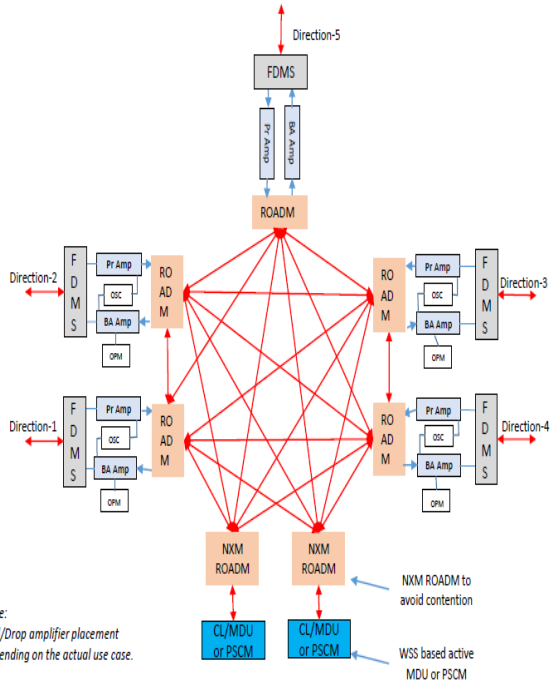
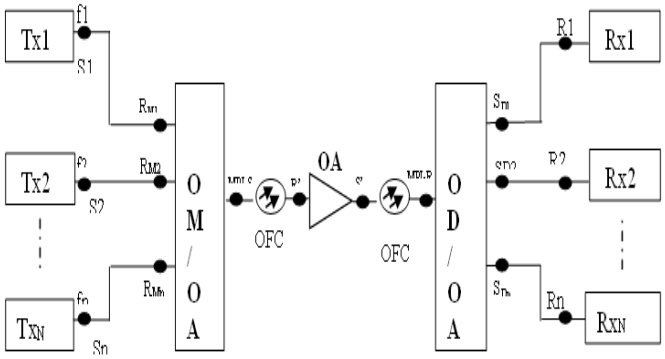
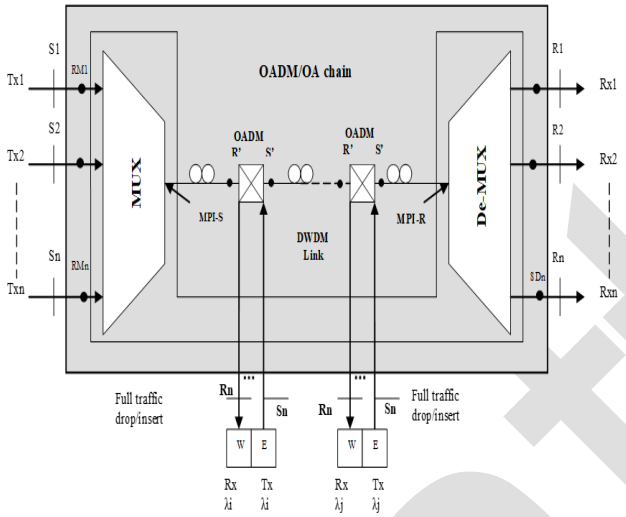


	Figure 6: Pictorial View of Colourless Directionless and COntentionless ROADM node architecture(New Figure proposed) **Note:** All above features of the ROADMs are optional features and may be decided by the purchaser as per the requirement.	
2.4	**Network Topologies:**	For type approval of the equipment, vendor may apply for any of the topologies from P2P, Linear OADM and Closed ring. The topology applied and tested shall be mentioned in the Type Approval certificate. Note: The minimum required channels shall be as per TAC requirements and rest of the channels to be simulated.
2.4.1	**Point-to-point topology:** The standard envisages a transverse compatible approach for point-to-point DWDM links, the reference model is outlined below in Figure-6:  	No test required. It is for information only.

	. **Figure 6- Point-to-point DWDM system** The DWDM system shall fully comply with parametric values & limits as per Table 1a, 1b, 2a, 2b, 3 & 4/Annexure-I of the standard, at reference points 'Sn/Rn', 'RMn/SDn' & 'MPI-S/MPI-R. The system shall also comply with the span-budget, dispersion, cross-talk limits from adjacent as well as non-adjacent channels and other specifications in all the spans as per Table 1a, 1b, 2a, 2b, 3 & 4/Annexure-I for even worst-case channel.	
2.4.1.1	In the point-to-point DWDM link, the equipment shall be able to carry the maximum traffic of 32/40/64/80/96/Flexible count of channels on a single fibre-pair depending on the channel spectral width 150GHz/100Gz/75GHz/50GHz/37.5GHz etc. The equipment shall be seamless in providing service migration path to linear add-drop or two-fibre DWDM ring structures, provided intention is expressed at the time of procurement by purchaser. Traffic shall be protected through client-layer protection mechanism which shall be unidirectional and single-ended..	In point to point DWDM link, check that equipment shall be able to carry the maximum traffic of 32/40/64/80/96/Flexible count of channels on a single fibre pair depending on the channel spectral width 150GHz/100Gz/75GHz/50 GHz/37.5GHz etc.

2.4.2	**Linear add-drop topology:** The reference model for linear add-drop topology is outlined in Figure-7 below:  **Figure 7- Reference Diagram for DWDM Linear-chain link**	
2.4.2.1	The DWDM equipment in linear-chain is to be able to carry a maximum traffic of 32/40/64/80/96/flexible count channels, on a fibre-pair with one fibre each for 'East-bound' and 'West-bound' direction. As required by the purchaser, a pre-configured drop & insert facility from both fibre directions at any intermediate OADM node shall be possible. The DWDM system shall provide channel re-use in subsequent spans, after termination of a wavelength at an intermediate OADM node.	In linear chain equipment, check that system is able to carry a maximum traffic of 40/80 channels, on a fibre-pair. Also, check if a pre-configured drop & insert facility from both fibre directions at any intermediate OADM node is possible if required by purchaser.

2.4.2.2	The system is capable of implementation of proper mechanism to combat OSNR penalties incurred due to continued channel add/drops of same wavelengths in subsequent spans at enroute OADMs.	Check power equalization and pre-emphasis features to combat OSNR penalties.
2.4.2.3	The add/drop channel transponders are supplied as an integrated part of the OADM in the same chassis.	Check as per the requirement of the clause.
2.4.3	**Two-fibre Ring DWDM ring:**	
	The two-fibre ring network may find two kinds of application topologies in a DWDM network: I.Two-fibre ring with a single 'Hub Node' (called 'Head-end') and; II.Closed two-fibre ring. **I.Two-fibre DWDM ring with a Hub:** In the two-fibre DWDM ring characterized by a Hub node, all the traffic shall be hubbed towards a 'Head-end'. The 'Head-end' shall consist of a back to back DWDM terminal for termination of 32/40/64/80/96/flexible count bi-directional channels from both fibres in both ('W'&'E') directions. The network shall support fibre termination or add/drop of a total of up to 32/40/64/80/96/flexible count bi-directional channels i.e. full traffic coming/going from East and West directions of the 'hub traffic' at any intermediate OADM node. The reference model for a hubbed ring is outlined in Figure-8	No test required. It is for information only.

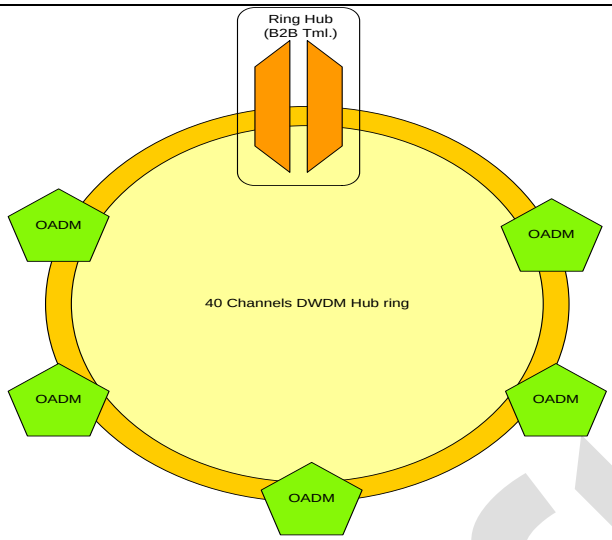


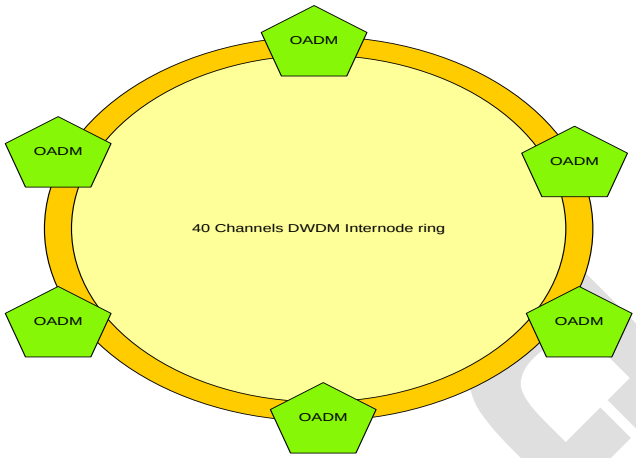
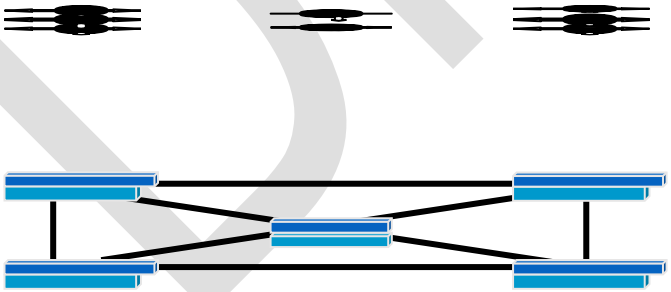
Figure 8-Reference diagram for a DWDM hubbed ring.

In DWDM ring configuration, the system shall fully comply with parametric values & limits as per Table 1a, 1b, 2a, 2b, 3 & 4/Annexure-I of the standard, at reference points 'Sn/Rn', 'R'/S' & 'MPI-S/MPI-R'. The system shall also comply with the span-budget, dispersion, cross-talk limits from adjacent as well as non-adjacent channels and other specifications in all the spans as per Table 1a, 1b, 2a, 2b, 3 & 4/Annexure-I for even the worst-case channel.

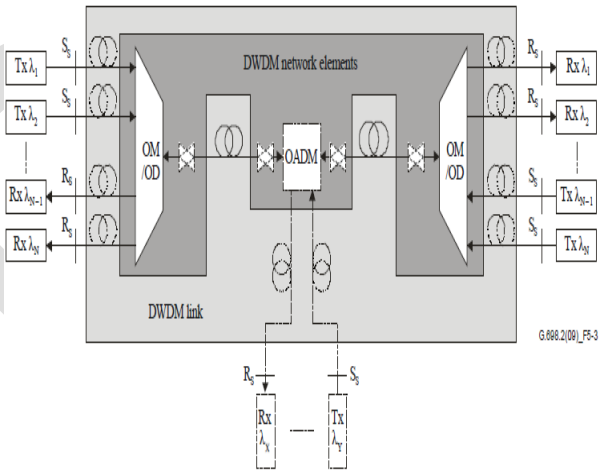
In the ring network, the '**working**' and '**protection**' paths for bi-directional traffic shall take different fibre routes around the ring ('East' and 'West') and the selection of the Rx signal shall be carried out at Rx-end.

II.Closed two-fibre ring:

The schematic of a closed two-fibre DWDM ring architecture with distributed traffic patterns between nodes is given in Figure-9. The protection mechanism shall operate at

	the client level. The network shall support termination of node to node traffic providing channel reuse feature.  **Figure 9-Reference diagram for an Internode DWDM ring.**	
2.4.4	**Meshed Network:** The schematic of a closed two-fibre DWDM Mesh Network architecture with distributed traffic patterns between nodes is given in Figure-10 in standard. The protection mechanism shall operate at the client as well as at line side.  **Figure 10- Reference diagram for a Mesh DWDM Network**	No test required. It is for information only.
3.0	**Functional requirements:**	
3.1	The system shall support a combination of client interfaces -STM-64, 10G Ethernet LAN and WAN PHY as per IEEE 802.3ae,40GE, 100GE as per IEEE 802.3ba and 400G as per	Record the interfaces offered in the equipment in the following table: STM-64(10G):

	IEEE 802.3bs,cd,ck,db,cs. The DWDM system shall also be capable of interfacing G.709 based OTN client signals such asOTU2, OTU2e, OTU3 & OTU4.For these client interfaces, various sets of Transponders and Muxponders have been defined and described later in the standard. A Transponder shall map grey STM-64, 10GigE/100GE/400GE and OTU2, OTU3 or OTU4 optical clients to a coloured DWDM wavelength towards Mux/Demux block and vice-versa. A Transponder shall be defined for Line Rate of OTU4/OTU-Cn. A Transponder shall interface with a client signal of 100GE/400G etc and will give a OTU4/OTU-Cn Line signal wavelength as output. A Muxponder shall multiplex different rate grey signal to coloured line interface , depending on the Muxponder 'type' and will give a OTU4/OUT-Cn wavelength to Mux/Demux. The block schematics of 100G/200G muxponders is shown at Fig.14 later in this standard. However, a muxponder with different rates of Line/client interfaces are also possible, in general the purchaser ask there client and line interface requirement accordingly bidder decides the modules.	10 GE WAN: 10GE LAN: 100GE: OTU-2: OTU2e: OTU-3: OTU-4: OTUC2:
3.2	The system shall support a set of optical cards that when equipped in a specific	Note that equipment for various configurations are

	configuration shall allow the system to function as an Optical Terminal Multiplexer (OTM), Optical Add/Drop Multiplexer (OADM) or In-Line Amplifier (ILA) or Dynamic Gain Equalizer (DGE). The system shall also support Reconfigurable Optical Add Drop Multiplexer (ROADM) in a specific manner as per the requirements of the purchaser. However, for ILA sites, size of the chassis may be decided by the purchaser	offered such as OTM, OADM, ROADM, ILA etc, if not otherwise specified by the purchaser. Note that the system supports Reconfigurable Optical Add Drop Multiplexer (ROADM) in case the purchaser requires it.
3.3	The OADM shall have East West separation resulting in traversing the East direction traffic not sharing the common cards with add/drop channels in the West direction. A separate booster and preamplifier cards shall be a precondition for EWS.  **Fig-11: OADM architecture with East West separation**	The OADM architecture shall guarantee east-west separation such that optical card failure(s) involving either the east or west direction of transmission shall not impact optical channels traversing in the respective west or east direction.
3.3.1	Upgrades to additional add/drop channels upto the limits proposed shall be supported and hitless. OADM shall facilitate unrestricted channel reuse in subsequent spans i.e. at all ILAs in chain/ring after a particular	There shall be no restrictions on wavelength assignment to the add/drop channels, allowing any or all unique

	wavelength is dropped at previous OADM node.	optical wavelengths to be added/dropped at any location. Both symmetric and asymmetric add/drop is supported.
3.3.2	OADM shall support the add/drop of any channel in resolution of single channel of bi-directional optical wavelengths up to the maximum of 32/40/64/80/96/flexible no. of bidirectional optical wavelengths, with the remaining optical wavelengths passed through to any other location without 3R regeneration. There shall be no restrictions on wavelength assignment to the add/drop channels, allowing any or all unique optical wavelengths to be added/dropped at any location. Both symmetric add/drop (whereby no. of dropped channels is equal to no. of inserted channels) and asymmetric add/drop (whereby no. of dropped channels is not equal to no. of inserted channels) shall be supported.	--as above--
3.3.3	The system design shall be such that it implements wavelength reuse at Optical Add/Drop Multiplexers, allowing any particular wavelength that has been dropped from a previous optical multiplex section to be reinserted into any subsequent optical multiplex section to carry new traffic. Any insertion losses incurred in the add/drop process is compensated within the system. The system shall support the physical ports for all the add/drop channels. No additional	--as above--

	hardware except, Muxponders/transponders shall be required for the future upgradation of the equipment. In case existing slots cannot accommodate the transponder/muxponder, new chassis may be required while upgrading the capacity.	
3.3.4	The technical requirements for static OADM shall be governed by the following specifications: a. Minimum no of OADM's that can be supported in a linear add/drop or ring topology before 3R shall be required as per link distances/losses in spans. b. In case of ring topology, true ring closure are supported without 3R depending upon link parameters	Already covered in clause no. 2.3
3.4	The system shall support various topologies such as point-to-point, linear add/drop, closed ring and Mesh topologies(with or without 3R regeneration). The standard document specifies multipleprotection at the DWDM Optical.	For type approval of the equipment, vendor may apply for any of the topologies from P2P, Linear OADM and Closed ring. The topology applied and tested shall be mentioned in the TA certificate.
3.5	The DWDM system shall work in unidirectional mode of operation for all network topologies using dedicated separate fibres for 'TX' and 'RX' directions in terrestrial Metro, Longhaul and Very Longhaul networks with or without In-Line Amplifiers (ILA) as per network requirements. The maximum no. of spans deploying In Line Amplifiers (ILAs)&	Note that the maximum no. of spans deploying In Line Amplifiers (ILAs) & OADMs/ROADMs or a combination thereof, shall be 3 to 8 or more for different applications for various span-budget

	OADMs/ROADMs/DGE or a combination thereof, shall vary from 3 to 8 or more for different applications/line rate for various span-budget specifications as mentioned later in the standard.	specifications.
3.5.1	The Booster Amplifier and Pre-Amplifier (optical amplifiers) shall be an integral part of DWDM Terminals, as well as ILAs and OADMs/ROADMs.	Note that the Booster Amplifier and Pre-Amplifier (optical amplifiers) shall be an integral part of DWDM Terminals, and OADMs/ROADMs.
3.5.2	The Optical Amplifiers shall amplify the aggregate DWDM optical signal received at the input using EDFA and RAMAN (Optional) technology and shall have the characteristics as given in the Table 1a, 1b, 2a, 2b, 3 & 4/Annexure-I. At least two types of Line Amplifiers shall be supported viz. Longhaul Amplifier and Very Longhaul Amplifiers based on the amplification capabilities which are specified in the Table 1a, 1b, 2a, 2b, 3 & 4/Annexure-I. The equalization and other parameters shall be the same for both types unless these are specified.	**a) Total launched power** Make the Test set up as shown in the figure 5 & 7. Connect output of amplifier(Booster/ Inline) to OSA/ Power meter. Adjust its wavelengths in the band of 1529 nm to 1565 nm. Note the total output power of amplifier on OSA/power meter /EMS. **b) Mean channel output power** Make the Test set up as shown in the figure 5 & 7. Connect output of amplifier (Booster/Inline) to OSA. Note the mean

		channel output powers for all channels on OSA/ EMS. **c) Maximum channel Power Difference (at point MPI-S & S'):** Make the Test set up as shown in the figure 5 & 7. Note the mean channel output powers for all channels on OSA/EMS. The difference between the channels having the lowest amplitude and one with highest amplitude shall be less than 10dB. Repeat the reading on all the Optical Line amplifiers including the Booster & the Inline amplifier. The optical fibre section loss in span shall be 22 dB. **d) Total receive power** Make the Test set up as shown in the figure 6 & 7. Connect input fibre of amplifier to OSA/power meter. Adjust its wavelengths

		in the band of 1529 nm to 1565 nm. Note the total receive power at amplifier on OSA /Power meter/EMS. e) **Mean channel input power** Make the Test set up as shown in the figure 6 & 7. Note the Mean channel input power at amplifier on OSA /EMS. f) **Maximum channel Power Difference (at point MPI-R & R'):** Make the Test set up as shown in the figure 6 & 7. Note the mean channel input powers for all channels on OSA /EMS. The difference between the channels having the lowest amplitude and one with highest amplitude shall be less than 6dB. g) **Multi Chl Gain Variation at Booster/Pre**

		amplifiers: Make the setup as shown in fig. 5 & 6. Configure simulated channels (spread over whole DWDM grid) through Tunable Laser source and connect it as input to the optical amplifier. The total input power to the optical amplifier is adjusted through an external VOA and readings are taken at the amplifier input/output on OSA/WDM analyzer. To simulate a nearly actual gain in the desired band for the Optical amplifier,through an external VOA, set the input power level of the Optical amplifier to maximum specified value of –3 dB at input and take the spectral reading on the OSA in EDFA mode. Shift the OSA to the output of the Optical Amplifier and

		take the spectral reading. Now take the gain of the each channel and record it. From the gain calculated from the readings, note difference, which shall be the Multi Chl gain varation. The Multi Chl gain variation in this case is less than 1dB in case of 100G and less than 2 dB in case of 200G system. Similarly, through an external VOA, adjust the input power to the Optical amplifier to minimum specified value of –8dB at input and record the spectral reading on the OSA in EDFA mode. Shift the OSA to the output of the Optical Amplifier and take the spectral reading. Now take the gain of the each channel and record it. From the gain calculated from the

		eadings, note the difference, which shall be the Multi Chl gain varation. The Multi Chl gain variation in this case is less than 1dB in case of 100G and less than 2 dB in case of 200G system. h) **Multi Chl Gain Tilt:** This is also referred as Inter-Channel gain-change ratio. This is defined as the ratio of the change in gain in each Channel to the change in gain at a reference Channel as the input conditions are varied from one set of input Channel power to second set input Channel powers. First, through an external VOA, adjust the input power to Optical amplifiers to its minimum specified level i.e., –8 dB at point R' (Input of Optical amplifier) . Now connect

		the OSA at the input of the Optical Amplifier as shown in figure 5, 6 & 7 and check the power spectral of each Channel and record it. Similarly, move the OSA to the output of the Amplifier i.e. at point S' with -8 db level in the input. Take the difference of output channel power and input channel power for each channel and calculate the Gain Similarly take the reading for maximum specified level i.e –3 dB at the point R' of Optical Amplifier and thereafter take the readings at point S' with the help of OSA and record the readings. From the set of reading at the input of the Amplifier and Output of Amplifier calculate the Gain of each channel. The Channel 40/80 shall be kept as

		reference channel. The gain tilt shall be Difference of Gain of an individual Channel at -3 dB input power to the Amplifier and -8 dB input power to the Amplifier divided by difference of Gain of Reference Channel under the same input power conditions to the Amplifier-In reading under two conditions for reference Chl is the gain tilt and its limit is 0.8 dB in case of 100G and 2 dB in case iof 200G. i) **Multi Chl Gain –Change Difference at Optical Amplifier:** This is also referred as Inter-Channel gain – change difference. The definition of Multi Channel Gain-change Difference is " For a specified Channel allocation, the difference in gain in one Channel with respect to

		the change in gain of another Channel for two specified sets of Channel input powers." To test this parameter make the test set up as shown in figure-5, 6 & 7. The Gain at the -3 dB and -8 dB Input powers to the amplifier is already recorded under the "Multi Channel Gain Tilt test. From the available readings, calculate the Gain change difference as under: Let G1 be the gain in Channel 1 under-3 dB and G1' under -8 dB input power condition and GX and GX' be the Gain of "X' channel under the same input power conditions of the Amplifier. Then the Gain change difference shall be: GD ={G1-G1'}- {GX-GX'}= ΔG1-ΔGX where as X=1 to 40/80 Note that the difference of highest and lowest

		readings which shall be the Multi Chl Gain change difference and the reading shall be ≤2dB. Similarly repeat the reading for each Optical amplifier. **j) Optical Signal to Noise Ratio (OSNR):** The purpose of this test is to take the Optical signal to Noise ratio of the DWDM link with the specified section loss and dispersion, which is 22 dB. Make the test set up as shown in figures 5, 6 &7, Program the DWDM Analyzer for the measurement of Optical Signal to Noise ratio measurement and the instrument shall have the provision of automatically taking the Optical signal to Noise Ratio. Record the reading. Alternatively for 100G

		signal, two methods are prevalent in the OSA for OSNR measurement – (i) Channel ON/OFF and (ii) Interpolation method. Make the test set up as shown in figures 5, 6 & 7, Program the OSA for the measurement of Optical Signal to Noise ratio measurement in Pol-Mux OSNR mode. Record the reading. OSNR will be calculated by OSA through interpolation method using these readings. **k) Signal Spontaneous Noise Figure:** NF is a test of the Amplifiers and is nor measured in the link. The instrument is connected to the input and output ports of the Amplifier where the instrument computes both the readings and

		gives the result of NF directly. Connect the OSA at the input of the Optical Amplifier as shown in figure 5, 6 & 7 and check the power spectral of each Channel on OSA in EDFA mode and record it. Similarly, move the OSA to the output of the Amplifier and check the power spectral of each Channel and record it. The instrument shall compute the input and output data and directly provides the Noise figure readings. The specs limit for the noise figure is < 7dB. Repeat the test for all the optical Line amplifiers one by one.
3.5.3	The Optical Amplifiers can be single stage/Mid Access type for booster amplifier with due implementation for gain-flatness, feed-back gain-control & channel-power balancing etc. and shall provide parametric compliance with Table 1a, 1b, 2a, 2b, 3 &	--as above--

	4/Annexure-I.	
3.5.4	There shall be active control and instantaneous adaptation of express traffic due to any degradation arising out from rapid reconfigurations. Sudden addition/removal of channels at intermediate site must not affect whole transmission of DWDM signals.	Please check that sudden addition/removal of channels at intermediate site must not affect whole transmission of DWDM signals.
3.5.5	The optical amplifiers shall respond automatically to changes in the number of channels without the need for manual intervention or realignment. Integrated VOA shall allow the amplifier units to automatically compensate for variations in span-attenuation due to ageing and splicing etc.	Ensure that optical amplifiers shall respond automatically to changes in the number of channels without the need for manual intervention or realignment. Check there are inbuilt integrated VOA to automatically compensate for span loss variations.
3.5.6	The adaptation response for restoration after ILA fault, fibre-plant restoration or change in power levels etc., shall be immediate. The Booster Amplifier, In Line Amplifier and Pre Amplifier shall support in built optical monitoring device, which will not apply the correction to channels to keep the spectrum flat, but also shall be used for the monitoring of optical monitoring as per ITU-T G.697. The parameters to be monitored are listed in the standard.	Check there is inbuilt optical monitoring so that adaptation response is immediate after fault restoration.
3.5.7	The system shall restore automatically on the restoration of link after fibre plant breakdown or a faulty amplifier.	--as above--
3.5.8	The optical amplifiers must implement the	Ensure that all the OAs

	following mechanisms to maintain error free system operation under dynamic conditions: a) **Fast gain control loop:** to protect against short term transient conditions such sudden loss of channels. b) **Slow output power control loop:** to protect against long term conditions such as fibre aging. The optical amplifiers shall be double-stage or triple-stage amplifiers that can accommodate the optical gain and power requirements up to a full channel capacity per node. **Note:** The above requirements shall hold for the optical amplifiers that are part of OADM, Mux & Demux also.	support gain control and power control.
3.6	ROADM nodes shall support following functionality:	
3.6.1	ROADM shall allow for full remote configuration to add/drop or pass-through any wavelength. It shall provide End-to-end service commissioning without visiting the intermediate sites.	Ensure that ROADM allows for remote configuration and reconfiguration.
3.6.2	In ROADM, since it is not clear beforehand as where a signal can be potentially routed, therefore there shall be a necessity of power balancing of these signals. ROADMs therefore shall also allow the automatic power balancing.	Check if automatic power balancing is provisioned in ROADM.
3.6.3	The ROADM shall be compact in size and shall require low power consumption and low	Ensure that ROADM provides add/drop

	insertion loss. It shall provide Express channel equalization. ROADM shall provide add/drop scalability from 0 to 32/40/64/80/96/flexible channels..	scalability from 0 to 40/80 channels
3.6.4	The ROADM node architecture can be (a) Coloured-Directional, (b) Coloured-Directionless, (c) Colourless-Directionless and (d) Colourless-Directionless-Contentionless . To enable ASON control plane node architecture must be Directionless. ROADM for optical service provisioning and restoration support for preplanned restoration	ROADM can be (a) Coloured-Directional, (b) Coloured-Directionless and (c) Colourless-Directionless but it is to be enabled by ASON control plane in case of directionless ROADM.
3.6.5	The ROADMs shall be provisioned with integrated VOAs (Variable Optical Attenuators) for DGE/automation and shall be in-service upgradable by a terminal from 2Degree-ROADM to Multi Degree-ROADM as per the requirement.	Check if ROADM is provisioned with Integrated VOA for automation.
3.7	The DWDM line transponders/interfaces shall implement the Forward Error Correction (FEC) algorithm as per ITU-T Rec. G.709, G.975 or G.975.1. The System shall support Hard Decision and Soft decision (SD) FEC mechanism for 100G/200G/300G/400G and above. Accordingly, Long Haul and Very Long Haul systems shall support either of following FEC coding gain: • OTN standard requires 7% Overheads FEC bytes with Hard-Decision (HD) decoding for a minimum Net Coding Gain (NCG) of 7.0 dB. • Soft-Decision (SD) decoder with 15% to	Check that the system supports out-of-band Forward Error Correction (FEC) with an enable / disable-through-the-EMS facility. Verify that with FEC enable, we get a BER of 10^{-12} and better.

	25% Overheads FEC bytes can improve NCG to 11 to 12.0 dB.	
3.8	The fibre-media as stipulated in this document shall be compliant to ITU-T Rec. G.652D/ITU-T Rec. G.657A single-mode optical fibre and ITU-T Rec. G.655 NZ-DSF fibre.	The fibre media shall be as per ITU-T Rec. G.652D/ITU-T Rec. G.657A single-mode optical fibre and ITU-T Rec. G.655 NZ-DSF fibre.
3.9	At the junction point, where the traffic from the terminating hop is to be patched onto the new originating hop, no RX-Transponder shall be required unless 3-R Regeneration of the channels is required or is specifically ordered by the purchaser.	This is for information that if a terminating lambda is required to transported through another originating hop, no transponder shall be required.
3.10	The equipment shall support Coherent Channel Systems to compensate the dispersion occurring in the link, equipped for the final capacity at the interface rate of 100G/200G/300G/400G and above.	Check coherent channel system (coherent receiver) is provided for dispersion compensation.
3.11	The manufacturer shall supply entire common hardware including ROADM, Mux/Demux, Coherent Channel System and embedded control & management software etc. for 32/40/64/80/96/flexible channels @ 100G/200G/300G/400G and above DWDM system on day one. The system shall hitlessly upgrade in field to any number of channels @100G/200G/300G/400G and above through insertion of Transponders/Muxponders cards and associated chassis only, to reach its full	Note that the ROADM, Mux/Demux, Coherent Channel System and embedded control & management software etc., for 40/80 channels @ 100G/200G DWDM system are provisioned on day one. No subsequent addition / deletion of any of these items shall be

	capacity..	allowed.
3.12	The removal/insertion of any Transponder/Muxponder card shall not disturb the working or deteriorate the BER of the other working channels in the system.	Configure the system for the check of BER on any channel and then insert and also extract any other Transponder/Muxponder card and observe that the BER is not disturbed at all. In case the BER is disturbed in the case of insertion as well as extraction of any other Transponder/Muxponder card, the equipment shall be rejected forthwith.
3.13	To accurately simulate the performance of the offered equipment under end of life conditions (i.e. equipment with aged components operating at maximum channels over aged fibre) and ensure successful transmission at 100Gbps/200Gbps/300G/400G and above per channel over high loss optical fibre, a comprehensive network planning tool shall be supported. The tool may be standalone or may be integrated in to EMS. The tool shall, among others, perform the following analysis and recommend the suitable hardware components as well as settings (i.e. optical power, gain) to mitigate the limiting effects: i) Attenuation (including optical fibre loss, system component loss and margins), ii) Chromatic dispersion (including required residual dispersion and dispersion	Ensure that the supplier of the equipment provides a network planning tool which may be either standalone or may be integrated in to EMS. The purpose of this n/w planning tool is to recommend the optimum settings of the optical power, gain etc. due to the factors like attenuation, CD, PMD, OSNR and also non-linear effects including XPM, SPM, FWM and SRS. The aging condition of the link can be simulated by

	compensation), iii) Polarization mode dispersion (including contribution from both optical fiber and system components), iv) Optical signal to noise ratio (OSNR) and v) Non-linear effects (inc. XPM, SPM, FWM and SRS) (optional) **Note:** DWDM Planning Tool shall be separate or integrated with NMS .	increasing the fibre loss in each span by 3 dB (i.e. 22dB+3dB) and the effects of the same may be analyzed.
3.14	As an option to the purchaser can ask DWDM system shall allow direct interface of any rate from 3rd party system as Alien wave to Mux input and the same signal shall be available directly from the De-multiplexer at the other end. In such cases, it may not be useful to use Transponders at either of the end points. That means the equipment shall support direct interworking with narrow wavelength coloured interface (as per ITU-T Rec. G.694.1 DWDM grid) from MSPP equipment for interfacing optical signals without Transponders..	Input a few coloured signals of the grid from some source such as tuneable laser source directly to the Mux equipment and observe them with a WDM Analyser that they are available at the output of the Booster Amplifier. Also, confirm that these signals are available at corresponding output ports of the Demux at other end.
3.15	The terminations for the unused channels shall be provided by the manufacturer as a part of the system. It shall be possible to equip the unused channel at a later date without affecting the existing traffic.	Note that the provision of the termination for the unused channels is proper. The unused channels are terminated with auto shutter type or Dust caps.
3.16	The system shall support one Optical	Ensure that the

	Supervisory Channel (OSC) as specified by ITU-T Rec. G.692 for the monitoring and configuration of OTM, ILA/DGE, OADM and ROADM on the route and shall be manageable from one location for the entire route via the EMS and LCT of the local equipment. All OSC related functions including transmission, termination and processing shall be integrated within a single card. The Optical supervisory channel is compliant to G.692 and uses the 1510 nm wavelength in both transmission directions. Optical shelf offers up to 16 OSC per NE as per node directions, each providing 12.5 Mbit/s or 150 Mbit/s bit rate OSC with a bandwidth of 10 Mbit/s or 75 Mbit/s respectively. This OSC design provides monitoring and configuration of OTM, ILA, DGE, FOADM,ROADM on the entire route, manageable from one location via the EMS or LCT of the equipment.	transmission, termination and processing of OSC channel is integrated within a single card. Separate cards for OSC extraction, OSC insertion and OSC processing should not be allowed. Also measure the wavelength of the OSC channel with a WDM Analyzer. It should be 1510 nm -/+ 10nm.
3.16.1	**Supervisory parameters:** The supervisory system of the equipment shall be capable of local & remote monitoring the following: 1. Input power of the Booster Amplifier 2. Output power of the Booster Amplifier 3. Laser temperature of the Booster Amplifier (optional) 4. Input power of the pre-amplifier 5. Output power of the pre-amplifier 6. Laser temperature of pre-	The supervisory system of the equipment shall be capable of local & remote monitoring the following of the Local and Remote equipment. Check that the parameters are possible to be monitored through the EMS. Record the results in the schedule given later in this document.

	amplifier(Optional) 7. Input power of the Optical Line Amplifier 8. Output power of the Optical Line Amplifier 9. Laser temperature of the Optical Line Amplifier(Optional) 10. Input power of the Insert Channel 11. Output power of the Dropped Channel 12. Input power of the Transponder 13. Output power of the Transponder 14. Laser temperature of the Transponder(Optional) 15. Input power of the individual optical channel 16. Input power of the Optical Supervisory Channel (optional) 17. Output power of the Optical Supervisory Channel (optional) 18. Laser temperature or Laser-Bias current of the Optical Supervisory Channel(Optional) 19. B-1 Errors of individual Transponders/Mux-ponder. 20. Total power at the input of Booster amplifier 21. Total power at the output of Booster amplifier. 22. Total power at the input of Line amplifier 23. Total power at the output of Line amplifier 24. Total power at the input of Pre- amplifier 25. Total power at the output of Pre- amplifier 26. Bit error ratio (BER) before FEC at OTU-4/OUT-Cn-line interface of the	Ensure that on crossing the limits an alarm shall be activated against each parameter listed.

	Transponders/Muxponders 27. Fan failure at OADM/ILA/DGE/OTM. 28. 100G/400G or above Transponder and Muxponder, as per Annexure-III	
3.16.2	The supervisory parameters shall be monitored and on crossing the specified limits an alarm shall be activated against each parameter listed as above. On the basis of nature of alarm, it shall be possible to mark it as Critical, Major and Minor.	**-do-**
3.16.3	The measurement accuracy of input/output power of the Booster/In-Line Amplifier/ Pre-Amplifier/ Transponders from the EMS of the system shall be within ± 1.0dB from the actual measured value on a wide-band Optical Power Meter.	-do-
3.16.4	The supervisory system shall provide necessary audio/visual alarm on equipment for indicating the alarms. Also from the EMS of the system it shall be possible to locate the faulty-section in the case the fibre is cut.	-do-
3.16.5	To maintain transparency and supervision capability of client services in accordance with ITU-T Rec. G.709, all client services shall be supervised by processing the ODU/OTU overhead bytes. At least path monitoring (PM) and section monitoring (SM) shall be supported.	-do-
3.17	The system shall provide software controlled Optical Pre-emphasis via Variable Optical Attenuators (VOA) in case of Fixed OADM's else use inbuilt mechanism when using WSS	Ensure that Variable Optical Attenuators (VOA) are provided for Optical Pre-emphasis. It is

	based ROADM's. The optical power per channel must be adjusted automatically, without using external measurement equipment. The adjustment arising out of adding/removing channels has to be done without manual adjustment.	desirable that the Pre-emphasis via Variable Optical Attenuators is software controlled.
3.18	The equipment shall have the provision for monitoring the performance of individual client through B1 byte of SDH. Also, in the case Ethernet support, there shall be the provision of analysis of Ethernet frames at GigE, 10 GE, 100 GE and 400GE Transponders on the client side..	Check that the client signals, SDH as well as Ethernet, can be monitored at the transponder and muxponders.
3.19	The equipment shall provide support for a comprehensive Element Management System (EMS). The managed-object database access protocol shall be either: TL-1, SNMPver.2c (or later) interface or any other communication mode based on any standard protocol stack shall be provided for South Bound Interface. In case of total loss of EMS connectivity, the sub-network shall continue to provide the services without any deterioration.	Test the SNMP v2c or any later version offered for testing with MIB browser.
3.20	The upgradeability of the equipment including Optical In-Line Amplifiers shall be possible without discarding the existing hardware.	Check that an ILA can be upgraded to either an OADM or TM without discarding the existing hardware. It should be mentioned by purchaser that ILA may be upgraded to TM or OADM in future.
3.21	The equipment shall provide built-in 'plug and	Check that to meet

	play' type of Optical Equalization/ Pre-emphasis, if any, to meet individual channel power difference (channel-power balancing) and individual channel OSNR requirements etc. No field adjustments such as use of external attenuators etc., at the output of Mux/Transponders shall be permitted for the purpose of equalization/gain adjustments etc.	individual channel power balancing, the Optical Equalization/Pre-emphasis are plug and play type for channel power balancing and individual channel OSNR requirements etc.
3.22	The equipment shall support built in soft selectable electronic optical attenuator or shall support built-in mechanism or shall support automatic gain control mechanism on the Booster amplifiers, ILAs and Pre Amplifiersto adjust the span loss as per the actual requirements of field. The optical attenuator shall be variable supporting upto 20 dB loss in steps of 0.5 dB. The manufacturer shall strictly comply with span-loss range for the ILAs & OADMs as per the standard to cope with parametric specifications of Table 1a, 1b, 2a, 2b, 3 & 4/Annexure I. The standard expects the ILAs and OADMs to be designed to cope with the span-loss range from 17-22 db for Longhaul& 23-28 dB for Very Long haul application codes, at a minimum.	Check that all the Optical amplifiers house software adjustable optical attenuator to adjust the span loss as per the requirements. Also ensure that the span loss of 17-22dB for LH and 23-28dB for VLH applications are attainable with these integrated attenuators.
3.23	From evaluation testing perspective, the client optical interfaces of the transponders at 10G/100G/400G bit rates shall be of different range/verity as per standard and asked in tender. Or other application codes may be demanded by the purchaser. The interfaces	Check as per the requirement of the clause. Note down the interfaces offered for testing.

	offered for testing shall be clearly marked out on the certificate..	
3.24	The equipment shall provide end to end performance at the BER of $1x10^{-12}$ at end of the life. To ensure end-of-life margins, the span lengths shall be tested for 3 dB higher values than that values specified during testing.	The BER should be 10^{-12} at the end of life. Therefore, at the beginning of life, each span length shall be tested with a 3 dB higher value. Similarly, the receiver sensitivity of Optical channels shall be 3 dB lower than the value specified.
3.25	The equipment shall adopt standard mapping techniques for GFP/GMP/AMP mapping. Forward Error Correction coding and multiplexing techniques as per ITU-T Rec. G.7041, G.975.1 and G.692 standards respectively. The output of Muxponder/Transponder shall be in a standard ITU-T format.	Ensure that GFP, FEC and multiplexing technique of Transponders and Muxponders are as per ITU-T standards.
3.26	There shall be sufficient sideways space for the running of the fibres/cables for inter- rack cabling etc. It shall be possible to handle the cabling from the front or rear side.	Ensure that sideways space is only utilized for running cables for inter rack connectivity.
3.27	There shall be provision of in-service monitoring points for the optical power, channel wavelength and OSNR measurement (Optional) at output points of Optical Amplifiers (including ILA's), OADM's, Mux & input point of Demux.	Check as per the requirement of the clause.
3.28	**Online Optical performance Monitering** The optical monitoring of the DWDM system	Check that monitoring points for the OBA, OPA,

	shall provide the facility of locally and remotely monitoring of some important parameters as specified in the ITU-T Rec. G.697. The system shall support centralized configuration for optical-layer parameters. Specifically, it shall perform monitoring and analysis of 100G/200G/400G and above system performance and in-service performance optimization, support visualized analysis of optical-layer performance data (such as multiplexed-wavelength optical power, single-wavelength optical power/OSNR(Optional), BER, gain, attenuation, fiber loss, and flatness) and comparison with historical performance data. The system shall monitor and report network optical-layer performance in real time to EMS. The system shall monitor main optical path performance, flatness, and input optical power of the receive-end OTU board. After receiving the error information reported by equipment, the system shall uniformly process the error information and starts optimizing abnormal trails. The system shall perform the following optical-layer performance optimization: line loss compensation optimization, optical power optimization, and optical signal-to-noise ratio (OSNR) equalization. The system will support following measurements: I. **Channel power:** a. Channel power at the DWDM transmitter	ILA have been provided wherein Channel power, OSNR (Optional), wavelengths are possible to be measured. Also, ensure that when any instrument is connected to such a monitoring point, the main transmission path is not affected.

	output before the multiplexer. b. Channel power at the DWDM receiver input after the demultiplexer. c. Channel power at the output of various stages of optical amplification(optional).. II. **Total power**: The equipment shall support the total channel powermeasurementsat the following points: a. Total power at input of various stages of optical amplification. b. Total power at output of various stages of optical amplification. III. The BER before FEC shall also be monitored by analyzing of the number of corrected bits by FEC as specified in ITU-T Rec. G.798. IV. **Fiber performance Monitoring (Optional)** The DWDM system or a separate system shall support to monitor and manage line fibers in a network. By precisely detecting the fiber connection status, the system shall help maintenance personnel to analyze the quality of fiber connectors and splicing points, which facilitates quick fiber issue diagnosis.In a WDM system, fiber issues, such as fiber aging, fiber damages, fiber coiling, large-radius bending, and large pulling stress, may cause large fiber attenuation and high BERs that will consequently impair network operating.	

3.29	**Jitter & wander:** The output jitter and input jitter tolerance specifications (considering the worst-case channel) for transponders, at all DWDM channels, shall be as per relevant ITU-T Recs. G.825 and G.783 for SDH and as per IEEE 802.3 standards for Ethernet client signals. The jitter and wander for the ODU (OTN) shall be as per ITU-T Rec. G.8251.	**Input Jitter Tolerance :** Configure the SDH Analyzer for Jitter and wander measurement. Select the option Maximum Tolerable Jitter (MTJ) mode. Now connect the output of the SDH Analyzer to the SDH client input of the Muxponder and client output of the corresponding Muxponder to the input of SDH Analyzer. Physically loop the Muxponder line. In the case the SDH Analyzer has got the Input Jitter Tolerance function option built in the instrument then run the mask directly on the Muxponders client ports. In the case the SDH Analyzer does not support an option as “Input Jitter tolerance function “, conduct the test by conventional method detailed as under; From the Transmitter of the SDH Analyzer select the Bit rate as STM-64, and select the Input Jitter tolerance mask at STM-

		64 bit rate from the Jitter/wander from the menus. Select the receiver part of the instrument for jitter measurement. Select the frequency vs amplitude mask mentioned below or programme the mask manually. Now connect the output of the SDH Analyzer to the input of the transponder and output of the corresponding transponder at Demuxer to the input of SDH Analyzer. In the case the SDH Analyzer has got the Input Jitter Tolerance function option built in the instrument then run the mask directly on the transponders Input Jitter Tolerance mask shall comply with G.825. Attach the printouts of the test results **Jitter Transfer:** Configure the SDH Analyzer for Jitter and

		wander measurement. Configure the SDH Analyzer for Jitter and wander measurement. Select the option Jitter Transfer Function (JTF) mode. Loop the SDH Analyzer at aggregate level. Run JTF test for reference values. Now insert the DUT into the circuit i.e connect the output of the SDH Analyzer to the client input of the muxponder and client output of the corresponding muxponder to the input of SDH Analyzer. Physically loop the Muxponder line. Now run the JTF test again. Jitter input mask to transponders input: Comply with G.783. **Jitter Generation (To be taken during the Environmental cycle also)** Configure the Jitter tester for Jitter and wander measurement. Select the option manual mode. Connect client output port

		to the Rx port of the instrument. Select the proper filters and run the instrument. Allow the measurement to continue for 1 minute. **Limits: For 10G :** 20kHz to 80 MHz =1.5 UI 4MHz to 80 MHz = 0.15 UI **Limits: For 40G :** 80kHz to 320 MHz =1.5 UI 16MHz to 320 MHz = 0.18 UI
3.30	**Monitoring points:** There shall be the provisioning of monitoring points for monitoring of channel power, OSNR and wavelengths at the output points of Booster Amplifier, In Line Amplifier and Pre-amplifier using external OSA/DWDM analyzer etc. These points shall be suitably connectorised and on connection of a measurement device, the main transmission path shall not be affected at all.	Check the provision for monitoring points for monitoring of channel power, OSNR and wavelengths at the output points of Booster Amplifier, In Line Amplifier and Pre-amplifier using external OSA/DWDM analyzer.
3.31	**Type of connectors:** The connectors used at the OTM, Optical Amplifiers and OADMs shall be SC/LC/E2000 type with automatic shutters having spring-action or provision of closing them manually.	Note that the connectors at the equipment is SC, LC or better connectors. The connectors at the

	When out-of-use, they shall remain closed or otherwise the optical connectors shall be so positioned as to be leaning down towards ground to avoid direct laser-beam incidence on the user. The Return Loss of the optical connectors shall be ≥40dB. At the ODF/FDF-end, the connectors used shall be FC/APC/UPC type.	FDF side shall be FC/APC type. In case this is not FC/APC type, two sets of suitable patch cords for each port. **Also, ensure that the return loss of the connectors is ≥ 40 dB**
3.32	**Error Performance:** The equipment shall support the following performance parameters relating to the ODU-k as specified in ITU-T Recs.G.8201 and G.7710. 1. Optical Channel Transport Unit Background Block Error (OTU_ BBE). 2. Optical Channel Transport Unit Errored Second (OTU_ ES). 3. Optical Channel Transport Unit Severely Errored Second (OTU_ SES). 4. Optical Channel Transport Unit Unavailable Second (OTU_ UAS). 5. Optical Channel Transport Unit Far End Error Background Block Error (ODU_FEBBE). 6. Optical Channel Transport Unit Far End Errored Second (ODU_FEES). 7. Optical Channel Transport Unit Far End Severely Errored Second (ODU_FESES) 8. Optical Channel Transport Unit Far End Unavailable Second (OTU_ FEUAS). 9. Optical Channel Data Unit Path Monitoring Background Block Error	Transmit any OTU-k signal from an instrument and connect the output of the instrument to the input OTU-k port of the equipment. Receive the same signal at the other end of the system and connect the same to the receive port of the same instrument or another instrument. Verify the performance parameters one by one and note the observation in the table.

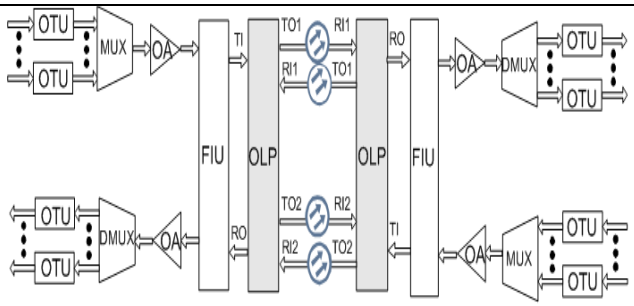
	(ODU_PM_BBE). 10. Optical Channel Data Unit Path Monitoring Errored Second (ODU_PM_ES) 11. Optical Channel Data Unit Path Monitoring Severely Errored Second (ODU_PM_SES). 12. Optical Channel Data Unit Path Monitoring Unavailable Second (ODU_PM_UAS). 13. Optical Channel Data Unit Path Monitoring Far End Error Background Block Error (ODU_PM_FEBBE). 14. Optical Channel Data Unit Path Monitoring Far End Errored Second (ODU_PM_FEES). 15. Optical Channel Data Unit Path Monitoring Far End Severely Errored Second (ODU_PM_FESES) 16. Optical Channel Data Unit Path Monitoring Far End Unavailable Second (ODU_PM_FEUAS)	
3.33	**Alarms requirement:** The equipment shall support the generation of following alarm conditions and it shall also be able to report alarms when integrated with the EMS: 1. Input power failure of the Transponder/Mux-ponder interface (including Ethernet interfaces). 2. Input power failure of the Amplifiers 3. Output power failure of the Amplifiers 4. Fan/s failure	Simulate the fault/error conditions and ensure that the alarms are reported in the EMS. Note down the observation in the table. Check that these alarms can be categorized as Urgent, Non-urgent and Deferred, with threshold

	5. Output power out of range for OA, ROADMs 6. Input power out of range for OA, ROADMs 7. Loss of input at Optical Add/Drop Multiplex equipment 8. Input channel failure at Optical Add/Drop Multiplex equipment 9. Hardware mismatch alarm 10. Low input power at Transponder 11. Low input power at OA, Optical Add/Drop multiplex equipment 12. Degraded input at OA, Optical Add/Drop multiplex equipment 13. Degraded output of OA, Optical Add/Drop multiplex equipment 14. Degraded output of the dropped channel. 15. GMP related alarm for GE clients. (Optional, may be decided by the purchaser)	programming by software, wherever applicable.
3.33.1	The equipment shall support following ODU-k related alarms, as listed in ITU-T G.798 and it shall also be able to report these alarms when integrated with the EMS: 1. OTU-k Loss of Frame alarm (OTU -LOF). 2. OTU-k Loss of Multiframe alarm (OTU -LOM). 3. Loss of Payload alarm (LOS-P). 4. OpenConnection Indication alarm (OCI). 5. OTU-k Degrade Defect alarm. 6. OTU-k Trace Identifier Mismatch alarm (OTU-k TIM). 7. OTU-k-AIS alarm	Simulate the fault/error conditions and ensure that the alarms are reported in the EMS. Note down the observation in the table.

	8. OTU-k Backward Defect Indication alarm (OTU-BDI). 9. OTU-k Payload Mismatch alarm. 10. ODU-k AIS alarm at path layers 11. ODU-k Backward Defect Indication alarm (ODU-kpBDI) at path. 12. ODU-k Locked Defect alarm at path layers. 13. ODU-k signal degrade alarm (ODU-kpDEG) 14. ODU-k loss of frame and multi frame. ODU-LOFLOM) 15. ODU-k Trace Identifier Mismatch alarm (ODU-k TIM) at path level. 16. ODU-k Payload mismatch alarm at path level (ODU-kp PLM). **Note:** These alarms shall be categorized as Urgent, Non-urgent and Deferred alarms, with threshold programming by software, wherever applicable.	
3.34	**Laboratory and Field testing of DWDM equipment:** The equipment shall be subjected to laboratory and field testing as per below schedule: **a) In Laboratory:** BER performance over a simulated-section shall be tested for 48 hours and BER performance shall be better than 10^{-12} (with FEC enable). For Ethernet clients, end to end IETF RFC 2544 compliance and ITU-T G.7041 – GFP mapping compliance shall be tested.	Check the BER performance over simulated-section (end-to-end) for 48 hours on a channel in the link. BER performance shall be better than 10^{-12} with FEC enable. Also, run an RFC-2544 tests on an end-to-end

	b) In field: BER performance for 48 hours shall conform to ITU-T Rec. G.828 for SDH payloads. For Ethernet clients, end to end IETF RFC 2544 compliance and ITU-T G.7041 – GFP/GMP/AMP mapping compliance shall be tested.	basis for any 10 GbE/100GbE port and ensure that the parameters such as throughput, latency and frame loss are ok.

<table>
<tr>
<td>3.35</td>
<td>
Network Protection:
The document specifies multiple protection at the DWDM/Optical level.
<table>
<tr><th>Protection</th><th>Description</th></tr>
<tr><td>Optical Line Protection (50 ms Protection)</td><td>It uses the dual fed and selective receiving function of the Optical Line Protection Switching device board to protect line fibers between adjacent stations by using diverse routing. Refer Fig.12 below.</td></tr>
<tr><td>Client 1+1 Protection (50 ms protection)</td><td>It uses the dual fed and selective receiving function of the Optical Line Protection Switching device board to protect the OTU and the OCh fibers. Refer Fig.12 below.</td></tr>
</table>
<u>Optical line protection</u>
</td>
<td>Remove the working fiber from line or client port and verify that the equipment restores back instantly i.e within 50 ms in case of Optical line protection and Client 1+1 protection.</td>
</tr>
</table>



Client 1+1 protection

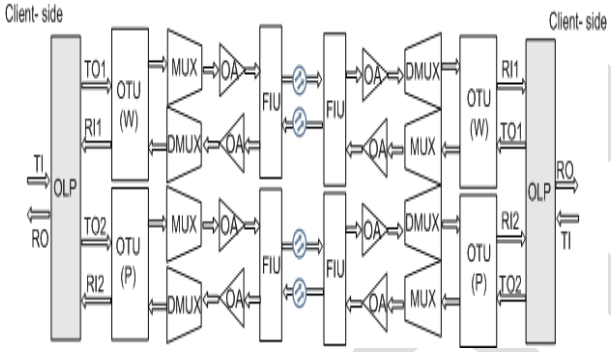


Fig 12: Diagram of OLP protection for 1+1 line & 1+1 client protection

Notations in the diagrams

OTU: Optical transponder unit

OTU(W): Optical transponder unit – Work Path.

OTU(P): Optical transponder unit – Protection path

MUX: Optical multiplexer

DMUX: Optical de multiplexer

OA: Optical amplifier

FIU: Fiber interface unit (For multiplexing & de multiplexing OSC)

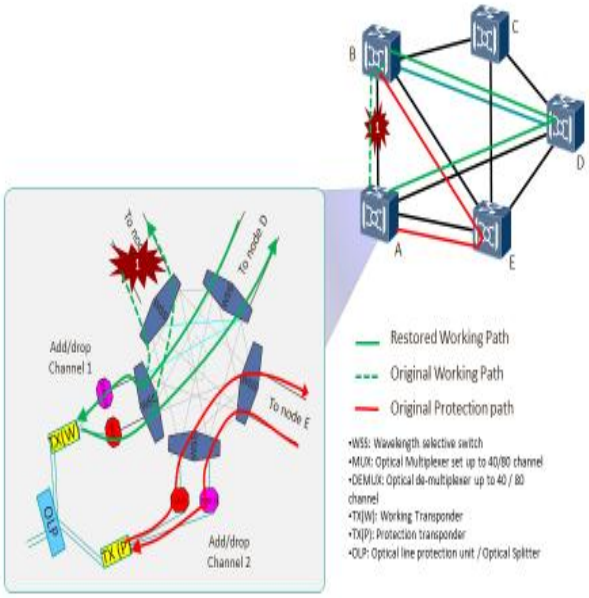
TO1: Transmit output 1

RI1: Receive input 1

TO2: Transmit output 2

RI2: Receive input2

3.36	In case of total loss of EMS connectivity, the performance data of the NE shall be stored in the controller card of the equipment, and shall be sent to central EMS server upon restoration of EMS connectivity. Minimum 6400 performance and fault data messages containing a minimum of 100 alarms shall be stored by the system.	Check as per the requirement of the clause.
3.37	**ASON Feature**	
3.37.1	The Automatically Switched Optical Network (ASON) has been defined in ITU-T Recommendation G.8081. The architecture of ASON is defined in ITU-T Recommendation G.8080. The ASON software provided by vendor shall be applied to the offered Metro DWDM equipmentonly to support the evolution from a traditional network to an ASON network. Such evolution complies with the ITU ASON related standards, such as G.7712 for call and connection management, G.7714 for auto-discovery technology, G.7712 for DCN, G.7715 for routing and G.7716 for link management.	Refer clause 3.37.3.
3.37.2	ASON technology involves signalling, switching and a control plane to enhance its network connection management and recovery capability. ASON technology shall provide wavelength-level ASON services at the optical layer for Metro DWDM system. It shall also supportend-to-end service configuration and the service level agreement (SLA). A typical ASON network is shown in the Figure.13 in the standard.	Refer clause 3.37.3.

	 **Figure 13-ASON protection and Management schematic**	
3.37.3	The ASON shall support following features:	
a.	It shall support automatic wavelength restoration on available path based on optical viability using Layer-0 Control Plane (WSON). •	Type of service with restoration enabled (Diamond or silver) should be selectable via GUI/NPT, whenever a fibre fault happens, automatic restoration should happen, provided a restoration path is available.
b.	Wavelengths can be automatically allocated for newly created services.	Service created via GUI/NPT, a wavelength should get automatically allocated, if no pre-configured wavelength

		with empty clients is available.
c.	Automatic configuration of end-to-end services.	For a client service configured via GUI/NPT a wavelength should get allocated automatically to the client.
d.	Automatic discovery of topology.	When NEs are connected and installed with pre-defined GNE in a network discovered network topology should be visible on GUI. This topology should be similar to physical network.
e.	Provides mesh networking that enhances the survivability of the network.	Automatic discovered topology should be mesh, if physical topology is mesh. In case of protection in mesh network, restoration on multiple cuts should happen if path exists.
f.	Supports different services which are provided with different levels of protection.	same a section 3.35
g.	Provide traffic engineering in such a way that user shall be able to do constraint based routing of the services.	'Network Planning Tool' should allow user to define TE parameters such as metric, color, SRLG. Same values should be visible on LCT/EMS. Routes selected should be based on these

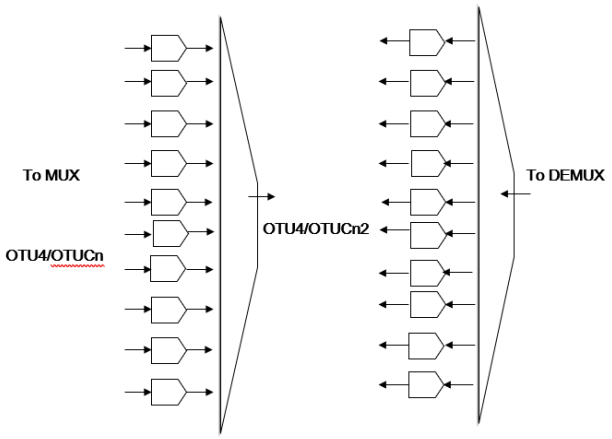
		constraints as selected in NPT.
h.	User shall specify the functionality of Layer-0 (WSON) Control which he intend to use in the network which can be implemented by the vendors byusing different protocols to ensure the intended functionality as desired by the user.	User should be able to select hardware and its configuration in NPT. Same wavelength should be used end-to-end (single light path). Same can be managed via LCT/EMS. Also ASON rerouting logs should be available in EMS/NMS. Signaling and routing for the selected hardware should be done using different ASON/GMPLS protocols.
3.38	**Diversified SLA (Service Level Agreement)** ASON supports services with different protection levels, that is, diamond, silver, and copper services. Services with different protection levels are charged differently. Such diversified service schemes are more flexible in meeting customer requirements. Table 1 Service levels available by ASON	a) NPT should provide protection schemes Diamond Service (1+1 with restoration and protection time 50 ms), Silver Service(pre-plan restoration for multi-cuts) and Copper Service (no protection) b) In case a fault happens in Diamond service switchover should happen within 50ms and in case of Silver within reasonable time (depending on hardware

		ttribute Service	*Protection and Restoration Scheme*	*Implementation Means*	*Performance*	selected).
		Diamond service	1+1 Protection with restoration.	1. Client 1+1 protection 2. Rerouting	1.Switching time < 50ms 2.Protect multi failures	
		Silver service	Restoration	1.Dynamic Restoration or pre plan restoration 2.Pre or post Calculation Restoration with proper 3R planning	Protect multi failures	
		Copper service	No protection	-	-	
3.39	The equipment shall support the generic requirements of fault, configuration, security, software, inventory and performance management when interfaced with EMS/NMS.					When interfaced with EMS/NMS, check that system support Element management system

	The details of these management functions is mentioned under Element Managements System later in this standard.	detailed under clause 14.0.
3.40	**LCT interface of NE:** The system shall provide at least one Local and remote Management Interface at each NE - a Terminal, an ILA, an OADM or 3-R DWDM Regenerator. The equipment shall provide an Ethernet port for Work Station connectivity with standard RJ-45 connector.	Check the provision of two management interfaces: remote management interface and Local Management Interface. Ensure that an Ethernet port with RJ-45 connector has been provided for Work Station/Network Server connectivity.
4.0	**Operational requirements:**	
4.1	The manufacturer shall guarantee satisfactory performance of the equipment without any degradation up to an altitude of 3,000 metres. A certificate to this effect shall be admissible.	Get a test certificate from the manufacturer.
4.2	The equipment shall be able to work without any degradation in saline atmosphere near coastal areas and should be protected against corrosion. A certificate to this effect shall be admissible. (Optional)	Get a test certificate from the manufacturer.
4.3	Visual indication to show power ON/OFF status shall be provided.	Verify whether any visual indication is provided to show the power ON/OFF condition.
4.4	Suitable visual indications shall be provided. (It is suggested that 'green' colour for healthy and 'red' colour for unhealthy conditions may be provided. Some other colour, preferably 'Amber', may be used for non- urgent alarms.)	Ensure that a healthy condition is indicated by green colored LED and 'red' colour is used for unhealthy conditions.
4.5	The software/hardware in equipment shall not	Verify that in case of any

	pose any problem due to changes in date and time caused by events such as changeover of millennium/ century, leap year etc., in the normal functioning of the equipment.	changeover such as millennium/ century, leap year etc., the software/hardware in equipment does not pose any problem in the normal functioning of the equipment.
4.6	**Redundancy requirements:** If the Controller/Processor unit/module failure does not affect the working traffic, no redundancy of Control/Processor unit shall be required. There shall be no disruption to the healthy operation of the equipment upon failure of controller/processor card. However, if the Controller/Processor unit failure does result in traffic failure, then (1+1) hot-standby mode redundancy of Controller/Processor shall be provided in the equipment. Further, there shall not be any disruption to system-working when the faulty card is taken out and the healthy one is inserted back. Immediately upon insertion of a healthy card, the system shall revert back to its pre-failure EMS configuration. There shall be support for dual-homing for EMS connectivity for no loss of EMS connectivity, through two Gateway NEs (GNE's) on a DWDM link. In case of total loss of EMS connectivity to the system/network, the system design shall provide local storage of all performance & fault data, as specified in Appendix-I of the standard, for all connections pertaining to all NEs, in the sub-network.	Check that if the control/processor unit fails, the working existing traffic does not fail or is not affected any way. This can be ensured by simulating a BER measurement and at the same time removing the control/processor unit. Under this condition, no error should be detected. Upon re-insertion of the unit back in its place, the BER should not be disturbed. It shall also be possible to designate any NE as GNE. The system shall support connectivity to two GNEs for dual homing such that the fault, performance data are stored in both the GNEs.

	Such connectivity loss might happen due to control-card failure at both GNE's and/or failure of DCN link to EMS. In-built intelligence shall be there in EMS for selection of appropriate GNE at distant end of a DCN link upon failure of control card at one of the GNE's, for EMS connectivity.	Failure of connectivity to one shall not amount to total loss of EMS data.
5.0	**Muxponders and Transponders** The DWDM equipment shall support various types of Fixed/Tunable Muxponders and Transponders. As per purchaser requirement, the Muxponders and Transponders can also be two port types and shall be provided with tuneable lasers for the DWDM line interface covering the complete C-Band i.e., 32/40/64/80/96/flexible count discrete wavelengths at 150/100/75/50 GHz/Flexible spacing with 3R functionality. If desired by the purchaser, the same can be of single port type. It is envisaged that all the client optics shall be of pluggable type (through SFP+/QSFP/QSFP-DD) for easy in-service upgrades & maintenance ease. Respective DWDM line interface of the Transponder/Muxponder shall be automatically verified by the system controller for correctly provisioned wavelength. The tuning shall happen automatically without using LCT/ EMS as soon as the card is inserted in the equipment Following is the details of Muxponders and	The DWDM equipment shall support various types of Fixed/Tuneable Muxponders and Transponders.

	Transponders, which shall be supported by the DWDM equipment.	
5.1	**Fixed/Tuneable Muxponder** Single port or multiport Muxponder can be used to multiplex multiple STM-64 bit rates SDH payloads or multiple 10GigE/100G or higher bit rate interfaces to form 100Gbps/200Gbps/400G or above coloured wavelength to Mux/Demux, after carrying out Forward Error Correction (FEC) encoding such as super-FEC specified in ITU-T G.975.1. The Muxponders shall be used at TX as well as RX end and shall be interfacing the Mux/Demux component of DWDM equipment.	No test needed. It is for information only.
5.1.1.1	**100G/200G/400G and above MUXPONDERS**  **Figure14: 100G/200G/400G and above Muxponder.**	Note that the equipment supports four types of Muxponders: I. 100G SDH Muxponder shall have 10 x STM-64 input ports and multiplex them to form a 100G signal. II. 100G Ethernet Muxponder shall have 10 x 10 GigE input ports and multiplex them to form a 100GE signal.

		III. 100G OTN Muxponder shall have 10 x OTU-2/2e input ports and multiplex them to form a 100G signal. IV. A combo type muxponder using STM-64, 10 GbE and OTU-2/OTU-2e input ports and multiplex them to form a 100G signal. Check that the function of FEC and Super-FEC in same boards can be enable/disabled through LCT/EMS. The following tests shall be taken at each of the Muxponders. **1.Receiver sensitivity of Muxponder:** Make the setup as shown in figure 4. Connect the Optical power output of OTU-2 Analyzer to the to the client input of the

		transponder under test. Connect the client output of the corresponding Muxponder at the Optical receive port of OTN Analyzer. Now add the attenuation in the path of 100G line by variable attenuator. Note the errors in the analyzer. When the equipment under test starts giving the errors, reduce the attenuation slightly to receive error free signals. Monitor the signals at OTN Analyzer for 15 minutes (BER minimum 10^{-12}). Note that the receive ports should not give an error up to a level 3 dB below the receiver sensitivity value specified for the application code in the tables for 100G/200G. 2. **Receiver overload of Muxponder:** Under the same test setup keep the variable attenuator to a value of 10 dB and thereafter reduce the attenuation allowing

		increase in the power. At the stage the errors are received on analyzer, increase the attenuation slightly so as to receive no errors. Monitor the data for 15 minutes (BER minimum 10^{-12}). Read the input power of the interface by using a power meter. Make the test setup as shown in figure 3 and measure receiver sensitivity and receiver overload at line side. **3. Eye pattern:** Make the setup as shown in figure 2. Connect the output of Muxponder to the Optical Modulation Analyzer (OMA). From the selection menu of the OMA select the Eye pattern function and bit rate 100G. The instrument shall display the built in standard mask of eye pattern as per ITU-T G.959.1 and the eye pattern of the equipment under test shall also be

		displayed. Note that the eye pattern equipment under test shall fall within the built in standard mask of the 100G. Take the printout of the mask and attach the prints. **4. Extinction ratio/EVM** From the same setup of eye pattern record the EVM value from constellation diagram for 100G signal from OMA. Also, print outs may be attached. **5. Optical Return Loss:** Procedure to measure Optical Reflectance Test instrument include optical return loss tester. Fig.1 shows the test setup. 1) Calibrate optical return loss according to the instrument user manual; 2) According to the test setup, connect the setup, and get the optical receiver reflectance test result (expressed in dB).

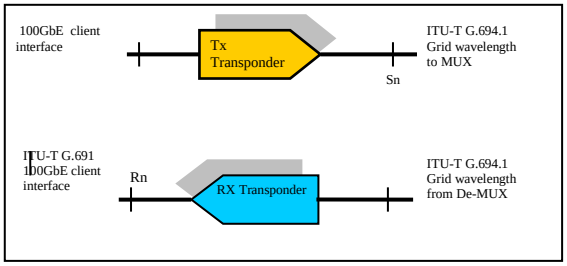
		6. Center Frequency: Make the test setup as shown in figure-2. Record the center frequency of tuned channel. Central freq : 193.1 THz **7. Center Frequency drift:** The test set up for the Center frequency drift shall be same as Center frequency From the test results of centre frequency note down the drifrt w.r.t to the specified frequencies for each Chl. The permissible drift shall be ±25pm. Record the drift in the table shown for centre frequency above. **8. Optical Spectral width:** Make test setup as shown in figure-2. Connect the Output of the Transponder to the Optical spectrum analyzer (OSA) and program the instrument for the measurement of optical spectrum. From the spectrum, record the Spectral width at 20dB point and Side Mode

		Suppression Ratio (SMSR): Specifications: Side Mode suppression Ratio: ≥30dB Spectral width at –20 dB: ≤0.5 nm **9. Launched power:** Connect the output of the Transponder to the Optical power meter and record the transmitted power of the Transponder/Muxponder.
5.1.2	**200G Tunable Muxponder** a) The client side of this type of Muxponder shall accommodate 10XSTM-64/10GE-WANPhy/10GE-LANPhy/ interfaces and 1x100 G Client. This type of Muxponder shall map up to 10 nos. of optical client STM-64/10GE-WANPhy/10GE-LANPhy streams individually into OPU-2/2e>>ODU2/2e frame format and 1 no. of Optical Client 100 G, which shall subsequently be multiplexed into OTUC2 frame format and transported via a 200 G optical wavelength in the DWDM grid as per ITU-T Rec. G.694.1. Hence, the DWDM line signal shall be an OTUC2 including Super-FEC as per ITU-T	Note that the equipment supports following types of Muxponders: 1. 200G SDH Muxponder shall have 20 x STM-64 input ports, multiplex them to form a 200G signal. 2. 200G Ethernet Muxponder shall have 20 x 10 GigE input ports and multiplex them to form a 200GE signal.

	standard. b) The client side of this type of Muxponder shall accommodate 20XSTM-64/10GE-WANPhy/10GE-LANPhy interfaces. This type of Muxponder shall map up to 20 nos. of optical client STM-64/10GE-WANPhy/10GE-LANPhy streams individually into OPU-2/2e>>ODU2/2e frame format which shall subsequently be multiplexed into OTUC2 frame format and transported via a 200G optical wavelength in the DWDM grid as per ITU-T Rec. G.694.1. Hence, the DWDM line signal shall be an OTUC2 including Super-FEC as per ITU-T standard. c) The client side of this type of Muxponder shall accommodate 2x100 GE/2xOTU4/ (mix of 1x100 GE and 1xOTU4) interfaces. This type of Muxponder shall map up to 2 nos. of optical client into OPU-4/4e>>ODU4/2e frame format which shall subsequently be multiplexed into OTUC2 frame format and transported via a 200 G optical wavelength in the DWDM grid as per ITU-T Rec. G.694.1. Hence, the DWDM line signal shall be an OTUC2 including Super-FEC as per ITU-T standard.	3. 200G OTN Muxponder shall have 20 x OTU-2/2e input ports and multiplex them to form a 200GE signal. 4. A combo type muxponder using STM-64, 10 GbE and OTU-2/2e input ports and multiplex them to form a 200G signal. 5. A combo type muxponder using STM-64 and 100 GbE/OTU-4 input ports and multiplex them to form a 200G signal. 6. A muxponder having 2XOTU-4 optical client mapped into OPU-4/4e>>ODU4/2e frame format which shall subsequently be multiplexed into OTUC2 frame format and transported via a 200 G optical wavelength.

5.2	**Transponder:** Following types of Transponders are envisaged in the standard: Type-I: OTU4 Transponder Type-II: 100GE/400G Ethernet Transponder	Note that two types of Transponders are equipped in the system - OTU4 Transponder, and 100G Ethernet transponder. Also, ensure that these transponders as well as the muxponders are provided with tuneable lasers for the DWDM line interfaces each covering the complete C-Band i.e., checking that each transponder can be tuned at the line side any wavelength at 50 GHz channel spacing within the C-band i.e., within 1529 to 1565 nm. The tuning of the transponders as well as the muxponders shall be through the LCT/EMS.
5.2.1	**Type-I: OTU4 Transponder** (a) One OTU4 client shall be mapped directly on DWDM coloured wavelength after regeneration and implementation of FEC algorithm. The Transponder shall interface OTU4 client from LAN and convert to electrical signal to carry out 3R functionality, subsequently to make it a data module of OTU-4 format as per ITU-T	The following tests shall be taken at each of the Transponders. Test will be same as mentioned in clause 5.1.1.1 for Muxponders.

	Rec. G.709. The Forward Error Correction (FEC) encoding shall be performed on the OTU-4 and computed redundant symbols of FEC shall be added as overheads to the OTU-4 data as per the algorithms of ITU-T Rec. G.975.1 for super FEC. The electrical data of OTU-4 with FEC data computed on it shall be assigned a discrete wavelength of ITU-T DWDM-Grid as specified in G.694.1. Such OTU-4 client then subsequently shall interface Mux part of DWDM equipment. (b) In the receive side, optical data received at the input of transponder having OTU4 and super FEC contents shall be brought to electrical stratum, the super FEC decoder shall perform error correction and shall be extracting the redundant symbols and shall regenerate that data that was encoded by the FEC coder. The OTU4 pay load shall go for electrical to optical conversion, as per the interface requirements. (c) The client optical interface at 'Receive Transponder' output towards 'Terminal Receiving Equipment' (TRE) for client interfaces shall be 1550nm single-mode interface. For OTU4 client's optical interfaces also, the equipment shall comply with the parametric requirements of Tables 1a,1b, 2a, 2b, 3 &4/Annexure-I, at 'Sn' & 'Rn' reference points.	



Figue15-TX & RX Transponder interface.

Note: The transponders described above shall provide 3-R functionality.

5.2.2	**Type-II: 100GE/400G Ethernet Transponder** (a) One 100GbE/400G client shall be mapped directly on DWDM coloured wavelength after regeneration and mapping necessary overheads for ODU and FEC. The Transponder shall interface 100GbE/400G data from LAN and convert to electrical signal to carry out 3R functionality, thereafter, the necessary processing of payload shall be done to add overheads of OPU/ ODU to make it a data module of OTU-4/OUT-c4 format as per ITU-T Rec. G.709. The Forward Error Correction (FEC) encoding shall be performed on the OTU-4/OUT-c4 and computed redundant symbols of FEC shall be added as overheads to the OTU-4/OUT-c4 data as per the algorithms of ITU-T Rec. G.975.1 for super FEC. The electrical data of OTU-4/OUT-c4 with FEC data computed on it shall be assigned a discrete wavelength of ITU-T DWDM-Grid as specified in G.694.1. The100GbE/400GE Ethernet data formatted in OTU-4/OUT-c4 format with added FEC, in optical domain shall interface Mux part of DWDM equipment. The optical interface of 100Gigabit Ethernet shall be 100GBASE-LR4 or 100GBASE-ER4 as per IEEE 802.3ba at 1550 nm window on single-mode fibre similarly 400G client interface with different IEEE standards. Figure 15 above, show a block schematic of a typical 100GbE transponder.	-as above-

	(b) In the receive side, optical data received at the input of transponder having OTU4/OUT-c4 and super FEC contents shall be brought to electrical stratum, the super FEC decoder shall perform error correction and shall be extracting the redundant symbols and shall regenerate that data that was encoded by the FEC coder. The payload data in OTU4/OUT-c4 format shall be demapped and overheads shall be removed and 100GbE/400G payload shall be reconstructed. The 100GbE/400G pay load shall go for electrical to optical conversion, as per the interface requirements. 100GbE/400G payload shall be assigned a grey wavelength, meeting the interface specifications of 100GBASE-LR4 or 10GBASE-ER4 as per IEEE 802.3ba. (c) The client optical interface at 'Receive Transponder' output towards 'Terminal Receiving Equipment' (TRE) for client interfaces shall be 1550nm single-mode interface. For 100GbE/400G client's optical interfaces also, the equipment shall comply with the parametric requirements of Tables 1 & 2/Annexure-I, at 'Sn' & 'Rn' reference points - like SDH client optical interfaces. **Note:** The architecture of OTU-4 shall be as per ITU-T Rec. G.806. The constituents and structure of OTU-4 shall be strictly as per ITU-T Rec. G.709. The mapping of Ethernet data	

<table>
<tr><td></td><td>on to an OTU-2 shall strictly follow the requirements specified in ITU-T Recs. G.709 and G.806 and shall support the generation of all the relevant alarms and monitoring and supervision of performance parameters specified in ITU-T G.709, G.707, G.798 and also in ITU-T Rec. G.872. The equipment shall support the management aspect of optical network as specified in ITU-T Rec. G.874.</td><td></td></tr>
<tr><td>6.0</td><td>DWDM System Technical specifications:</td><td></td></tr>
<tr><td>6.1</td><td>DWDM window of operation -The optical window of operation of the DWDM system shall be in the range from 1529nm to 1565nm (C-band) as per ITU-T Rec. G.694.1.</td><td>Inspect the transponder/muxponder cards offered by the manufacturer and record the nomenclature of the cards. Tune a particular Wavelength to the Muxponder/ transponder and ensure that the same Wavelength is received at the receiver of Muxponder/ Transponder or at Demux output.

<table><tr><td>In the Range of 1529–1565 nm</td><td>Received OK /Not OK</td></tr></table></td></tr>
</table>

6.2	**Channel spacing** - The nominal central wavelength spacing shall be 150/100/75/50GHz/flexible grid and the source wavelength variation shall be as per Tables 1a, 1b, 2a, 2b, 3 &4/Annexure-I. Any consecutive 32/40/64/80/96/flexible count wavelengths may be chosen by purchaser from DWDM-grid as specified in ITU-T Rec. G.694.1.	Check that the system supports channel spacing between the adjacent channels as 50 GHz for 80 Channels and 100GHz for 40 Channels. For the flexible DWDM grid, check that frequency slots have a nominal central frequency 193.1 + n*0.00625 where n is a positive or negative integer and slot width is 12.5 * m in GHz where m is a positive integer.
6.3	**Central frequency-** The allowed channel frequencies are based on a grid with reference frequency at 193.1 THz.	The spec limit is 193.1 THz.

6.4	**Client interface specifications and channel bit rates for 100G/200G/400G and above DWDM Equipment:** The client interface channel bit-rates at DWDM transponders/muxponders shall be as detailed below: a) **SDH interfaces** **STM-64 (9953.280Mb/s):** This client interface shall support @ PIII-2D1/Table-3 application code of ITU-T G.959.1, P1S1-2D2b/Table 8.4 of ITU-T G.959.1 on single mode optical fibre and S-64.2a/b interfaces as per ITU-T G.691. The client interface shall also support OTU-2 IrDI interface as per ITU-T Recs. G.959.1 and G.709. The jitter and wander specifications shall be as per ITU-T Recs. G.825, G.783 and G.8251. The selection of interfaces shall be as per purchaser's requirements. b) **Ethernet interfaces:** **Optical 10 Gigabit Ethernet (10GbE):** 10G BASE-LR & ER as per IEEE 802.3ae standard optical interfaces for LAN applications(10.3125Gb/s), 10GBASE-LW and 10GBASE-EW as per IEEE 802.3ae standard optical interface for WAN applications (9.95328Gb/s-PHY) over single mode fibre shall be supported. The	Ensure that the DWDM equipment supports the Optical standards laid down in the respective TEC standards STM-64/Ethernet/OTN Client, detail test is covered under clause 5.2. Note down the interfaces offered by the vendor: STM-64: Offered/ not offered : If offered, the application code is : 10GE: Offered/ not offered: If offered the application code is : 100GE: Offered/ not offered: If offered the application code is : OTU-2: Offered/ not offered: If offered the application code is: OTU 2e: Offered/ not offered : If offered the application code is : OTU 3: Offered/ not

	selection of interfaces shall be as per the purchaser's requirements. Interface specifications of 10GE interfaces shall be as per Table-6 (Table 52-7/IEEE 802.3ae), Table-7 (Table 52-9/IEEE 802.3ae), Table-8 (Table52-12/IEEE 802.3), Table-9(Table 52-13/IEEE 802.3), Table-10(Table 52-16/IEEE 802.3) and Table-11(Table 52-17/IEEE 802.3) as given in Annexure-I. The dispersion requirements and jitter & wander characteristics shall be as per IEEE 802.3ae. **Optical 100 Gigabit Ethernet (100GbE):** This interface is defined by the IEEE 802.3ba-2010 standard. Two interfaces, 100GBase-ER4 (Extended range) and 100GBase-LR4 (Long range) are port type for single-mode fiber and uses four lasers using four wavelengths around 1300nm. Physical CodingSublayer64b/66b PCS for these interfaces is defined in IEEE 802.3 under clause-82 and Physical Medium Dependent PMD in Clause-88. Each wavelength carries data at a rate of 25.78125Gbit/s. **New clause Optical 400 Gigabit Ethernet (400GbE):** This interface is defined by the IEEE 802.3bs,cd,ck,db,cs etc	offered: If offered the application code is : OTU 4: Offered/ not offered: If offered the application code is : **a) SDH interfaces** **STM-64 (9953.280Mb/s) Interface:** **i. Receiver sensitivity of STM-64 interface:** Loop the DWDM aggregate via 20 dB attenuator. From the SDH Analyzer select the STM-64 bit rate S-64.2b optical data at 1550 window at a level of +3 dBm. Connect the Optical power output of SDH Analyzer to the input of the muxponder under test via a variable attenuator. Connect the output of the corresponding port of the muxponder out at the Optical receive port of SDH Analyzer. Now add the attenuation in the path of STM-64 payload by variable attenuator in the

	standard. Interfaces400GBase-LR4 (Long range), 400GBase-DR4, 400GBase-SR4 etc are different type uses four lasers using four wavelengths around 1300nm. **(c) OTU4** OTU4 on the client side shall support G.709 compliant forward error correction, PRBS function. It shall also support PM & TCM non-intrusive monitoring function. **(d) Optical 40 Gigabit Ethernet Interface(Optional):**40GBASE-LR4 (Long Range) is a port type for single-mode fiber and uses 1300 nm lasers. Its Physical Coding Sublayer 64b/66b PCS is defined in IEEE 802.3 Clause 82 and its Physical Medium Dependent PMD in Clause 87. It uses four wavelengths delivering serialized data at a rate of 10.3125 Gbit/s per wavelength.	input interface port. Note the errors in the mapped VC4/B1 errors. When the equipment under test starts giving the errors, reduce the attenuation slightly to receive error free signals. Monitor the error free signals at SDH Analyzer for 15 minutes (BER minimum 10^{-12}). Note that the receive ports should not give an error up to a level 3 dB below the receiver sensitivity value specified for the application code in the tables in Annexure-I of standard. **ii. Receiver overload of STM-64 interface:** Under the same test setup, keep the variable attenuator to a value of 10 dB and thereafter reduce the attenuation allowing increase in the power. At the stage the errors are received on the demapped VC4 /B-1 error, increase the attenuation slightly so as

		to receive no errors. Monitor the data for 15 minutes (BER minimum 10^{-15}) Read the input power of the interface by using a power meter. **Minimum Overload: -0 dBm** **iii. Eye pattern:** Make the setup as shown in figure-2. Loop the DWDM aggregate via 20 dB attenuator. Connect the output of corresponding port to the Digital Communication Analyser. From the selection menu of the Communication Analyser select the Eye pattern function and bit rate STM-64. The instrument shall display the built in standard ITU-T mask of eye pattern and the eye pattern of the equipment under test shall also be displayed. Note that the eye pattern equipment under test shall fall within the built in standard mask of the STM-64. Take the

		printout of the mask and attach the prints. **iv. Extinction ratio** Under the same test set up as stated above, program the Communication Analyser for the Extinction ratio test. The instrument is direct reading type, record the reading. Also, print out may be attached. **Limit: ≥ 12 dB** **v. Optical Return Loss:** Test instrument include optical return loss tester. Fig.1 shows the test setup. 1) Calibrate optical return loss according to the instrument user manual; 2) According to the test setup, connect the setup, and get the optical receiver reflectance test result (expressed in dB). **Limit: Return Loss : > 24 dB** **Reflectance: > - 27dB** **vi. Optical Spectral width**:

		Make setup as shown in figure-2. Connect the output of the corresponding port of the muxponder to the Optical spectrum analyzer (OSA) and program the instrument for the measurement of optical spectrum. From the spectrum, record the following: Central frequency, Spectral width at 3 dB point and Side Mode Suppression Ratio (SMSR): **Specifications:** **Side Mode suppression Ratio: ≥30dB** **Spectral width at –20 dB: ≤0.5 nm** **Central freq : 193.1 THz** **vii. Launched power:** Connect the output of the muxponder to the Optical power meter and record the transmitted power of the Muxponder. **viii. Optical Jitter test:** See Clause 3.20.

		b) Ethernet interface: **i. 10Gig Ethernet Interface:** The following parameters shall be checked and to ensure that they are within the prescribed limits (for 10BaseEW and 10BaseER are only given): **Transmit characteristics:** **1. Signalling speed:** EW: 9.95328 GBd ±20 ppm ER: 10.3125 GBd ±100 ppm **2. SMSR:** 30 dB **3. Average launch power** Max = 4.0 dBm Min = - 4.7 dBm **4. Extinction ratio** : 3 dB **5. Optical Return Loss:** 21 dB (min) **6. Transmitter eye mask** : As per 802.3ae **Receive characteristics:** **1. Signalling speed :** 10GBASE-ER = 10.3125 GBd ±100 ppm 10GBASE-EW = 9.95328 GBd ± 100 ppm

		2. Average receive power Max = - 1.0 dBm Min = – 15.8 dBm **3. Receiver Reflectance:** Max : –26 dB **4. Stressed eye jitter** = 0.3 UI pk-pk **ii. 100Gig Ethernet Interface** The following parameters shall be checked and to ensure that they are within the prescribed limits **100G Base-SR4** **Transmit characteristics:** **1. Signalling speed:** 100G Base-SR4: 25.78125 GBd ±100 ppm **2. RMS Spectral Width:** 0.6 nm **3. Average launch power** Max = 2.4 dBm Min = - 8.4 dBm **4. Extinction ratio** : 2 dB **5. Optical Return Loss Tolerance:** 12 dB (max) **6. Transmitter eye mask** : As per 802.3 Table 95-6 **Receive characteristics:** **1. Signalling speed :**

		100G Base-SR4 = 25.78125 GBd ±100 ppm **2. Average receive power** Max = + 2.4 dBm Min = – 10.3 dBm **3. Receiver Reflectance:** Max : -12 dB **4. Stressed eye J2 jitter** = 0.39 UI **100G Base—LR4** **Transmit characteristics:** **1. Signalling speed:** 100G Base-LR4: 25.78125 GBd ±100 ppm **2. SMSR:** 30 dB **3. Average launch power** Max = 10.5 dBm Min = - 4.3 dBm **4. Extinction ratio** : 4 dB **5. Optical Return Loss Tolerance:** 20 dB (max) **6. Transmitter eye mask** : As per 802.3 Table 88-7 **Receive characteristics:** **1. Signalling speed :** 100G Base-LR4 = 25.78125 GBd ±100 ppm **2. Average receive power** Max = + 4.5 dBm Min = – 10.6 dBm **3. Receiver Reflectance:**

		Max : -26 dB **4. Stressed eye J2 jitter =** 0.3 UI **c) OTN Client Interface Testing:** The method of testing of the OTN interfaces is same as that of SDH interfaces. Similarly optical parameters (launched power, receiver sensitivity, receiver overload should be tested for line side of muxponder and transponder.

6.4.1	The equipment shall support following client-side pluggable modules: I. 40GBase-LR4-10Km-CFP II. 40GBase-ELR4-40Km-CFP III. 100GBase-LR4-10Km-QSFP28 IV. 100GBase-ER4-40Km- QSFP28 V. 100GBase-10*10G-10km- QSFP28 VI. (100GBase-4*25G)/(OUT4-4*28G)-10Km QSFP28 VII. 400GBase LR4 QSFP28-DD VIII. 400GBase FR4 QSFP28-DD IX. 400GBase DR4 QSFP28-DD X. 400GBase SR4 QSFP28-DD	Check as per the requirement of the clause.
6.5	**100G and 200G Technical Specifications:**	
6.5.1	100G DWDM equipment shall support following DWDM- side fixed modules: I. 40000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent-QPSK(HFEC) with HD FEC II. 55000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent-QPSK(SDFEC) with SD FEC(SDFEC) (Optional)	Check as per the requirement of the clause.
6.5.2	200 G DWDM equipment shall support following DWDM- side fixed modules: I. 20,000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent-mQAM (m = 8) with HD FEC as well as/or SDFEC II. 16,000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent-	Check as per the requirement of the clause.

	mQAM (m = 16) with HD FEC as well as/or SDFEC New clause 300 G DWDM equipment shall support following DWDM- side fixed modules: I. 20,000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent- mQAM (m = 16/32) with SDFEC II. 10,000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent- mQAM (m = 32/64) with SDFEC New clause 400 G/600G DWDM equipment shall support following DWDM-side fixed modules: I. 20,000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent- mQAM (m = 8) with SDFEC II. 15,000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent- mQAM (m = 16) with SDFEC New clause 800G DWDM equipment shall support following DWDM- side fixed modules: I. 15,000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent- mQAM (m = 16) with SDFEC	

	II. 10,000 ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent- mQAM (m = 32) with SDFEC The specifications of DWDM- side fixed modules are given in Table-15, Table-16, Table-17 and Table 18 whereas specifications for client – side pluggable modules are given in Table-19, Table -20, Table- 21and Table - 22 at Annexure-I.	

6.6	**Client interface Tech specs QSFP28/ QSFP-DD Standard**	
6.6	a) The 100G QSFP28 LR4 is a 100Gb/s transceiver module designed for optical communication applications compliant to 100GBASE-LR4 of the IEEE P802.3ba standard. The module converts 4 input channels of 25Gb/s electrical data to 4 channels of LAN WDM optical signals and then multiplexes them into a single channel for 100Gb/s optical transmission. Its 100Gb/s high sensitivity PIN receivers provide superior performance for 100Gigabit Ethernet and OTU4 applications up to 10km links and compliant to optical interface with IEEE802.3ba 88 100GBASE-LR4 requirements. **New clause** : The 100G QSFP28 ER4 is a 100Gb/s transceiver module designed for optical communication applications compliant to 100GBASE-ER4 of the IEEE P802.3ba standard. The module converts 4 input channels of 25Gb/s electrical data to 4 channels of LAN WDM optical signals and then multiplexes them into a single channel for 100Gb/s optical transmission. Its 100Gb/s high sensitivity PIN receivers provide superior performance for 100Gigabit Ethernet and OTU 4 applications up to 40km links.	No test needed. It is for information only.

	(b) The 100G QSFP28 SR4 is a four-channel, pluggable, parallel, fiber-optic QSFP+ SR4 optical transceiver module for 100/40 Gigabit Ethernet, Infiniband DDR/EDR and 32GFC applications. This transceiver is a high performance module for short-range multi-lane data communication and interconnects applications. It integrates 4 data lanes in each direction with 112.2 Gbps bandwidth. Each lane can operate at 8.055Gbps up to 70M using OM3 fiber or 100M using OM4 fiber. The module is designed to operate over multimode fiber system using a nominal wavelength of 850nm. New clause The 400G QSFP28-DD FR4 is a 400Gb/s transceiver module designed for optical communication applications compliant to 400GBASE-FR4 of the IEEE P802.3cu standard. The module converts 4 input channels of 100Gb/s electrical data to 4 channels of LAN WDM optical signals and then multiplexes them into a single channel for 400Gb/s optical transmission. Its 400Gb/s high sensitivity PIN receivers provide superior performance for 400Gigabit Ethernet applications up to 2km links.	

	New clause The 400G QSFP28-DD LR4 is a 400Gb/s transceiver module designed for optical communication applications compliant to 400GBASE-LR4 of the IEEE P802.3cu standard. The module converts 4 input channels of 100Gb/s electrical data to 4 channels of LAN WDM optical signals and then multiplexes them into a single channel for 400Gb/s optical transmission. Its 400Gb/s high sensitivity PIN receivers provide superior performance for 400Gigabit Ethernet applications up to 10km links. **New clause** The 400G QSFP28-DD DR4 is a 400Gb/s transceiver module designed for optical communication applications compliant to 400GBASE-DR4 of the IEEE P802.3bs standard. The module converts 4 input channels of 100Gb/s electrical data to 4 channels of LAN WDM optical signals and then multiplexes them into a single channel for 400Gb/s optical transmission for 400Gigabit Ethernet applications up to 500m links **Note-1**: The purchaser may also specify requirements for IEEE 1000BaseSX, 10GBASE-SR and 10GBASE-SW at multi-mode optical interfaces. **Note-2:** The optical power budgets for the Ethernet interfaces are as given in Annexure-	

7.0	**Engineering requirements:**	
a.	The equipment shall be fully solid-state and adopt state-of-the-art technology. There shall be common shelf for all possible configurations e.g., Terminal, OADM and ILA. Only a main universal self and extension universal selves shall be allowed for any configuration. But the entire OADM, OTM and ILA shall be controlled by a single control card in the respective nodes.	No test needed. It is for information only.
b	The equipment shall be compact and composite in construction and shall be light-weight. The actual dimensions and weight of the equipment shall be furnished by the manufacturer.	For information only, no test is required.
c.	All connectors shall be reliable and of standard type to ensure failure-free operation over long periods under specified environmental conditions. All cables & components shall be CACT approved.	QA to ensure the requirements.
d.	All connectors and cables used shall be of low-loss type and suitably shielded. The type of connectors used at the application interfaces & the user- interfaces shall be of wire-wrapping type or as per any other international industry standard. No soldering shall be allowed for the connectors. The positioning of the connectors shall be on the front end of the relevant Transponder/Muxponder cards so as to facilitate the ease of handling during operation.	Verify and note down.
e.	The equipment shall be housed in standard	Verify and note down.

	19" or ETSI standard rack and shall provide front access as well as rear access in standard 300mm, 600mm or 850mm depth rack.	
f.	The equipment shall provide natural cooling arrangement which shall not involve any forced cooling by using fans etc., either inside or outside the equipment. In case, the natural cooling arrangement is not sufficient, the manufacturer may use fans for cooling purposes provided: • The fan failure is reported through LCT/EMS. • Multiple fans are there in one tray with hot-standby redundancy. • Fans are located at convenient place in the equipment not disturbing the internal equipment layout. • Fans are DC operated. • MTBF is better than 1,00,000 hours. • Inclusion of fans for cooling purposes does not deteriorate the MTBF values of the equipment. • There shall be fan failure alarm for each of the installed fan. • The power consumption of all the fans provided with equipment shall not exceed the 20% of the total power consumption of that particular sub-rack under the fully equipped conditions.	Verify and note down.
g.	The supervisory indications, built-in test equipment (BITE) and other control/ switches	Verify and note down whether the supervisory

	shall be provided at convenient locations for ease of maintenance.	indications, built-in test equipment (BITE), and other control/ switches are provided at convenient locations for ease of maintenance.
h.	The plug-in units shall be hot-swappable to allow easy removal/ insertion while the equipment is in energized condition.	Verify and note down as to whether the plug-in units are hot-swappable as to allow their removal/ insertion while the equipment is in energized condition.
i.	The mechanical design and construction of each card/ unit shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage & transport and shall conform to the latest quality manuals of the purchaser.	Climatic tests as per QM-333 Cat. A- shall be carried out separately. Note down the functional as well as spec. tests readings to form a test report.
j.	Each sub-assembly shall be clearly marked with schematic references to show its function, so as to be easily identifiable from the layout diagram in the handbook.	QA to verify and note down.
k.	Each terminal block and individual tag shall be numbered suitably with clear identifying code and shall correspond to the associated wiring drawings.	QA to verify and note down.
l.	All controls, switches & indicators etc., shall be clearly marked to show their circuit designation and functions.	Verify and note down.
m.	Important Do's and Don'ts about the operation of the equipment shall be clearly indicated at	Verify and note down.

	a convenient place on the equipment.	
n.	The optical safety shall be as defined in ITU-T Rec. G.664 & IEC 60825-1 (latest edition). The optical access ports shall be designed to protect themselves against the entry of dust when they are not occupied by an external fibre-optic connection. To prevent the failures in the optical line devices due to ingress of dust, the connectors provided at all high output devices shall be provisioned with the auto-shutter or shall be so positioned as facing downwards to avoid direct incidence of laser-beam on the user. The optical access port shall be easy to clean by the user.	Ensure that all the high power connectors are provided with auto shutter and that they are downward facing. If auto shutters are not provided, dust Caps have to be provided for all Optical Ports.
o.	All the optical connections shall have front access only. No access from the rear or from the sideways shall be permitted. There shall be elevated fibre guide with clip & wire saddles to guide the fibre to/from each module. There shall be separate channel in the rack to run the electrical cables and fibres. It shall be preferable that there shall be separate fibre slot for routing the client side fibres and line side fibres. All the leading–in cable shall have the proper arrangements to avoid accidental failures.	Ensure that all the connectors have front access only.
8.0	**Quality requirements:**	
8.1	The manufacturer shall furnish the MTBF/MTTR values. MTBF values wherever specified in the standard, shall be met. The calculations shall be based on the latest operator's quality manual on "Reliability Methods and Predictions" or any other	Record the values for MTBF/MTTR as supplied by the manufacturer.

	international standard.	
8.2	The equipment shall be manufactured in accordance with international quality management system ISO-9001:2015 for which the manufacturer shall be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer, shall be required to be submitted. The equipment shall also meet the latest quality manual of the operator on a. Quality and reliability in product design, b. Guidelines for standard of workmanship for printed boards and assemblies, c. Guidelines for standard of workmanship for surface mounted devices, The supplier shall furnish a certificate from the manufacturer to this effect which shall be verified at the time of technical evaluation of the system.	Get a copy of the ISO-9001:2015 certificate awarded to the company. Obtain a copy of the certificate from the manufacturer that the equipment has been manufactured as per his quality manuals. Tester shall verify the compliance of the quality manuals
8.3	The equipment shall conform to the requirement for the latest operator's quality manual for specification for environmental testing of electronic equipments for transmission and switching use for operation, transportation and storage, including vibration test.	Climatic tests shall be conducted separately as per latest operator's quality manual for the environmental testing. Vibration test shall also be conducted as per the operator's quality manual.
8.4	The equipment shall conform to the requirements for environment as specified in the DoT-QA document QM-333 (Issue March 2010) - "Specification for environmental	Climatic tests as per TEC SD: QM-333 Cat. A shall be carried out separately. Note down the functional

	testing of electronic equipment for transmission and switching use". The applicable tests shall be taken for environmental category A including vibration test.	as well as spec. tests readings to form a test report.
9.0	**Electromagnetic Compatibility (EMC) Requirements:** - The instrument shall conform to the EMC requirements as per the following standards and limits indicated therein. A test certificate and test report shall be furnished from a test agency.	The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab for the compliance of EMC standard laid down in this clause.
9.1	**Conducted and radiated emission:** **Name of EMC Standard:** "CISPR 32 {2015} - Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment". **Limits:-** i) To comply with Class A of CISPR 32 {2015} ii) The values of limits shall be as per TEC Standard No. TEC/SD/RD/EMC-002/02Oct.2016 with Amendment No. 1 dated 01.01.2008. iii) For radiated Emission tests, limits below 1Ghz shall be as per Table 4(a) or 5(a) for measuring distance of 10m or Table 4(a1) or 5(a1) for measuring distance of 3m	The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab for the compliance of EMC standard laid down in this clause.
9.2	**Immunity to Electrostatic discharge** **Name of EMC Standard**: IEC 61000-4-2 {2025) {latest issue}-"Testing and measurement techniques of Electrostatic discharge immunity test".	The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab for the compliance

	Limits: i) Contact discharge level 2 {± 4 kV} or higher voltage; ii) Air discharge level 3 {± 8 kV} or higher voltage;	of EMC standard laid down in this clause.
9.3	**Immunity to radiated RF** **Name of EMC Standard**: IEC 61000-4-3 (2020) {latest issue}- "Testing and measurement Techniques-Radiated RF Electromagnetic Field Immunity test" Limits:- **For Telecom Equipment and Telecom Terminal Equipment with Voice interfaces (s)** i) Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and ii) Under test level 3 (10 V/m) for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz. **For Telecom Terminal Equipment without Voice interfaces (s)** Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and for protection against digital radio telephones and other RF devices in frequency range 800 MHz to 960 MHz and 1.4 GHz and 6.0 GHz.	The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab for the compliance of EMC standard laid down in this clause.
9.4	**Immunity to fast transients (burst)** **Name of EMC Standard**: IEC 61000- 4- 4 {2012) {latest issue}- "Testing and	The manufacturer shall be asked to submit a certificate and the test

	measurement techniques of electrical fast transient's/burst immunity test" **Limits**: -Test Level 2 i.e. a) 1 kV for AC/DC power lines; b) 0. 5 kV for signal / control / data / telecom lines;	results from an accredited test lab for the compliance of EMC standard laid down in this clause.
9.5	**Immunity to surges** **Name of EMC Standard:** IEC 61000-4-5 (2014) {latest issue}- "Testing & Measurement techniques for Surge immunity test" **Limits:-** i) For mains power input ports: (a)2 kV peak open circuit voltage for line to ground coupling (b) 1 kV peak open circuit voltage for line to line coupling ii) For telecom ports: (a) 2 kV peak open circuit voltage for line to ground (b) 2 kV peak open circuit voltage for line to line coupling	The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab for the compliance of EMC standard laid down in this clause.
9.6	**Immunity to conducted disturbance induced by Radio frequency fields:** **Name of EMC Standard:** IEC 61000-4-6 (2023){latest issue}-"Testing & measurement techniques-Immunity to conducted disturbances induced by radio- frequency fields" **Limits:-** Under the test level 2 {3V r.m.s.} in the frequency range 150 kHz-80 MHz for AC / DC lines and Signal /Control/telecom lines.	The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab for the compliance of EMC standard laid down in this clause.
9.7	**Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports, if any):**	The manufacturer shall be asked to submit a certificate and the test

	Name of EMC Standard: Name of EMC Standard: IEC 6100-4-11 (2020) {latest issue}- "Testing & measurement techniques- voltage dips, short interruptions and voltage variation immunity tests" **Limits:** i. A voltage dip corresponding to reduction of the supply voltage of 30% for 500 ms (i.e 70 % supply voltage for 500 ms) ii. A voltage dip corresponding to reduction of the supply voltage of 60% for 200 ms (i.e 40 % supply voltage for 200 ms) iii. A voltage dip corresponding to reduction of the supply voltage of > 95% for 5 s iv. A voltage dip corresponding to reduction of the supply voltage of > 95% for 10 ms	results from an accredited test lab for the compliance of EMC standard laid down in this clause.
9.8	**Immunity to voltage dips & short interruptions (applicable to only DC power input ports, if any):** **Name of EMC Standard**: IEC 61000-4-29:2000: Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests **Limits:** i. Voltage Interruption with 0% of supply for 10ms. Applicable Performance Criteria shall be B. ii. Voltage Interruption with 0% of supply for 30ms, 100ms, 300ms and 1000ms.	The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab for the compliance of EMC standard laid down in this clause.

Applicable Performance Criteria shall be C.

iii. Voltage dip corresponding to 40% & 70% of supply for 10ms, 30 ms. Applicable Performance Criteria shall be B.

iv. Voltage dip corresponding to 40% & 70% of supply for 100ms, 300 ms and 1000 ms. Applicable Performance Criteria shall be C.

v. Voltage variations corresponding to 80% and 120%of supply for 100 ms to 10s as per Table 1c of IEC 61000-4-29. Applicable Performance Criteria shall be B.

Note 1: The test agency for EMC tests shall be an accredited agency and details of accreditation shall be submitted.

Note 2: For checking compliance with the above EMC requirements, the method of measurements shall be in accordance with TEC Standard No. TEC 11016:2016 (earlier No. TEC/SD/DD/EMC-221/05/OCT-16) (or latest release) and the references mentioned therein unless otherwise specified specifically. Alternatively, corresponding relevant Euro Norms of the above IEC/CISPR standards are also acceptable subject to the condition that frequency range and test level are met as per above mentioned sub clauses (a) to (g) and TEC Standard No. TEC 11016:2016 (earlier No. TEC/SD/DD/EMC-221/05/OCT-16) (or latest release) . The details of IEC/CISPR and their corresponding Euro Norms are as follows:

IEC/CISPR	Euro Norm

		CISPR 32 / EN 55032 IEC 61000-4-2 / EN 61000-4-2 IEC 61000-4-3 / EN 61000-4-3 IEC 61000-4-4 / EN 61000-4-4 IEC 61000-4-5 / EN 61000-4-5 IEC 61000-4-6 / EN 61000-4-6 IEC 61000-4-11 / EN 61000-4-11 IEC 61000-4-29 / EN 61000-4-29	
10.0	**Safety requirements:**		
10.1	The equipment shall conform to IS 13252 part 1: 2010 “Information Technology Equipment Safety Part 1: General Requirements” [equivalent to IEC 60950-1 {2005} “Information Technology Equipment –Safety- Part 1: General Requirements”].		The manufacturer shall be asked to submit a certificate and the test results from an accredited test lab.
10.2	If the fibre is broken or an optical connector is opened, the laser shall be automatically shut down or the optical power to be decreased to a value less than -10 dBm. Optical connectors, if used in the system, shall be self-protective against entry of dust when not occupied by external patch cord.		Check that in case the fiber is broken or an optical connector is opened, the laser gets automatically shut down or the optical power to be decreased to a value less than -10 dBm. Also. Ensure that the caps for the optical ports or auto-shutter type optical ports are provided. If auto shutters are not provided, dust Caps have to be provided for all Optical Ports.
10.3	The equipment shall have the provision of Automatic Laser Shut-Down (ALSD) in the case of fibre-plant breakdown and automatic		Check as per the requirement of the clause.

	re-start on restoration of fault in accordance with ITU-T Recs. G.664. The system shall restore within 0 – 10 second (programmable) after restoration of fibre-plant breakdown or a faulty amplifier.	
11.0	**Protection requirements:**	
11.1	The equipment shall have a terminal for grounding the rack.	Check that terminal for grounding the rack is provided.
11.2	Protection against short circuit/ open circuit in the accessible points shall be provided.	Check that the protection against short circuit/open-circuit in the accessible points is provided. Also that all switches/controls panels have suitable safeguards against accidental operations
11.3	All switches/controls on front panel shall have suitable safeguards against accidental operation.	Check that accidental operation of switches/controls on front panel does not create any problem in the system.
11.4	The equipment shall be adequately covered to safe-guarded against entry of even dust, insects etc.	Note that the equipment is provided with front panel cover.
12.0	**Mechanical standards:** a. The equipment shall be housed in the standard 19" width sub-racks or ETSI standard racks. The sub-racks shall be fitted with mother-board duly masked to avoid short-circuiting. The height of the main rack shall be 2750 mm maximum or as per ETSI standards. No mini rack shall	Check as per the requirement of the clause.

	be accepted. The PCB's back and forth movement shall be very smooth without any significant sideway play. b. Optional Note: If required the equipment can also be housed in the standard 21"/23" width sub-racks or ETSI standard racks.The same can be decided by the purchaser. c. The connectors used on the PCB and their mating-connectors on the mother-board shall have tight grip to avoid jacking problems. d. No damage shall take place to PCBs when loaded in the wrong slot except in power supply units. The PCBs shall have the provision of locking/ screwing to the sub-rack. e. There shall be proper covers on the sub-racks/ main-racks or similar arrangements to avoid the ingress of dust. f. The permanent wiring such as distribution of power supply and ground etc. shall be pre-wired. During Type Approval and supply of the equipment, the racks and sub-racks quality supplied by the manufacturer shall be ensured. g. The front opening of the sub-rack/main rack is envisaged. No rear-side/side-way opening shall be permitted. The access to data terminations shall be from the front or rear side.	

13.0	**Power supply:** The power supply to the equipment shall be fed from the station power plant. The equipment shall meet the following requirements in respect of the power supply: a) Nominal power supply is -48V DC with a variation over the range -40V to -60V. The equipment shall operate over this range without any degradation in performance.	a) The equipment shall work on the nominal voltage of - 48 V DC supply. Now reduce this voltage to -60 V DC and then increase it to -40 V DC. Check that in both the cases, the equipment is functioning perfectly. Note down the minimum and maximum voltages at which the equipment functions correctly : Minimum voltage : Maximum voltage :
b.	The equipment shall be protected in case of voltage variation beyond the range specified in sub-clause (a) above and also against reverse input polarity. The manufacturer shall furnish the value of guaranteed input voltage up to which no irreversible damage to the equipment shall occur.	Check that the equipment is not damaged while the input voltage vary beyond the range specified above. Also check that the equipment is not damaged when the polarity is reversed : (OK / Not OK)
c.	The derived DC voltages in the equipment shall have protection against over- voltage, short-circuit and overload.	Check that the following protections are provided by the derived voltages : (i) over voltage : Ok / Not Ok (ii) short circuit : Ok / Not Ok (iii) overload : Ok / Not Ok

d.	If the power-supply is provided through a centralized power-supply unit at chassis level, a hot-standby power-supply shall be provided at chassis level, to ensure smooth working of the equipment during failures.	Check that a hot standby is available at chasis level if power is provided through a centralized power-supply unit.
e.	Further, there shall be provision for dual-feed arrangement to the chassis power-supply, such that in case of failure of one feed, the system shall be able to function in a healthy manner without traffic interruption. The changeover of all redundancy actions shall be completed within 50ms.	Check that the equipment is provisioned for working with dual feed and that when the working feed fails, the other one takes over without any disturbance. This may be confirmed by checking that the BER is not disturbed when the input power feed changes over.
f.	The equipment requiring AC mains shall operate from single phase AC power supply without any degradation in the performance. The nominal AC voltage shall be 230V with variation of –15 % to +10 % at 50 Hz ± 2 Hz. The actual power consumption shall be furnished by the manufacturer.	In cases where the equipment requires to operate on AC mains, check that the equipment is able to function without any degradation in the performance within the voltage range of 195 – 255 volts. Note down the power consumption of the equipment:
14.0	**Element Management System**	
14.1	Functional Requirements:	
1.	The EMS shall be multi-user system and based on Graphical User Interface.	Check that the EMS provided is a multi-user

		system and GUI based.
2.	It shall provide the graphical layout of the network elements with modules drawn using different colours to indicate their status. This color codes should be different from the color codes used in Alarm.	Check that the EMS provides the graphical layout of the network elements with modules drawn using different colors to indicate their status.
3.	It shall be possible to execute any schedulable administrative command i.e.- NE backup, software download, performance, operator log-in/log-out etc., at any time by attaching a time tag to the command and it shall be executed when the Network real time matches the time tag. It shall be possible to define both time and date. If no date is mentioned, the command shall be executed daily at the time indicated.	Check that any administrative command like NE backup, software download, performance, operator log-in/ log-out etc. attach a time tag to the command and is executed when the network real time matches the time tag. Check that it is possible to define both time and date.
4.	The EMS shall have a messaging system which will generate and send alert messages on e-mail or SMS to the designated personnel depending upon the location of NE, on generation of alarms.	Check that the EMS has a messaging system which will generate and send alert messages on telephone (mobile), e-mail or SMS to the designated personnel depending upon the location of NE, on generation of alarms.
5.	Response time for query/command on any operator terminal, local or remote shall be 10 seconds or better. For updation on topological	Check that the response time for query/command on any operator terminal,

	information on the terminals, the response time shall be better than 20 seconds under normal conditions. The response time of any terminal shall however, be reviewed depending upon total NE load and topology by purchaser during testing of EMS.	local or remote is 10 seconds or better. For updation on topological information on the terminals, the response time is better than 20 seconds under all conditions. (Note that the response time is reviewable depending upon total NE load and topology by purchaser during testing of EMS).
6.	It shall be possible to manage complete DWDM link involving distant-end terminal, Optical Line Amplifiers and Optical Add/Drop Multiplexers en-route. For passive elements like Optical Add/Drop multiplexers, only viewing will be possible.	Check that it is possible to manage the distant TM, OADMs and ILAs with the EMS.
7.	It shall be possible to have a view of selected sub-networks/rings controlled by the Element Management System as per requirement. By zooming-in, it shall be possible to drill down up to module-level in each NE for configuration and fault management. It shall also provide the ability to drill down to the individual element, then to subsystem, then to card and then to port level configuration template from the domain-map by clicking on the icon of the network element. The same shall be provided through user-friendly GUI commands.	Check as per the requirement of the clause.
8.	The Element Manager shall provide the	Check that the EMS

	complete view of the network elements and the interconnecting links. The EMS shall have the ability to include the network elements and the links in the visual/graphical map of the domain. The visual maps shall display the elements and the links in different colour depending upon the status of the links. It is preferable that green colour for healthy and amber/yellow colour for degraded condition and red for unhealthy condition is used.	provides the complete view of the network elements and the interconnecting links in the visual/graphical format. Also check that the visual maps display the elements and the links in different colour depending upon the status of the links - preferably green colour for healthy and amber/yellow colour for degraded condition and red for unhealthy condition.
9.	It shall be possible to produce different type of reports based on the data available in the database.	Check that it is possible to produce customized reports and that customization of reports based on the data available in the database from time to time is possible.
10.	It shall be possible through a single Man-Machine Command or through GUI to obtain a list and the total number of equipment of a particular domain in various states (e.g. managed, Loss of Association, in-service, blocked etc.).	Check that it is possible through a single Man-Machine Command or through GUI to obtain a list and the total number of equipment of a particular domain in various sta

14.2	**Configuration Management:**	
1.	It shall be possible to configure the DWDM equipment for various capabilities and features like enabling/disabling of optical wavelengths, transponders configuration, optical channels addition/deletion, restricting client-speed at GigE interfaces, protection enabling/disabling at all wavelengths & inventory details of the local station as well as remote station at card level etc. The GUI shall provide efficient mechanisms to edit, re-groom, or decommission the service when necessary.	Check various capabilities and features like enabling/disabling of optical wavelengths, transponders configuration, optical channels addition/deletion, protection enabling/disabling & inventory details of the local station as well as remote station at card level etc.
2.	Users shall be able to identify explicit routing through the network, or just define the end-points and service characteristics and select from a list of automatically generated viable recommended paths through the network.	Check that there is provision to find explicit routing through the network or defining end point and service characteristics.
3.	The system shall support 'Point & Click' provisioning in the DWDM sub-network, in respect of following: i. Network Element creation in the NE Management domain. ii. Programming of a multiple interface unit. iii. Create, update, delete and retrieve the managed network topology data. iv. Assigning the equipment protection to unit/interface/wavelength/channel. v. Selection of protection switching within the	Check that system shall support following: i. Creation and also deletion of the NEs. ii. Creation, update, deletion and retrieval of the managed network topology data. iii. Assigning the equipment protection

	managed network and protection switching granularity enable/disable at individual channel level. vi. Error detection thresholds. vii. Network Element configuration. viii. Software download (local & remote). ix. It should be possible to provide an end-to-end wavelength service from an EMS Client system. x. Power values overlaid on the topology map/drop down menus for selected Lambda by User - Per Lambda Power - Total AMP Power - OSC (Optical Supervisory Channel) Power xi. It should be possible to define the threshold (High/Low) for Power levels and EMS should be able to display if Power level is crossing the threshold. xii. The configuration of the various network elements like creating, viewing, and editing shall be possible from the EMS. The configurations of the network elements shall also be stored in EMS which can be retrieved in case of failure.	to a unit. iv. Selection of protection switching within the managed network and protection switching granularity. v. Configure multiple interfaces i.e. clients. vi. Setting thresholds for the detection of errors. vii. Configuring the NEs. viii. Local & remote software download. ix. Enabling/disabling of protection switching for individual traffic interface. x. Configuration of wavelength for end-to-end traffic. xi. Enabling/disabling of FEC. xii. Set threshold values for power levels and check if power is crossing the thresholds.
14.3	**Fault Management:**	

1.	The EMS shall support 'Fault Management Functions'. The 'Equipment Management Function' within the NE shall perform a persistency check on the fault-cause, before it declares an alarm which is causing failure in the DWDM network. Each alarm/failure and clearance, thereof, shall be time-stamped.	Check that the persistency check on the detection and the reporting of faults is as per G.784. Each failure and clearance, thereof, shall be time-stamped. An alarm report shall include type of fault, occurrence time, clearance time, severity, probable cause etc.
2.	The equipment shall carry out surveillance of alarms & their detection, reporting of relevant events and conditions that lead to the generation of alarm after filtering. The system shall produce, store and display the alarm history on demand. Further, the element management system shall have the following capabilities: i. Path alarm notification to be generated and recorded, the alarm notification shall include: type, occurrence, severity, probable cause and clearing. ii. Path alarm shall be graphically shown by the EMS/LCT. iii. Alarm and status display. iv. v. Fault correlation control. vi. Storing and processing of current alarm information, up to module/unit level. vii. Storing and processing of historical	Also check that the following functionalities are provided: i. Generation and reporting of the path alarm notification include type, occurrence, severity, probable cause and clearing. ii. Path alarm is shown graphically by the EMS/LCT. iii. Display of alarm and the status. iv. Localization of fault. v. Correction control of fault. vi. Storing and processing of current alarm information.

	alarm information for 30 days minimum. The EMS/LCT shall provide on-line logging capability for historical alarms and events with sufficient information such as managed resources, alarm/event type, alarm severity, day and time of occurrence etc. The retrieving functions with filtering capabilities for historical alarms and events shall be provided as well. viii. FCS errors for Ethernet clients. ix. Assigning alarm severity i.e., Urgent, Non-urgent and Deferred. x. The EMS shall be able to diagnose its own faults by running diagnostic software. xi. The information model shall be as per specified standards. The EMS shall support correlation (filtering and suppression) to avoid multiple alarms from a single source of failure within the sub-network. Single Alarm shall be provided for the events that are correlated and are due to a common cause. However, it may be possible for the user to see other related alarms. xii. The EMS shall provide the visual presentation of the Network Element's status and the alarms. It shall also present the complete map of the network domain with suitable icons and in suitable colour like green for healthy, red for non-operational, yellow for	vii. The EMS/LCT shall provide on-line logging capability for historical alarms and events with sufficient information such as managed resources, alarm/ event type, alarm severity, day and time of occurrence etc. viii. FCS errors for Ethernet clients. ix. It should be possible to assigning alarm severity i.e., Critical, Major, Minor & Deferred. x. Diagnose its own faults by running diagnostic software. xi. Check that the EMS provides correlated single alarm from single source instead of multiple alarms from a single source. xii. Check that the EMS provides the visual presentation of the Network Element's status and the alarms.

	degraded mode of operation etc.Colour codes used for elements status and alarm should be different. xiii. From the EMS, it shall be possible to view the status of any Network Element whether it is out-of-service or in-service. xiv. The EMS shall carry out the systematic Health Monitoring of the elements of the Network. Check on the health of the card of any element of the Network shall be possible through reports with settable periodicity - @ 24 Hrs, 1 week, 1 month. xv. It shall be possible to log recent operations which be re-displayed on request through GUI. xvi. From a service assurance perspective, service to fault alarm correlation shall be supported. For each service there shall be an alarms tab visible on the service Display tab which displays the alarms impacting that specific service. xvii. The DWDM related alarm conditions, as mentioned under Clause 3.33 and 3.33.1 in this GR shall be displayed by the EMS.	xiii. Check that it is possible to take any Network Element out-of-service & in-service from the EMS. Also check that restarting the Network Element from EMS is possible. xiv. Check that the EMS is able to carry out the health monitoring of the Network Elements, cards of any NE and that the periodicity can be set as 24 Hrs, 1 week, 1 month. xv. Check that recent operations can be logged and re-displayed on request through GUI. xvi. For each service an alarms tab should be visible on the service Display tab which displays the alarms impacting that specific service. xvii. The DWDM related alarm conditions, as

		mentioned under Clause 3.18 and 3.37 in this GR shall be displayed by the EMS.
14.4	**Performance Management:**	
1.	The EMS shall support the 'Performance Management' functions which shall consist of a set of functions that define, evaluate and report on the behaviour of the Network Elements and their effectiveness relating to the overall functions carried out by the network.	The performance management of the system shall conform to ITU-T Recs. M.2100, M.2101, M.2120, G.828 and G.826. The near-end performance monitoring, far-end performance monitoring, performance data collection and performance history shall be as per ITU-T Rec. G.784.
2.	EMS shall provide the information regarding degradation of the optical paths. It shall have the capability to monitor and display certain important parameters like optical power, λ & Pre FEC BER measurements of channels and of DWDM Central Office equipment, Line System and Remote Terminal. The EMS shall provide non-intrusive B-1 byte monitoring of individual channel of DWDM systemand shall provide error-ratio/error-count along with other ITU-T Rec. G.826 parameters provisioning. EMS shall also be capable of setting the equipment performance thresholds in the	Check the following as per the requirement of the clause: • Reporting and monitoring of the performance data. • Check of FCS errors for Ethernet clients. • Check of Frame/Packets dropped in case of Ethernet frames.

	range of $1x10^{-5}$ to $1x10^{-12}$.	
3.	There shall be a provision for near-end performance monitoring, far-end performance monitoring, performance-data collection and performance history. The main performance functionality to be provided shall be as under: i. Configuration of threshold concerning the error counters. ii. Performance monitoring by BIP check. iii. Performance monitoring and reporting. iv. Performance History (data logging).	The following performance monitoring functionalities are required to be provided by the equipment: • Check near end and far end error performance parameters for SDH and OTN clients. • Logging the performance history shall be possible wherein different parameters are stored. • Prints outs of the statistics and histograms.
4.	EMS shall store the performance data of the system including NE name, date and the time. The collection of the performance counters will have to be performed at pre-assigned rate. Inaddition, it shall also be possible to take print out of the statistics and histograms.	Check the performance data of the system is stored including NE name, date and the time for at least one month.
5.	It shall be possible to configure scheduling of performance measurement, collection, storage and transfer of traffic/ performance statistics for at least one month in the EMS system, after which it shall be possible to transfer the data to external media like USB, CD or any other server. It shall also be possible to generate daily, weekly, monthly	The following performance monitoring functionalities are required to be provided by the equipment: • Check that it is possible to generate daily, weekly, monthly reports

	reports for the individual element as well as complete domain. The report generation shall be supported inText/CSV/Excel/pdf format and graphic reports as and when requested as well as at configurable interval automatically.	for the individual element as well as complete domain. • Check there is provision to transfer the performance data to external media. • Check there is provision to configure the schedule of performance measurement.
6.	The EMS shall store the performance data of the sub-network in terms of configured circuits.	Check that performance data of the sub network is stored.
7.	It shall be possible to generate customised reports for various types of faults, performance history, security management etc. It shall also be possible to generate reports at various clientslevels to facilitate monitoring of performance statistics in predefined/customised format.	Generate customized reports for various types of faults, performance history, security management etc. at various client levels.
14.5	Security Management: The management system shall provide adequate security in respect of the data and the access to the management system as per the following details:	The management system of the equipment shall provide adequate security to the data.
1.	The EMS shall have the capability of supporting the management of network through local and remote operator terminals. The authorizations and the privileges of the operator terminals (Remote and Local) shall depend upon the Login and Password.	Note and verify that there are three levels of access to the management system and each level requires a separate programmable password

	i. Low level protection for read only access to faults and performance information. ii. Medium level protection for reads only access to configuration status and features. iii. High level protection for access to change in the configuration and control parameters.	for the following leveled access: a) Level-1: Low level access for read only and shall have the access to faults and performance information only; b) Level-2: Medium level protection for access to configuration status and features; c) Level-3: High level protection access for control of access to aforesaid clauses and to change the configuration and control parameters.
2.	The EMS shall support multi-level passwords as below- i. EMS shall allow the System Administrator to define the level of access to the network capabilities or feature for each assigned password. It shall be desirable that the EMS shall block the access to the operator in case of wrong login password and ID and also for unauthorized commands being tried for five consecutive times in both the occasions. ii. The system administrator shall be able to monitor and log all operator activities in the EMS including operator terminal and Local Craft Terminal.	i. . Check that the System Administrator is capable to define the level of access for each assigned password. EMS blocks the access to the operator in case of unauthorized commands or wrong password being tried for five consecutive times. ii. Check that the system administrator shall be able to monitor and log

	iii. The dynamic password facility shall be provided in which the operator may change its password at any time.	all operator activities in the EMS and LCT. iii. Dynamic password facility has been provided.
3.	It should be mandatory for the system to have a record of all log-ins in read only password protected file for a period of at least six months after which a backup should be possible under system administrator command. All log-in and log-out attempts shall be logged in the security log file of the EMS system.	Each log in and log out attempt is logged in the security log file of the EMS system.
4.	The LCTs shall normally operate through the local interface of local NE. In case of EMS link failure between NE location and EMS, the LCT should be able to supervise/monitor the local NE assigned to it and can access up to 32 remote NE through Optical Supervisory Channel (OSC)"	In the case of failure of the link between LCT location and the EMS, check that the LCT is able to supervise/monitor the faults and performance.
5.	It shall be possible to provide the connectivity of EMS and the network elements through IP-MPLS-VPN network for providing the inherent security required for the management information in addition to the login and Password based authorization for the operators of the Network Manager.	Check that it is possible to connect EMS and the network elements to the IP-MPLS network and also that the EMS and the Network Management layer (NML)/ Service Management Layer (SML) of a purchaser is a part of the common MPLS-VPN. Check that the security, login and Password based authorization are provided

		to the Network Manager.
6.	The EMS shall be able to back up and restore the data base to and from external storage media.	Check that the backup for programs and data are provided.
14.6	**Inventory management:**	
1.	It shall indicate the presence or absence of any physical module in hardware elements. It shall also indicate the usage of module i.e. how many ports are in use, which interfaces are in use and which are free to be used.	Check that it is possible to indicate the absence or presence of any physical module and also how many ports are in use, which interface is in use and which are free to be used.
2.	The EMS shall be able to discover, keep and display the device information	Check that the EMS provides discovery and the device information.
3.	The EMS shall be able to keep track and report chronologically on any change in the network inventory.	The EMS provides any change in the network inventory reports the change of events chronologically.
4.	The EMS shall be capable of providing the inventory information to the Network Management layer (NML)/Service Management Layer (SML) so that SML is able to create and activate a service to the customer.	Check that on the basis of the inventory information provided by the EMS to the Network Management layer (NML)/ Service Management Layer (SML), the SML can create and activate a service to the customer automatically.
5.	The EMS shall provide the complete view of location wise network elements and the	Check that the complete view of the network

	interconnecting links, in map format, list or rack picture format etc. for each independent links/networks as well as for all the links/networks under management of the EMS.	elements and the interconnecting links are provided by the EMS.
14.7	**Software Management:** It shall be possible for the EMS to carry out the following tasks under the software management function:	Under the software management, check that the following activities are possible:
1.	Loading of new system software in EMS/local terminals/remote terminals and the LCTs.	loading of new software.
2.	Managing different versions of software.	manage different versions of software.
3.	Managing multiple versions of software for individual elements. In this case, one software version shall remain active and other versions shall be passive.	Manage multiple versions of software such that one software version remains active and other versions passive.
4.	Installation of software patches.	Installs of software patches.
5.	Local & remote software download via management system to NEs and LCT shall be possible, including the means of identification of software module versions. No loss of data/traffic & connection-map shall take place during the software downloading process. At the time of downloading the software, the message shall be displayed that the software has been downloaded successfully or failed and at what stage.	Check that no loss of data/traffic & connection-map shall take place during the software downloading process. display of downloading message of software such as downloaded successfully or failed and at what stage.
6.	Downloading of Software, configuration, patches etc., to the Network Element through	EMS support of FTP/TFTP for download of software,

	FTP/TFTP. No loss of data/loss of connection map shall take place during the software downloading process.	configuration, patches etc., to the Network Element.
7.	Changing the system configuration, reconfiguration of input and output devices.	Check local & remote software download via management system to NEs.
8.	All commands which are executed over the EMS program or data shall be logged in a file (read only) and it shall be possible to retrieve the same on demand whenever required, using Man-Machine Commands. The EMS shall have suitable system level backup mechanism for taking backup of EMS data of at least one month on DVD, CD or transfer to another storage through LAN. The file usage of up to 50%, 75% and 90% shall generate alerts in the server platform, of suitable category prompting the operator to initiate the backup operation.	Check that all the executed commands over the EMS program or data are logged in a file and retrieval of the same on demand is possible. File usage of up to 50%, 75% and 90% generates alerts in the server platform, prompting the operator to initiate the backup operation.
9.	During the log-in by the system administrator, the system will provide the visibility of at least last 20 commands on the screen as system log or the system should provide audit log for last 24 hours.	Check that at the system level, it is possible to store at least the last 20 commands on the screen and any command is re-executable by scrolling and editing.
10.	The EMS of the DWDM equipment shall have e-protection from the virus.	Check that EMS of the DWDM equipment have e-protection from the virus.
14.8	**EMS Server**	
1.	EMS system shall consist of Application and	EMS system consist of

	Database servers and it shall possible to mount these servers on different or on single server.	both Application and database server.
2.	The memory of the Database Server shall be sufficient to store the data of minimum 500 fully loaded NEs with a capability of storing performance/ fault history of 30 days.	Sufficient memory is provided in Database server to store the data of minimum 500 fully loaded NEs with a capability of storing performance/ fault history of 30 days.
3.	Application and Database servers as well as firewall system (if provided) shall have redundancy for control module, disk, power supply and LAN interface.	Application and Database servers as well as firewall system (if provided) have redundancy for control module, disk, power supply and LAN interface.
4.	Industry standard Relational Database Management system (RDBMS)/NoSQL DB or Cassandra or Elastic Search for storing allthe data related to the network and the system shall be used .	Industry standard relational database (RDBMS) for storing all the data related to the network and the system is provided.
5.	TEC 48140:2018 (earlier numbered as TEC GR No. TEC/GR/IT/SRV-001/02/MAR-18) or latest may be referred for servers.	Refer TEC GR No. TEC/GR/IT/SRV-001/02/MAR-18 or latest edition for servers.
14.9	**Firewall [optional requirement]:** If EMS is required to be connected to public network, it is desirable to provide security to EMS from public network. In such case a dual redundant hardware based Firewall system may be provided at each of the EMS locations for providing security to the various	Provisioning of the Firewall system is optional. If provided or if the purchaser has demanded for its provisioning, then check the following features:

	servers at the EMS. For Firewall System specifications TEC GR No. TEC 49090:2014 (Earlier numbered as TEC/GR/IT/FWS-001/04.MAR.2014) or latest may be referred. **Note**: For offering DWDM system for Type Approval, Firewall shall not be mandatory.	i. Check that the Firewall system for providing security to the EMS, is redundant. Other requirements of the Firewall system shall be as per TEC GR No. TEC 49090:2014 (Earlier numbered as TEC/GR/IT/FWS-001/04.MAR.2014) or latest. ii. Ensure that the firewall system provides the security cover to the Web Based Customer Care System from the internet. Also ensure that this provides the security to the EMS Database from the Internet and the Web Based Customer Care Users & the Systems.
14.10	**Local Crafts Terminal/Client Terminal/Work Station:** (1) Local Craft Terminal performs two types of functions in a network at NE level namely Configuration Management and Fault Management. (2) LCT shall be capable of performing its function for at least 32 NEs. LCT can be	Check if LCT is able to access a local NE through a LAN or a serial port on DWDM equipment and any remote NE through data communications channel (DCC) of the DWDM system. For fault

	installed on a client PC or Laptop. The LCT shall be able to access a local NE through a LAN or a serial port on DWDM equipment and any remote NE through data communications channel (DCC) of the DWDM system. For fault management it shall handle only basic alarm functions like Alarm Monitoring Policy Settings, Alarm Viewing and Alarm Deletion etc.	management it shall handle only basic alarm functions like Alarm Monitoring Policy Settings, Alarm Viewing and Alarm Deletion etc.
14.11	Typical minimum Desktop/Laptop configuration for LCT/EMS terminal shall be as follows or latest: "Desktop, Workstation/ Remote terminal: CPU Intel Core i3, 13 generation core or equivalent or better Processor, 1TB HDD or minimum 512GB SSD with 8 GB DDR5 RAM or better, 17" TFT/LED flat screen display for Remote Terminal and 21" TFT/LED for NOC workstation, 12 MB L-3 cache, Ethernet interface 10/100/1000 Mbps) with industry standard Operating system like Windows10 or higher version/Linux, Optical mouse, Keyboard, Four USB ports, 4x CD RW/DVD Drive or above, Antivirus Software with 3 years' validity or better. " Laptops: CPU Intel core i5, 13 generation core or equivalent or better, 12 MB L-3 Cache, 8 GB DDR5 RAM or better, 15" TFT/LED display, 500 GB (or higher) Hard Disc Drive or minimum 512GB SSD, Integrated LAN & Wi-Fi, Integrated Audio with in-built speaker &	Check configuration is as mentioned in the clause.

	Mike, Three USB port, and one HDMI, Integrated Bluetooth 4.0, Touch pad, Windows10 or higher, more than 4 Hrs of Battery Life, AC Adaptor and Carry Bag, MacAfee/Quick heal/Norton Antivirus Software with 3 years support or better.	
14.12	**EMS Architecture**	
14.12.1	Though the EMS can be PC based system for a small network, for a network having large numbers of NEs, Centralised EMS with server based architecture should be provided.	
1.	To ensure EMS connectivity to the sub-network under control-card failure, it shall be possible to dual home the EMS to two Gateway NEs (GNEs) in a sub-network so that performance and fault data for the sub-network shall be available even if the master control-card at one GNE fails.	For no loss of EMS data, check that dual-homed connectivity of EMS to two Gateway NEs (GNEs) in a sub-network under control-card failure, has been provided. The performance and fault data for the sub-network is be available even if the master control-card at one GNE fails. In case of total loss of EMS connectivity, the sub-network continues to provide the services without any deterioration.
2.	In case of loss of EMS connectivity, the LCT privilege shall not be affected for monitoring and for local configurations, as per the privileges assigned by EMS administrator.	Check that in case of loss of EMS connectivity, monitoring of faults and local configurations is possible through LCT.

3.	It shall be possible to operate the Main and DR locations in 1+1 mode, either with manual switchover or with automatic switchover. The system shall have data replication and synchronization mechanism so that servers at both locations have same data. Synchronization shall be in real time or in steps of 15 minutes or less.	Check that it is possible to operate the main and DR locations in 1+1 mode, either with manual switchover or with automatic switchover. Check that the system has data replication and synchronization mechanism in real time or in steps of 15 minutes or less.
4.	Any failure in EMS including software bugs shall not affect the healthy working of the DWDM system.	Check that healthy working of DWDMsystem is not affected by any failure in EMS including software bugs.
5.	It shall be possible to assign rights to each local and remote terminal for EMS function for monitoring and issue of commands for all links or any number of independent links or sub-networks by the EMS administrator.	Check that it is possible to assign rights to each local and remote terminal for EMS function for monitoring and issue of commands for all links or any number of independent links or sub-networks by the EMS administrator.
14.12.2	**Scalability Aspects:**	
1.	The EMS should be able to support at least 500 NEs. NE is an OADM or TM or ILA with fully equipped line and client side interfaces. These elements may be spread over any number of independent links or sub-networks	Ensure that the EMS is able to support at least 500 NEs.

	of the capacity up to 10G/40G/100G.	
2.	Operating system and applications for EMS including database server shall be multi-user with minimum 25 concurrent users including local terminals at EMS site and remote terminals which access the EMS through a WAN.	Ensure that the OS of the EMS including database server provide a multi-user system where a minimum of 25 users can operate simultaneously including local terminals at EMS site and remote terminals i.e. LCTs which access the EMS through a WAN.
3.	The EMS shall be equipped to connect to at least 10 local terminals at EMS site. It shall also be upgradeable to 25 local terminals.	Ensure that the EMS shall be equipped to connect to at least 10 local terminals at EMS site. It shall also be upgradeable to 25 local terminals.
4.	EMS of the system shall have the capability of supporting dual stack 32/128 bit IP addressing, for internal communication with the equipment.	The EMS shall support 32/128 bit IP addressing.
14.13	**Management Interface:**	
14.13.1	**Southbound Interface of EMS:** EMS shall provide south bound interface towards NE as implemented in the Gateway NEs (GNEs).	Check the provision of two management interfaces: remote management interface and Local Management Interface. Ensure that SNMP version2c [or later interface] has been provided on all the Gateway NEs (GNEs) to

		interact with a centralized Element Management System (EMS). Run the standard MIBs Browser with SNMP version2c [or later interface]. In case SNMP is not provided, ensure that either ITU-T specified Qx or Bellcore specified TL1 interface implemented on TCP/IP remote management interface has been provided.
14.13.2	**Northbound Interface:** The North bound interface meant for connectivity with NMS shall be open interface such as SNMP v2 or better/ XML/TL-1/ MTNM TMF-508, 613, 814 specified CORBA, using standard MIBs/ GDMO/ PICS etc., as per ITU-T Rec. G.873.1.	Ensure that the northbound interface of the EMS towards NMS layer is TMF 814 CORBA [version 3.0] whereas the southbound interface towards NEs shall be SNMPv2c [or later interface] implemented on UDP/IP stack, as stated earlier.
15.0	**DWDM Equipment required for Type Approval** The minimum DWDM equipment, which the manufacturer/supplier is required to provide for type approval under DWDM Point-to-point,	The topology and the application offered for testing shall be mentioned in the TA Certificate.

	Linear Add/Drop System,Ring Configuration and for DWDM mess configuration is given at Annexure-II of this standard.	All other requirements mentioned in this clause of the standard must be adhered to before commencement of the testing. As far as ROADM is concerned, at least 4 directions shall be demonstrated during the testing with all 4 directions fully equipped.

CHAPTER-2

Clause No.		*Type of Test / Test No. etc. **
	Guidelines for Purchaser Following are the guidelines, which the purchaser may follow while deciding for the procurement or maintenance of the DWDM system including Element Management System. However, the purchaser needs to make decision on various aspects/parameters of this standard.	
16.0	**Equipped channel capacity:** The purchaser may ask the DWDM system vendor to provide an end to end capacity for n32/40/64/80/flexible channels @100G/200Gbit/400G and above- Ethernet interfaces, on day one. The required number of actual equipped channels with Transponders/Muxponders of various 'types' is to be decided by the purchaser. Proper termination of the unused channels shall be provided by the manufacturer as part of system design. It may be possible to utilize the unequipped channels at a later date without affecting the existing traffic.	Ensure that the common boards are configured for 40 / 80 channels on day one.
17.0	**DWDM applications:** As required by the purchaser, the DWDM system is to be designed for use in transport networks as a protocol transparent solution for a variety of client/services. The DWDM is to find its applications for the following variety of services and protocols e.g., SDH @ STM-	Ensure that the system supports transmission of different services. This can be verified by transmitting a STM-64 and 10GE signals from A-terminal and receive the

	64 as well as 10GigE/40GE/100GE/400GE as per different IEEE 802.3xx standards.	same signals at B-terminal.
18.0	**Application codes:** The standard envisages two different application codes for a point to point, linear-chain & ring in accordance with Table-1a, 1b, 2a, 2b, 3 & 4/Annexure-I of the standard. Under all network topologies, viz., point to point, linear add/drop, DWDM ring and mesh architecture, all fibre-spans between 'MPI-S & MPI-R', S' & R' and 'Sn & Rn' reference points of figure no 16, is to be limited by Table-1a, 1b, 2a, 2b, 3 & 4/Annexure-I specifications for both application codes for the worst-case channel. All the optical amplifiers (ILA) and OADMs are to be designed for 17-22db span-loss for Long Haul applications and 23-28db span-loss for Very Long Haul applications at a minimum. The attenuation per span between the Optical Line Amplifiers (Booster Amplifier, In Line Amplifiers and Pre-amplifier) and Optical Add/Drop Multiplex shall be as follows: i) Long haul application: 17-22 dB (80km) ii) Very long haul application:23-28 dB (100km) **i) Longhaul application code** The LH equipment to acquire approximately 800 km route length for 100G and 500 km route length for 200G before acquiring 3R	Note the application code offered: Long Haul / Very Long Haul application. **Longhaul application** Verify the limits of the parameters given in Cl. 19.0 with the enroute ILAs,

	regeneration. This is based on 0.28 db/km loss over single mode optical fibre as per ITU-T Rec. G.652. Based on these projections, total dispersions requirements shall be 14400 ps/nm for LH configuration @18ps/nm.km over C-band for G.652 SMF. The dispersion shall be compensated by Coherent Channel System 100 G/200 G upon reaching these limits. Span-loss between MPI-S & R', S'& MPI-R and S' & R' reference points for all spans shall be 17-22 dB with Forward Error Correction (FEC) enabled. There may be upto 8 such spans or more for 100 and upto 6 spans for 200 G.	ROADMs or a combination of them.
	ii) Very Longhaul application code	Very Longhaul application
	The VLH equipment to acquire approximately 600 km route length for 100G and 300 km route length for 200G before acquiring 3R regeneration. This is based on 0.28 db/km loss over single mode optical fibre as per ITU-T Recs. G.652. Based on these projections, total dispersions requirements will be 10800 ps/nm for VLH configuration @18 ps/nm.km over C-band for ITU-T Rec. G.652 SMF. The dispersion shall be compensated by Coherent Channel System for 100G/200G system. Span-loss between MPI-S & R', S'& MPI-R and S' & R' reference points for all spans shall be 23-28 dB, with Forward Error Correction (FEC) enabled. There may be upto 5 such spans or more for 100G and upto 3 spans for	Verify the limits of the parameters given in Cl. 19.0 with the enroute ILAs, ROADMs or a combination of them.

	200 G. **Note 1:**The above power-budgets is to be valid even for the worst-case channel for which proper channel equalization scheme should be implemented in the system to adhere to end-to-end OSNR requirements in uniformity with other channels as per Table-1a, 1b, 2a, 2b, 3 & 4/Annexure-I of the standard. **Note 2:**The exact distances covered to be subject to actual fibre-attenuation coefficient and dispersion parameters for the worst-case channel. **Note 3:**The actual number of possible OADMs in the link, for all application codes, as well as continuous add/drop of the same wavelength/s in subsequent spans to be supported, for the entire spans in the link. The LH links shall support 8 such OADMs in a link. **Note 4:**All enroute nodes for both application codes - Longhaul& Very Longhaul, shall be ILAs, OADMs or a combination of them. The insertion-loss of OADMs shall be compensated by the OA element contained within OADM node. The OA element shall be designed accordingly. **Note 5:** In linear add/drop and ring topologies, all parametric specifications at 'S' & 'R'	

	reference points of OADM's add/drop ports shall also comply as specified for In Line Amplifiers in Table-1a, 1b, 2a, 2b, 3 & 4/Annexure-I of the standard. The "Sn/Rn" reference points shall provide parametric compliance to Table-1a, 1b, 2a, 2b, 3 & 4/Annexure-I.	
19.0	**Span attenuation:** The section-loss of the optical cable including splice-losses and cable-margin etc to be as per Note-5 above, for respective application codes. The section-losses specified in the clause are beginning-of-life values and a margin for the ageing of fibre and optical amplifiers etc., to adhere to end-of-life values shall be tested. Testing of the link shall be performed for a span-loss 3db higher than beginning-of-life values during testing.	The system must supports 3dB margin during the testing. The parameters specified are the end-of-life values, and includes 3 dB margin for the ageing of fibre and optical amplifiers.
20.0	**Number of spans without 3R:** For a comprehensive network planning, the purchaser may ask the vendor to provide the relevant network planning tool for the network design. Since the DWDM equipment is required to function in both Long haul as well as Very Long haul applications and the no. of spans in respect of both these applications varies depending upon the type of NEs used i.e., TMs, ILAs, OADMs, the purchaser may ask the vendor to carry out the complete network planning as per the network information provided by the purchaser. It is presumed	The equipment shall be able to support the span lengths for Long Haul and Very Long Haul applications through G.652 and G.655 fibres in respect of 40 Channel as well as 80 Channel as given in the Table in the standard. This link shall include no regeneration of any kind. Before commencement of the test, note the following

	that ILAs in metro networks may not be used in a large extent, it is therefore proposed that the requirement of ILA in Metro Networks may be decided by the purchaser as per his need. The 100G DWDM link over the Single-mode Optical fibre shall support the no. of spans as under: a) Long haul application shall be up to 8 spans or more. b) Very Long haul application shall be up to 5 spans or more. The 200G DWDM link over the Single-mode Optical fibre shall support the no. of spans as under: a) Long haul application shall be up to 6 spans or less b) Very Long haul application shall be up to 3 spans or less. The Longhaul equipment shall work satisfactorily for 800 km or more without 3-R regeneration. This is based on 0.28 db/km fibre-loss assumption (inclusive of splice-loss and cable-margin etc.) over single-mode optical fibre as per ITU-T Rec. G.652. Similarly, Very Longhaul equipment shall work satisfactorily for 600 km or more without regeneration, based on the same assumption of fibre-loss. The 400G DWDM link over the Single-mode	information: 1. Channel capacity of the equipment: 2. Type of fibre: 3. Application code – Long haul / Very long haul. 4. No. of spans supported: 5. Span length : 6. Total span length:

	Optical fibre shall support the no. of spans as under: c) Long haul application shall be up to 6 spans with DGE after 3rd ILA. d) Very Long haul application shall be up to 3 spans. The Longhaul equipment shall work satisfactorily for 500 km or more without 3-R regeneration. This is based on 0.28 db/km fibre-loss assumption (inclusive of splice-loss and cable-margin etc.) over single-mode optical fibre as per ITU-T Rec. G.652. Similarly, Very Longhaul equipment shall work satisfactorily for 300 km or more without regeneration, based on the same assumption of fibre-loss.	
21.0	**Accessories:** The purchaser may ask the supplier to provide one complete set of:	Ensure that the supplier has supplied one complete set of the following:
a)	All the necessary interfaces, connectors, connecting cables and accessories required for satisfactory and convenient operation of the equipment. Types of connectors, adapters to be used and the accessories of the approved quality to be clearly indicated in the operating manuals, which should be in conformity with the detailed list in the standard;	Set of connectors, connecting cables, adapters and any other accessories required for satisfactory working of the equipment.
b)	b) Software and the arrangement to load the software at site. **Note**: Additional sets may be ordered	A copy of the software on a CD and detailed procedure in the eqpt. manual as to

	optionally.	how to down load the same at site
21.1	Special tools, extender boards, extender cables and accessories essential for installation, operation and maintenance of the equipment to be clearly indicated and supplied along with the equipment.	Special tools, extender boards, extender cable and accessories for the installation operation and maintenance of equipment shall be noted and be supplied along with the equipment.
21.2	Special tools, extender boards, extender cables and accessories essential for repair of the equipment to be clearly indicated and supplied in case the same are ordered.	Special tools, extender boards, extender cable and accessories for the repair of equipment shall be noted and be supplied along with the equipment.
22.0	**Maintenance requirements:** Maintenance philosophy is to replace faulty units/subsystems after quick on-line analysis through monitoring sockets, alarm indications and Built-in Test Equipment/ hand-held terminal/laptop PC. The actual repair will be undertaken at centralized repair-centres. The corrective measures at site shall involve replacement of faulty units/sub-systems.	In order to provide quick maintenance by replacing the faulty units all the traffic affecting units shall have the front access and shall not involve any screw to mount them. Also ensure that online analysis is provided in case Built-In-Test Equipment facility is supported by the equipment.
22.1	The equipment should have easy access for servicing and maintenance.	Verify that easy access, front access in particular is provided for ease of maintenance.

22.2	Suitable alarms to be provided for identification of faults in the system and faulty units.	Check that LEDs are provided to indicate the faults in the system and also for the faulty units.
22.3	Suitable provision to be made for extension of summary alarms.	Check that potential free contacts are provided to extend the alarms.
22.4	Ratings and types of fuses used are to be indicated by the supplier.	Ensure from the documents supplied by the manufacturer that the types of fuses used and their ratings are provided.
23.0	**Contentionless ROADM** The colourless and directionless ROADM network has some limitations that could require manual intervention in some cases. Thus, the colourless/directionless ROADM network is not completely flexible. The problem is that wavelength blocking can occur when two wavelengths of the same colour converge at the same WSS structure at the same time. This will cause network contention. This blocking/contention situation is avoided by partitioning the add/drop structures so that different coloured wavelengths are associated with different structures – thus eliminating the possibility for two wavelengths of same colour to converge on the same add/drop structure simultaneously. While this level of engineering does resolve wavelength contention potential from a provisioned perspective. It means that operators sacrifice a level of dynamic	No test is required. This is for information only.

	flexibility and may require additional add/drop structures to accommodate particular wavelength channels. The new concept is that of contention-less ROADMs networks. A contention-less architecture, allows multiple signal of the same wavelength on a single add/drop structure (without any partitioning restrictions). A colourless /directionless architecture combined with true contention-less functionality is the ultimate goal for transport network. Such architectures are known as Colourless, Directionless and Contention-less (CDC) Network and give the ultimate level of flexibility at the optical layer.	
24.0	**EMS Requirement:**	
24.1	As a cost effective measure, two display units are adequate for all the servers (application, database, and for firewall). Purchaser is at discretion to convey any additional requirements. It shall be possible to access any server from any of the display.	Check that unless mentioned by the purchaser, only two display units are provided for all the servers (application, database, and firewall servers) and that it is possible to access any server from any of the display
24.2	The purchaser shall communicate requirements for (1+1) server backup or internal constituents of server.	Check the provision of (1+1) server backup or internal constituents of server as required by the purchaser.
24.3	The purchaser may validate vendor's claim for management functions as well as protocol compliance through Protocol Analyzer etc.	Check the management functions and also the protocol compliance for

		Qx or SNMP interface through MIB Browser.
24.4	For Application Server, typically Category-I Blade Server (CISC) can be selected as per TEC Standard No. TEC 48140:2018 (earlier No. TEC/GR/IT/SRV-01/04/MAR-18) or latest However, the exact dimensioning is to be decided by the purchaser based on the actual requirement and future growth of the network.	In case of Application server, category-I Blade Server can be as per TEC Standard No. TEC 48140:2018 (earlier No. TEC/GR/IT/SRV-01/04/MAR-18) or latest
24.5	For Database Server, typically Category-II Blade Server (CISC)/Category-II X 2 Blade Server (RISC) can be selected as per TEC Standard No. TEC 48140:2018 (earlier No. TEC/GR/IT/SRV-01/04/MAR-18) or latest. However, the required dimensioning is to be decided by the purchaser based on the actual requirement and future growth of the network.	For Database Server, Category-II Blade Server (CISC)/Category-II X 2 Blade Server (RISC) can be as per TEC Standard No. TEC 48140:2018 (earlier No. TEC/GR/IT/SRV-01/04/MAR-18) or latest.
24.6	For Combined Server, typically Category-I X 3 Blade Server (CISC)/ Category-II X 3 Blade Server (RISC) can be selected as per TEC Standard No. TEC 48140:2018 (earlier No. TEC/GR/IT/SRV-01/04/MAR-18) or latest. However, the required dimensioning shall be decided by the purchaser based on the actual requirement and future growth of the network.	For Combined Server, typically Category-I X 3 Blade Server (CISC)/ Category-II X 3 Blade Server (RISC) can be as per TEC Standard No. TEC 48140:2018 (earlier No. TEC/GR/IT/SRV-01/04/MAR-18) or latest
24.7	The requirement of EMS at DR site may be decided by the purchaser.	Ensure that provision for EMS at DR site is available if required by purchaser.
24.8	Minimum of four operator terminals will be provided at the EMS site. The purchaser	Note that atleast four operator terminals are

	however, can decide about the actual numbers of operator terminal at EMS site and also about the requirement of LAN switch. For LAN switch TEC Standard No. TEC 48060:2014 (Earlier No. TEC/GR/IT/LSW-001/05.MAR.2014 or latest may be referred.	provided at the EMS site and that the EMS has the capability to connect at least 10 local terminals at EMS site which is upgradeable to 25 local terminals
24.9	The supplier is to provide infrastructure requirements to the purchaser for setting up the EMS. The items of infrastructure include A/C power Air-conditioning load, space etc.	Obtain an infrastructure requirements from the supplier for setting up the EMS. The typical items of infrastructure include A/C power, Air conditioning load, space etc.
24.10	Installation & commissioning of the EMS shall include supply & installation of cables, distribution frames, electrical switches etc shall be prescribed by purchaser.	Note that whosoever installs and commission the EMS, shall be liable to arrange and supply cables, distribution frames, electrical switches etc.
24.11	Format for creation of database of links, OTMs, ILAs, DGE, OADMs etc., and their numbering scheme, details of built up points across various rings other commissioning details, supplementary information, order reference, dates etc. shall be prescribed by purchaser. This can be done at the time of validation of EMS. The purchaser may also ask for customisation of reports pertaining to functional requirement of DWDM system.	The purchaser shall prescribe a format for creation of database of rings and their numbering scheme, details of built up points across various rings other commissioning details, supplementary information, order reference, dates etc.
24.12	The purchaser may prescribe that for	Note that all the

	validation of all the components of EMS, instruments necessary for carrying out validation test shall be arranged by supplier.	components of EMS and features of EMS shall be validated. All the instruments necessary for carrying out validation test shall be arranged by supplier
24.13	The purchaser may ask the manufacturer to arrange testing for various interfaces during the testing as per the PICS and MIBs (as applicable) and shall support the factory test results of its EMS during testing of their products. The manufacturer should also submit the soft as well as hard copy of his PICS and MIBs (as applicable) along with the equipment for testing.	Obtain a soft copy as well as hard copy of the PICS and MIBs.
24.14	The functional as well as protocol compliance for the management system may be tested. Complete information on the EMS Northbound, Southbound interfaces and the EMS implementation protocol stacks shall be disclosed in details, in writing to during the testing process.	Ensure that the details of southbound and northbound interfaces are disclosed in writing. A hard copy as well as a copy in a CD shall be obtained.
24.15	The manufacturer is to submit the soft as well as hard copy of his PICS & MIBs (as applicable) along with equipment for testing.	Obtain a soft copy as well as hard copy of the PICS and MIBs.
24.16	**External Security Measures {Optional Requirements}** The purchaser may decide to provide network security by deploying external devices/machines/ firm-ware at the Network Operation Centre [NOC], like- i. Firewalls	The requirements for the external security measures are optional, but if provided, check that external devices/machines/ firm-ware like firewalls, data

	ii. Access control servers iii. Data encryption devices/use of PKI keys iv. Anti-virus packages. v. in the data communication network (DCN) for management system, VLAN tags/MPLS labels may be used for security to information flows from Gateway NEs (GNEs) to DCN Gateways with IPSec, PKI security options. vi. In order to avoid attacks to the DWDM network via DCN, the DCN transmits all the management data with encryption. The encryption should be done by 128bit encryption key.	encryption devices/use of PKI keys, access control servers, anti-virus packages, VLAN tags/ MPLS labels etc. are provided.
24.17	Manufacturer may be asked to provide soft copy of his EMS on a CD on per-ink or per-ring basis (or as asked for by the purchaser). The setup/procedure to download the software shall be clearly mentioned in the system manual of the equipment.	Ensure that the manufacturer provides soft copy of his EMS on a CD on per-ink or per-ring basis (or as asked for by the purchaser). Also note that the setup/ procedure to download the software is clearly mentioned in the system manual of the equipment.
24.18	The supplier may be asked provide all necessary interface details (with the documents) for integration of its EMS with existing or proposed NMS (irrespective of its brand/make) and also provide time bound support for its integration.	Ensure that the supplier provides all necessary interface details (with the documents) for integration of its EMS with existing or proposed NMS (irrespective of its brand/make) and also provide time bound

		support for its integration
24.19	The centralized EMS may consist of standalone application server, database server and firewall server or it can be a standalone EMS server subject to scaling requirements. The supplier may be asked to provide any other server required for meeting the purchaser requirements.	Check that the centralized EMS consists of standalone application server, database server and firewall server or it is a standalone EMS server which is scaleable. Also check whether any other servers, if required by the purchaser, are provided or not.
24.20	Operating system and applications for EMS including database server shall be multi-user with minimum 25 concurrent users (including local terminals at EMS site and remote terminals i.e. LCTs). Any more requirements may be communicated by purchaser.	Ensure that the OS of the EMS including database server provide a multi-user system where a minimum of 25 users can operate simultaneously including local terminals at EMS site and remote terminals i.e. LCTs.
24.21	Complete details of the interface variants and the protocols pertaining to each layer of the protocol-stack implemented in the management system, may be asked to be made available, for the purpose of integrating the local management capabilities with the centralized NMS. The requirement may include the following: • Protocol details at all layers of OSI or TCP/IP (as applicable). • PHY I/F at each layer. • Database structures.	Ensure that the complete details of the management interface and the protocols, as pertaining to each layer of the protocol-stack implemented in the management system, is available, for the purpose of integrating the local management capabilities with the centralized NMS at a later date. Check that

	• Number formats. • Node addressing system. • Management signalling details. • Complete application software details etc. • NMS/EMS software check-sum.	the following details are provided: • Protocol details at all layers of TCP/IP stack. • PHY I/F at each layer. • Database structures. • Number formats. • Node addressing system. • Complete application software details etc. • EMS software check-sum.
24.22	For connecting remote terminals to the centralised EMS, typically leased lines or MPLS based WAN will be required to set up. For this purpose, LAN switch/Router at central location and leased line/MPLS terminating equipment will be planned by the purchaser.	Ensure that if leased lines or MPLS based WAN is provided for connecting remote terminals to the centralized EMS as planned by the purchaser.
25.0	Documentation: Technical literature in English with complete layout, detailed block schematic and circuit diagram of various assemblies with test voltages/waveforms at different test-points of the units to be provided. All aspects of installation, operation, maintenance and repair to be covered in the manuals. The soft copy as well as hard copy of the manuals shall also be provided. The manuals include the following:	Ensure that the technical literature is also in English language. It contains the complete layout detailed block schematic and circuit diagrams of various assemblies. Ensure that the repair philosophy is defined in the documents in respect of installation, operation and maintenance. Further the

		manual shall include the following.
a)	**i) Installation, Operation and Maintenance Manual-** Safety measures to be observed in handling the equipment;	Ensure that the safety measures have been listed in handling the equipment
b)	Precautions for installation, operation and maintenance;	Ensure that the precautions for installation, operation and maintenance are given in the manual.
c)	Test jigs and fixtures required and procedures for routine maintenance, preventive maintenance, trouble-shooting and sub-assembly replacement;	Ensure that the details of test jigs and fixture if any, required procedures for routine maintenance, preventive maintenance trouble shooting and sub assembly replacement have given in the manuals.
d)	Illustration of internal and external mechanical parts.	Internal and external mechanical parts are illustrated.
e)	The detailed description about the operation of the software used in the equipment including its installation, loading and debugging etc.	Ensure that the detailed description about the operation and procedure for software download, installation and debugging etc. are given
	ii) Repair Manual (to be supplied when ordered)	**Repair manual :** Verify the documents for the

a)	List of replaceable parts used including their sources and the approving authority;	following : a) Ensure that the repair manuals contain the list of replaceable parts and their source and approving authority.
b)	Detailed ordering information for all the replaceable parts shall be listed in the manual to facilitate reordering of spares as and when required;	Ensure that the repair manuals contain the detailed ordering information for all replaceable parts.
c)	Procedure with flow chart for troubleshooting and sub-assembly replacement shall be provided Test fixtures and accessories required for repair shall also be indicated. Systematic trouble-shooting charts (fault-tree) shall be given for the probable faults with their remedial actions.	Ensure that the repair manuals contain the procedure for the trouble shooting and sub-assembly replacement if any. Also note that details of fixture and accessories if any required for repair is given in the repair manuals. Check that the systematic trouble shooting chart is given in the repair manuals.
26.0	The purchaser may indicate the exact number of add/drop channels for fixed OADM (Static).	Purchaser should indicate exact number of add/drop channels for OADM.
27.0	Various combination of colorless & directionless configuration is up to the discretion of purchaser based on his network requirements. Purchaser can fulfil his	Check as per the requirement of the clause.

	requirements in any of the following combinations, however for realizing the optical layer ASON, directionless feature is must requirement.	
28.0	The system shall also support Reconfigurable Optical Add Drop Multiplexer (ROADM) in a specific manner as per the requirements of the purchaser. All features of the ROADMsmentioned are optional features and may be decided by the purchaser as per the requirement. However, for ILA sites, size of the chassis may be decided by the purchaser.	Check as per the requirement of the clause.
29.0	Each ROADM node shall be a multi-degree node supporting up to 8 directions. However, during the evaluation testing, support of at least 4 directions can be demonstrated. Purchaser can indicate the actual no. of directions to be supplied.	Check as per the requirement of the clause.
30.0	In case the purchaser requires the link engineering support/link engineering exercise, the manufacturer shall provide such support using link planning/design tools or any other method.	Check as per the requirement of the clause.
31.0	Opting for the Planning Tool shall be optional and will decided by the purchaser.	Planning tool is optional and will be decided by purchaser.
32.0	Application codes other than those mentioned in standard may be demanded by the purchaser.	Check as per the requirement of the clause.

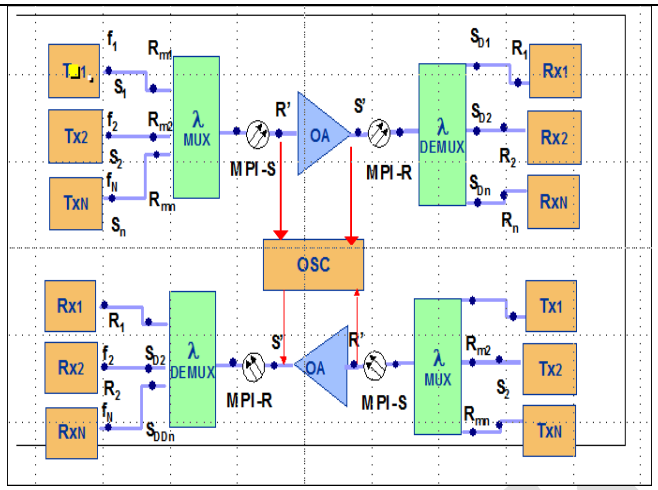


Figure 16 : Main Path Interface Reference Points

** Physical Check/Declaration/Documentation/ Report from Accredited test lab/ Functional verification / Information / Test No.*

I. TEST SETUP & PROCEDURES:

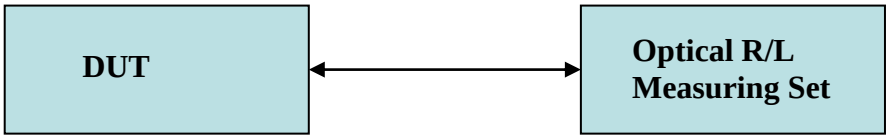


Fig.1: Optical Power and Optical return loss test setup

Figure-2: Test setup for spectral characteristics /Wavelength measurement

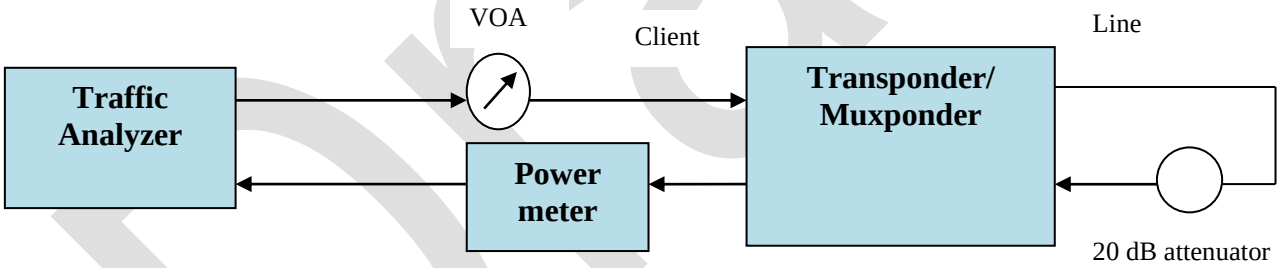


Fig. 3: Test setup for Receiver sensitivity and Overload measurement at client ports

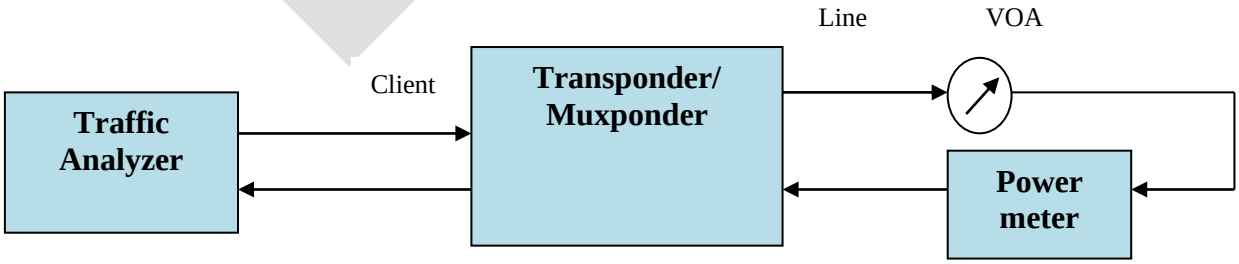


Fig. 4: Test setup for Receiver sensitivity and Overload measurement at line port

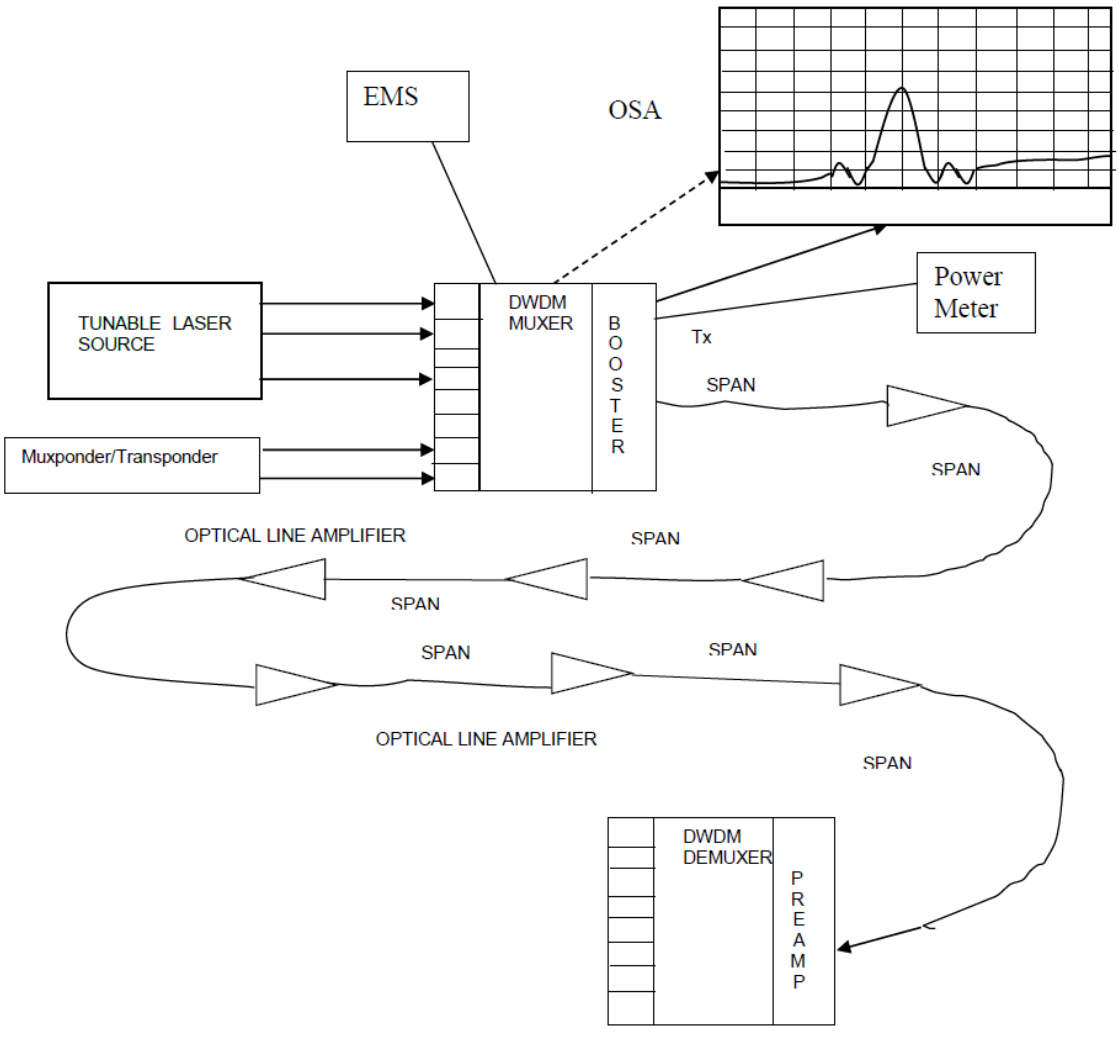


Figure-5: Test Setup for the Check of Optical Parameters at Muxer/ Booster

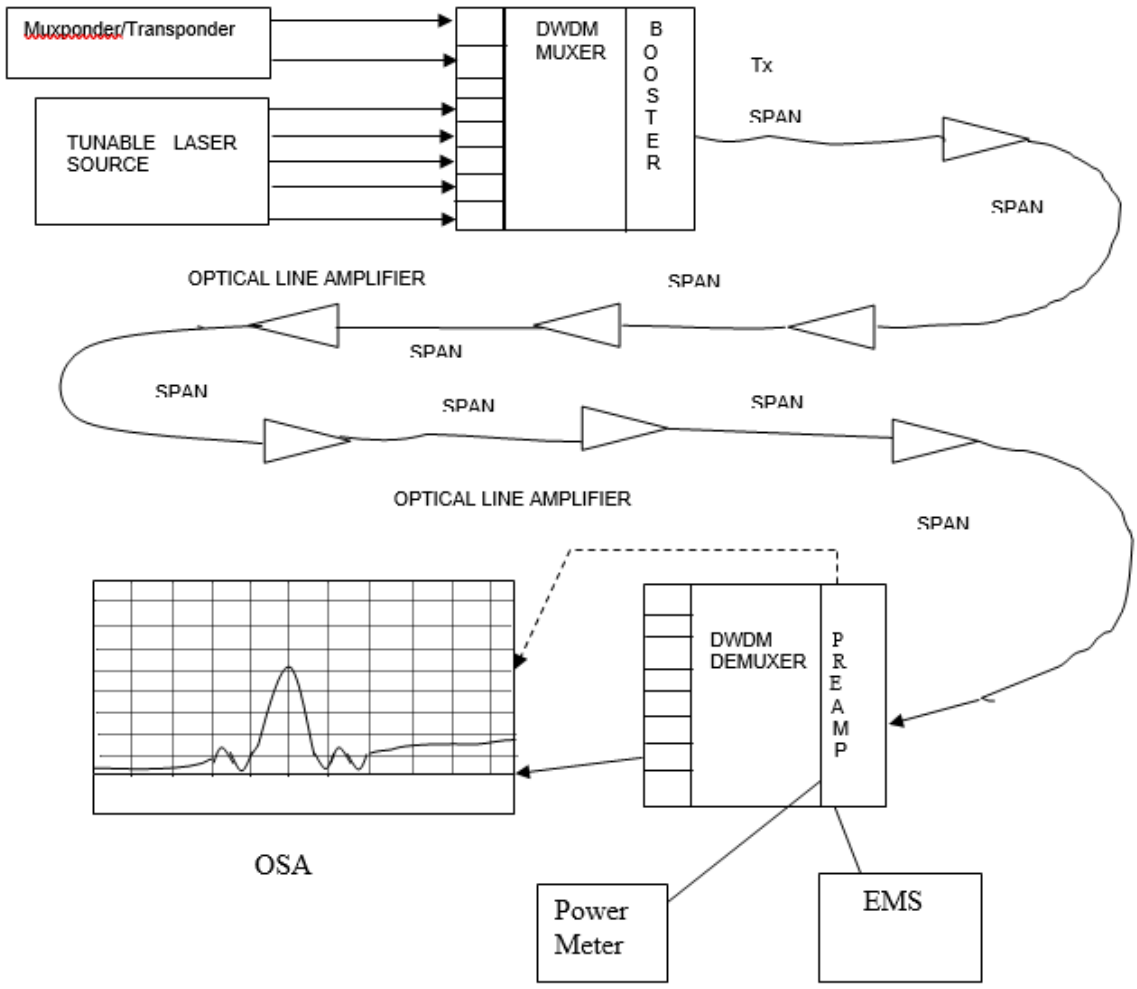


Figure-6: Test Setup for the Check of Optical Parameters at Pre-amp/ Demuxer

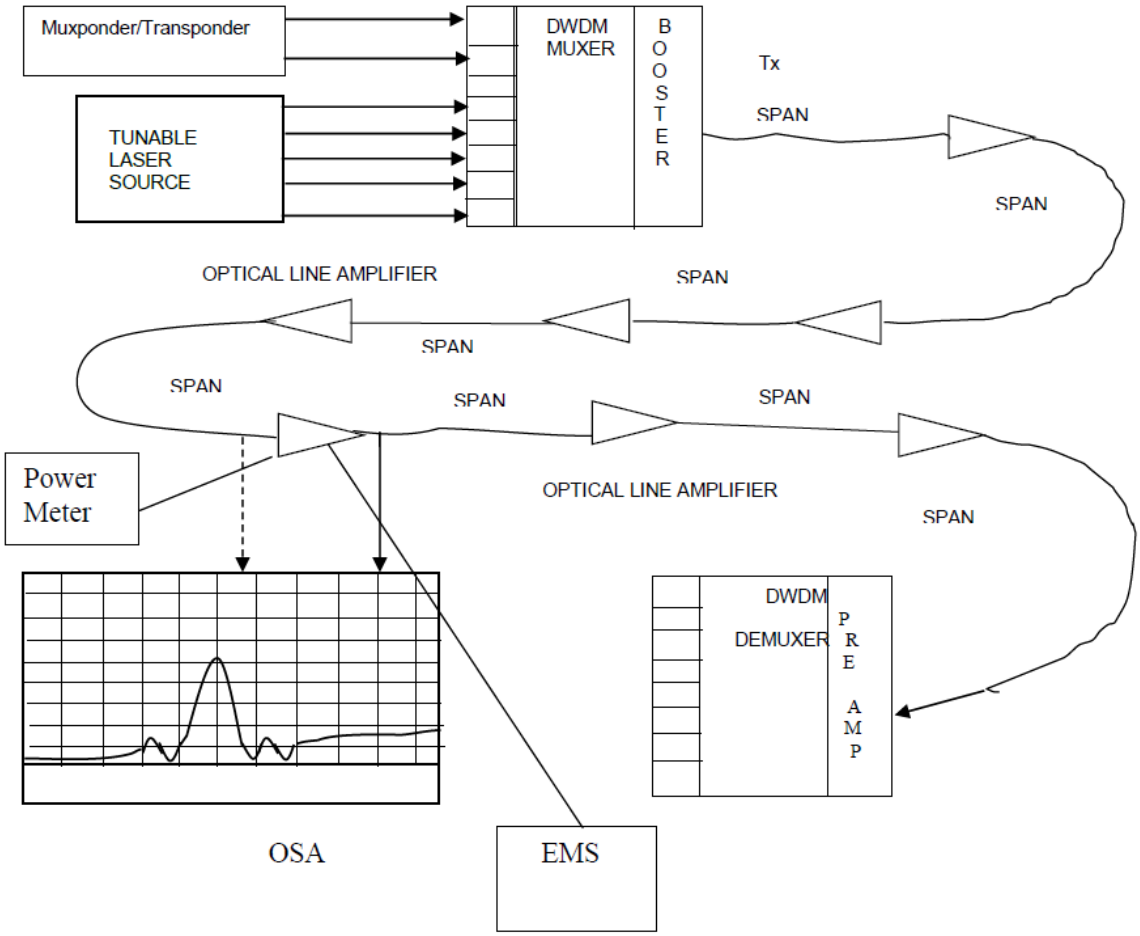


Figure-7: Test Setup for measurement of Optical Power at the Line Amplifier

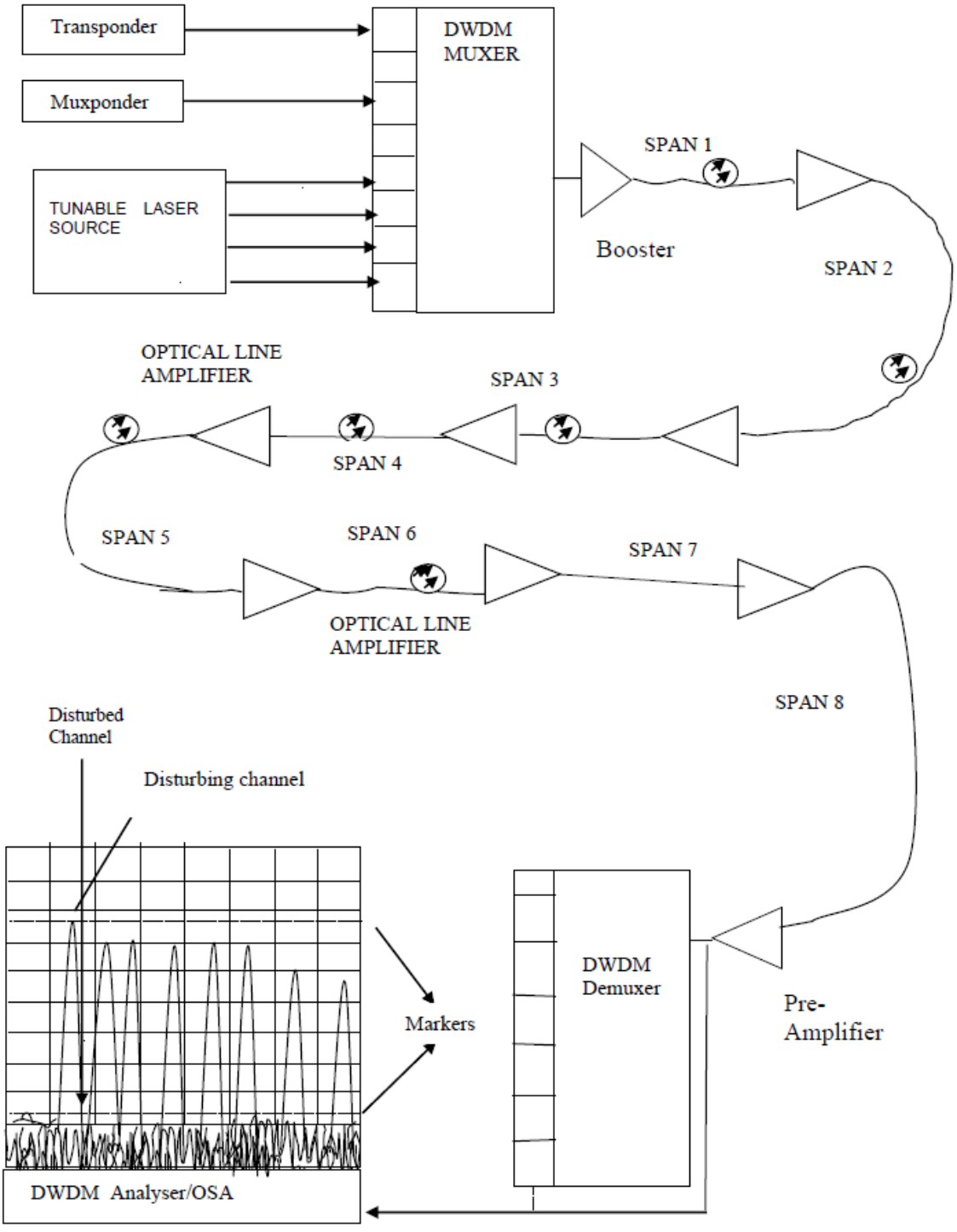


Figure-8: Test Setup for Cross Talk at Demuxer Output port/Pre-Amplifier Output Port

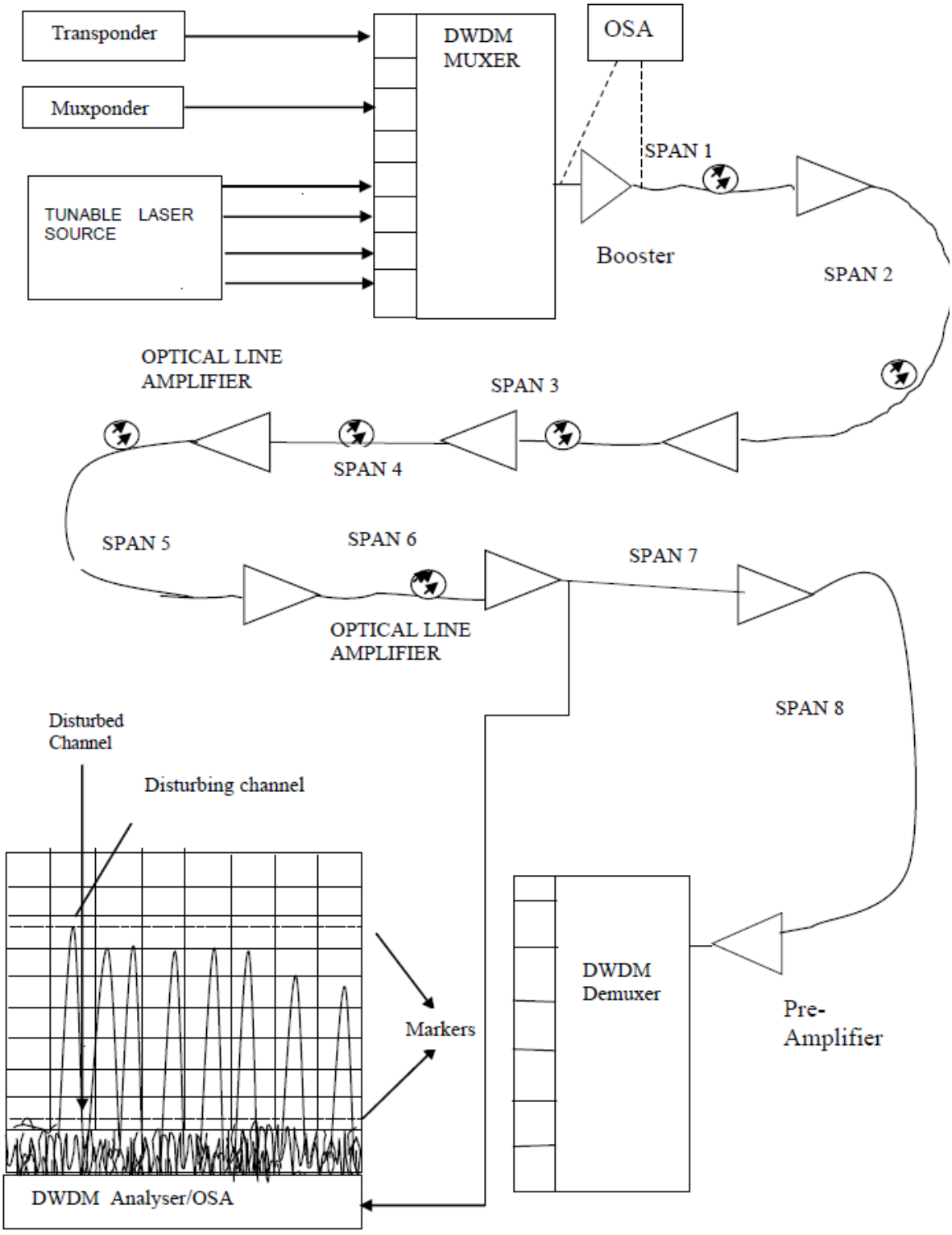


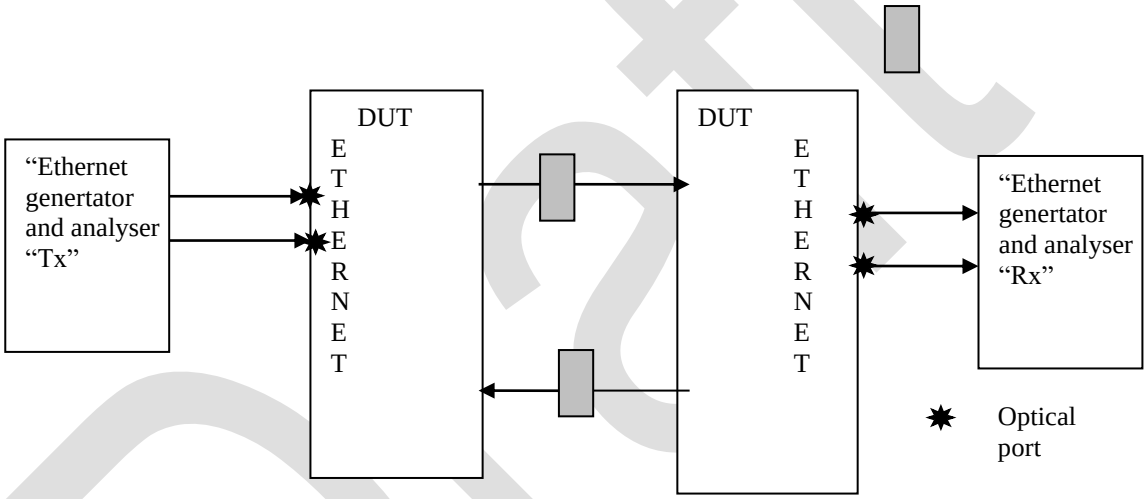
Fig.9: Test Setup for Cross Talk at Muxer Output/Booster Output/Line Amplifier Output Port

Testing of Ethernet ports:

The service tests of Ethernet testing involve RFC 2544 standards of IETF. The following tests shall be conducted for 10GE LAN ports and . 10GE WAN ports shall be tested with SDH frames.

I. Throughput tests

The object of this test is to verify the capability of VC-4 to support the fully Ethernet traffic and to assess the capacity of the buffers of the equipment under test. The test set up connections for this test is shown in Fig..



Test setup for Ethernet

Configure "Ethernet generator and analyser" for RFC-2544 Throughput tests for Ethernet MAC protocol.

Run the instrument for the throughput test. Store the results and take the print of the results.

The following results are expected from the instrument

a. Port address, :
b. Half duplex/Full duplex operation:
c. List of frame size transmitted on "pair 1 and pair 2" in this case there only two ports enabled
d. % of TXTput

e. Average rate (fps)

f. Tolerance %

Check the through put for various packet sizes such as: 64, 128, 256, 512, 1024, 1280, 1518 byte frames and also for Runt and Jumbo frames.

Throughput test with Virtual concatenation Auto negotiation" and "Flow control" enabled									
Port address : Port 1 : Port 2 : Port 3 : Port 4 : This test is not applicable to 2R transponders"									
Ethernet rate	Frame sent	Frame received	Byte Sent	Byte received	Packet dropped	% of TX Tput	Average rate (fps)	Latency	NMS of DUT Frame dropped /received with error
Packet size of 64 bytes per frame									
Packet size of 128 bytes per frame									
Packet size of 256 bytes per frame									
Packet size of 512 bytes per frame									
Packet size of 1024 bytes per frame									
Packet size of 1280 bytes per frame									
Packet size of 1518 bytes per frame									
Runt Frame									
Jumbo Frame									

Prints of Log dumps : Enclosed/Not Enclosed									

II. Frame loss rate tests

The test setup connections for this test remain the same.

Configure “Ethernet generator and analyser” for RFC-2544 Throughput tests for Ethernet MAC protocol.

Run the instrument for the Frame loss test. Store the results and take the print of the results.

Check the through put for various packet sizes such as: 64, 128, 256, 512, 1024, 1280, 1518 byte frames and also for Runt and Jumbo frames.

Frame Loss test with Virtual concatenation Auto negotiation” and “Flow control” enabled										
Port address: Port 1 Port 2: Port3: Port4:										
Port No	Ethernet rate	Frame sent	Frame received	Byte Sent	Bytes received	Packet dropped	% of TXTput	Average rate (fps	Frame loss if any	NMS of DUT Frame dropped /received with error
Packet size of 64 bytes per frame										
1										
2										
3										
4										
Packet size of 128 bytes per frame										
1										
2										
3										
4										
Packet size of 256 bytes per frame										

1										
2										
3										
4										
Packet size of 512 bytes per frame										
1										
2										
3										
4										
Packet size of 1024 bytes per frame										
1										
2										
3										
4										
Packet size of 1280 bytes per frame										
1										
2										
3										
4										
Packet size of 1518 bytes per frame										
1										
2										
3										
4										
Prints of Log dumps : Enclosed/Not Enclosed										

III. Latency tests

The “Ethernet generator and analyser” automatically give the Latency under “Throughput test” bench marking. From the print out of the Throughput tests mentioned in this document take the Latency figure and record in the tables given below.

Throughput test with Virtual concatenation									
Port address : Port 1 : Port 2 : Port 3 : Port 4 : This test is not applicable to 2R transponders"									
Ethernet rate	Frame sent	Frame received	Byte Sent	Byte received	Packet dropped	% of TX Tput	Average rate (fps)	Latency	NMS of DUT Frame dropped /received with error
Packet size of 64 bytes per frame									
Packet size of 128 bytes per frame									
Packet size of 256 bytes per frame									
Packet size of 512 bytes per frame									
Packet size of 1024 bytes per frame									
Packet size of 1280 bytes per frame									
Packet size of 1518 bytes per frame									
Runt Frame									
Jumbo Frame									
Prints of Log dumps : Enclosed/Not Enclosed									

TEST SCHEDULE

In the minimum equipment requirements clause of the standard it has been envisaged that for Type Approval, the details of minimum equipment to be offered are as given under.

For 40/80 channels for 100G:

Long haul application for 100G:

1. DWDM Multiplexer &Demultiplexer at each terminal : 2 nos. each
2. Optical Line Amplifiers : 4 nos.
3. Optical Add /Drop Mux along with channel add/drop RX & TX-Transponders: 3 Nos. (Total 05 Nos. OADMs for Mesh configuration with no TE required)
4. Muxponder/ Transponders / 100GE Ethernet Transponders (Combination of all three) : 50 nos
5. Optical fibre 22dB loss irrespective of length: 8 spools for 8 spans

Very Long haul application 100G:

1. DWDM Multiplexer &Demultiplexer at each terminal : 2 nos. each
2. Optical Line Amplifiers : 2 nos.
3. Optical Add /Drop Mux along with channel add/drop RX & TX Transponders: 2 nos. (Total 05 Nos. OADMs for Mesh configuration with no TE required).
4. Muxponder/ Transponders / 100GE Ethernet Transponders (Combination of all three) :44 nos
5. Optical fibre 28dB loss irrespective of length: 5 spools for 5 spans

For 40/80 Channels for 200G

Long haul application for 200G:

1. DWDM Multiplexer &Demultiplexer at each terminal : 2 nos. each
2. Optical Line Amplifiers : 2 nos.
3. Optical Add /Drop Mux along with channel add/drop RX & TX-Transponders: 2 nos.
4. Muxponder/ Transponders : 50 nos
5. Optical fibre 25dB loss irrespective of length: 6 spools for 6 spans

Very Long haul application 200G:

1. DWDM Multiplexer &Demultiplexer at each terminal : 2 nos. each
2. Optical Line Amplifiers : 1 nos.
3. Optical Add /Drop Mux along with channel add/drop RX & TX Transponders: 1nos.

4. Muxponder/Transponders:44 nos

5. Optical fibre 28dB loss irrespective of length: 3 spools for 3 spans

Sample tables for recording the measured results / observation have been given below. The tester may use additional tables as per requirements.

Check of individual channel wavelength:

Chl. No.	Approximate nominal central w/l in nm	Frequency in THz	Measured w/l in nm	Measured Freq. in THz
1.	1529.55	196.00		
2.	1529.94	195.95		
3.	1530.33	195.90		
4.	1530.72	195.85		
5.	1531.12	195.80		
6.	1531.51	195.75		
7.		195.70		
8.		195.65		
9.		195.60		
10.		195.55		
11.		195.50		
12.		195.45		
- - - -	- - - -	- - - -	- - - -	- - - -
65.		192.70		
66.		192.65		
67.		192.60		
68.		192.55		
69.		192.50		
70.		192.45		
71.		192.40		
72	1558.52	192.35		
73.	1558.92	192.30		
74.	1559.32	192.25		
75.	1559.72	192.20		
76.	1560.12	192.15		
77.	1560.52	192.10		
78.	1560.92	192.05		
79.	-	192.00		
80.	-	191.95		
-	1565.00	-		

i. **Launched Power:** Connect the output of the Transponder to the Optical power meter and record the transmitted power of the Transponder/Muxponder.

Terminal A

OTU4 Transponders: (100G Line)

Transponder No.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No.8
Optical Launch power								

100GbE Transponders (100G Line)

Transponder No.	No. 1	No. 2	No. 3	No. 4
Optical Launch power				

100G Transponder (client)

Optical Launch power	100G Muxponder No.			
	Port 1			
	Lane 1	Lane 2	Lane 3	Lane 4
Total				

100G Muxponder (clients):

Optical Launch power	100G Muxponder No.									
	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10

Note: Similar tables can be added in case of 200G Muxponder/Transponder

Note : Similar Tables are to be mandatorily filled for Terminal B, OADM-1,OADM-2 and OADM-3.

ii. **Optical Spectral width at line & client interfaces**

Optical Spectral width:

Connect the Output of the Transponder to the Optical spectrum analyzer (OSA) and program the instrument for the measurement of optical spectrum. From the spectrum, record the following:

Central frequency, Spectral width at 3 dB point and Side Mode Suppression Ratio (SMSR):

Specifications: Side Mode sup ression Ratio: ≥30dB

Spectral width at –20 dB: ≤0.5 nm

Central freq : 193.1 THz

A-Terminal

OTU-4 Transponder:

Transponder No.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No.8
Central Freq.								
SMSR								
Spectral Width at –20 dB								

100GbE Transponders:

Transponder No.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No.8
Central Freq.								
SMSR								
Spectral widthl at –20 dB								

100G Transponder(Client):

Transponder No.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No.8
Central Freq.								
SMSR								
Spectral Width at –20 dB								

100G Muxponder (Client):

Transponder No.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No.8
Central Freq.								
SMSR								
Spectral widthl at –20 dB								

Note : Similar Tables are to be mandatorily filled for Terminal B and OADMs.

Note: Similar tables can be added in case of 200G Muxponder/Transponder

iii. Eye Pattern at line & client interfaces

Terminal A: (Transmit Transponders/Muxponders Colour Interfaces)

OTU-4 Transponder/Muxponder	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
Eye pattern	Enclosed/Not enclose	Enclosed/ Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclos	Enclosed /Not enclosed	Enclosed/Not enclos	Enclosed/Not enclose	Enclosed/Not

Eye pattern at client side

100G Muxponder SDH clients	Muxponder No.							
	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8

Eye pattern	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclose	Enclosed/Not enclose	Enclosed/Not enclose	Enclosed/Not enclose	Enclosed/Not

100G Muxponder Ethernet clients	**Muxponder No.**							
	Port 1	**Port 2**	**Port 3**	**Port 4**	**Port 5**	**Port 6**	**Port 7**	**Port 8**
Eye pattern	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclos	Enclosed/Not enclose	Enclosed/Not enclos	Enclosed/Not enclose	Enclosed /Not enclosed

100G Muxponder OTN clients	**Muxponder No.**							
	Port 1	**Port 2**	**Port 3**	**Port 4**	**Port 5**	**Port 6**	**Port 7**	**Port 8**
Eye pattern	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclos	Enclosed /Not enclosed	Enclosed/Not enclos	Enclosed/Not enclose

Note: Similar tables can be added in case of 200G Muxponder/Transponder

Note: Similar Tables are to be mandatorily filled for Terminal B and OADMs.

iv. **Extinction ratio at line & client interfaces**

Terminal A: (Transmit Transponders/Muxponders Colour Interfaces)

OTU-4 Transponder/Muxponder Line Side	**Chl. No.**	**Chl. No.**	**Chl. No.**	**Chl. No.**	**Chl. No.**	**Chl. No.**	**Chl. No.**	**Chl. No.**
Extinction ratio	Enclosed/Not enclose	Enclosed/Not enclos	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclose	Enclosed /Not enclosed	Enclosed/Not enclos	Enclosed/ Not

100G Muxponder SDH clients	Muxponder No.							
	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8
Extinction ratio	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclos	Enclosed/Not enclose	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclos	Enclosed/Not

100G Muxponder Ethernet clients	Muxponder No.							
	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8
Extinction ratio	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclosed	Enclosed/Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclosed	Enclosed/Not enclosed	Enclosed/Not enclosed

100G Muxponder OTN clients	Muxponder No.							
	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8
Extinction ratio	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclosed	Enclosed /Not enclosed	Enclosed/Not enclosed

Note: Similar tables can be added in case of 200G Muxponder/Transponder

Note: Similar Tables are to be mandatorily filled for Terminal B and OADMs.

v. Receiver Sensitivity at line & client interfaces

Terminal A:

100G Transponders/Muxponders (Line side):

Transponder/ Muxponder	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.
Receiver Sensitivity								

100G (10Gx10) Muxponder (Client side)

Muxponder .No.	Muxponder No. 1									
Client port	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10
Rece. Sensitivity										

Muxponder .No.	Muxponder No. 2									
Client port	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10
Rece. Sensitivity										

100G Transponders (client side):

Receiver sensitivity	100G Muxponder No.			
	Port 1			
	Lane 1	Lane 2	Lane 3	Lane 4

Note: Similar tables can be added in case of 200G Muxponder/Transponder.

Note: Similar tables are to be mandatorily filled for Terminal B and OADMs.

vi. Receiver Overload at line & client interfaces

Terminal A:

100G Transponders/Muxponders (Line side): Limit: 0 dBm

Transponder/Muxponder	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.
Receiver overload								

100G (10Gx10) Muxponder (Client side): Limit - -14dBm (10km)

Muxponder .No.	Muxponder No. 1									
Client port	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10

Receiver overload										

Muxponder .No.	Muxponder No. 2									
Client port	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10
Receiver overload										

100G Transponders (client side):

Receiver overload	100G Muxponder No.			
	Port 1			
	Lane 1	Lane 2	Lane 3	Lane 4

Note: Similar Tables are to be mandatorily filled for Terminal B and OADMs.

Note: Similar tables can be added in case of 200G Muxponder/Transponder

vii. Optical Signal to Noise Ratio at receiver ofTransponder/Muxponder/Demuxer output (individual Channel):

For 40 Channel

A-B direction

Individual Channel Optical Signal to Noise Ratio (Long Haul Application)								
Optical Signal to	Chl #1	Chl #2	Chl #3	Chl #4	-	-	-	-
	-	-	-	Chl #36	Chl #37	Chl #38	Ch#39	Ch#40

B-A direction

Individual Channel Optical Signal to Noise Ratio (Very Long Haul Application)								
Optical Sign	Chl #1	Chl #2	Chl #3	Chl #4	-	-	-	-
	-	-	-	Chl #36	Chl #37	Chl #38	Ch#39	Ch#40

For 80 Channel

A-B direction

Individual Channel Optical Signal to Noise Ratio (Long Haul Application)								
Optical Sign	Chl #1	Chl #2	Chl #3	Chl #4	-	-	-	-
	-	-	-	Chl #76	Chl #77	Chl #78	Ch#79	Ch#80

B-A direction

Individual Channel Optical Signal to Noise Ratio (Very Long Haul Application)								
Optical Sign	Chl #1	Chl #2	Chl #3	Chl #4	-	-	-	-
	-	-	-	Chl #76	Chl #77	Chl #78	Ch#79	Ch#80

Note: Similar tables can be added in case of 200G Muxponder/Transponder

viii. Optical Return Loss (Optical interfaces/Mux/Demux)

Terminal A: Transmit side

100G Transponders/Muxponders (Line side): Limit ≥40dB

Transponder/Muxponder	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.	Ch.no.
Return Loss								

100G (10Gx10) Muxponder (Client side)

Muxponder .No.	Muxponder No. 1									
Client port	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10
Return Loss										

Muxponder .No.	Muxponder No. 2									
Client port	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Port 9	Port 10

Return Loss										

100G Transponders (client side):

Transponder No.	No. 1	No. 2	No. 3	No. 4
Return Loss				

Note: similar tables shall be mentioned for Terminl A: Receive side

Note: Similar Tables are to be mandatorily filled for Terminal-B Transmit and Receive side.

Note: Similar tables can be added in case of 200G Muxponder/Transponder

Note: Similar Tables are to be mandatorily filled for OADMs Transmit and Receive side

ix. Booster and Pre-amplifier parametric measurements

a. Total Launched power

A-B Direction:

Measurement port	Booster output	OADM 1	OADM 2	OADM 3	Optical Line Amplifier#1
Total Launch Power reading					
Measurement port	Optical Line Amplifier#2	Optical Line Amplifier#3	Optical Line Amplifier#4	Optical Line Amplifier#5	Optical Line Amplifier#6
Total Launch Power reading					

B-A Direction:

Measurement port	Booster output	OADM 1	OADM 2	OADM 3	Optical Line Amplifier#1
Total Launch Power reading					
Measurement port	Optical Line Amplifier#2	Optical Line Amplifier#3	Optical Line Amplifier#4	Optical Line Amplifier#5	Optical Line Amplifier#6

Total Launch Power reading					

b. Total Receive power/Mean total power: (Power at the input of Optical Line amplifier/Pre Amplifier)

A-B direction

Long Haul Application				
Measurement port	OADM #1	OADM #2	OADM #3	Optical Line Amplifier #1
Mean Total Power Reading				
Measurement port	Optical Line Amplifier #2	Optical Line Amplifier #3	Optical Line Amplifier #3	Optical Line Amplifier #3
Mean Total Power Reading				
Measurement port	Optical Line Amplifier #3	Pre Amplifier		
Mean Total Power Reading				

B-A direction

Long Haul Application				
Measurement port	OADM #1	OADM #2	OADM #3	Optical Line Amplifier #1
Mean Total Power Reading				
Measurement port	Optical Line Amplifier #2	Optical Line Amplifier #3	Optical Line Amplifier #3	Optical Line Amplifier #3
Mean Total Power Reading				
Measurement port	Optical Line Amplifier #3	Pre Amplifier		
Mean Total Power Reading				

c. Mean Channel output power:

For 40 Channels

Terminal A

Channel output power at Long haul application Muxer Output									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Channel output power at Long haul application Booster amplifier									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
Maximum Channel Power Difference									

Note: Similar tables shall be filled for Terminal B.

Similarly connect the instrument at the output of OADMs, Optical line Amplifiers, pre-Amplifier one by one and record the output power of each channel in the spectrum of the Optical Line Amplifier.

A-B direction

Channel output power at Long haul application OPA OUT OADM-1									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Channel output power at Long haul application OBA OUT OADM-2									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Channel output power at Long haul application OPA OUT OADM-3									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Channel output power at Long haul application Optical Line Amplifier #1									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
Channel output power at Long haul application Optical Line Amplifier #2									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

B-A direction

Channel output power at Long haul application OPA OUT OADM-1									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Channel output power at Long haul application Optical Line Amplifier #1									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Mean Launched power - Maximum (Long haul application Line amplifier# 1)

Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					

Channel output power at Long haul application OBA OUT OADM-2									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Channel output power at Long haul application OPA OUT OADM-3									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Channel output power at Long haul application Optical Line Amplifier #2									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40

Note: Similar tables shall be mentioned for 80 Channels

d. Mean channel input power:

For 40 Channels

A-B Direction:

Mean Launched power (OADM# 1)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					
Mean Launched power (OADM# 2)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					
Mean Launched power (OADM# 3)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					

Mean Launched power Maximum (Long haul application Line amplifier# 2)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					

Mean Launched power Maximum (Long haul application Pre amplifier)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					

B-A Direction:

Mean Launched (OADM# 1)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					
Mean Launched power (OADM# 2)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					
Mean Launched power (OADM# 3)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					

Mean Launched power Maximum (Long haul application Line amplifier# 1)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					

Mean Launched power Maximum (Long haul application Line amplifier# 2)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					

Mean Launched power Maximum (Long haul application Pre amplifier)									
Chl# 1	Chl# 2	Chl# 3	-	-	-	-	Chl# 38	Chl# 39	Chl# 40
MAX		MIN		Mean chl input power (Max)					

Note: Similar tables can be added in case of 80 Channels

e. Maximum channel power difference at MPI S & S'

For 40 Channel

A-B Direction:

Maximum channel power difference (Long haul application at point S') Output of Muxer									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM-1									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM-2									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM -3									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-1									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-2									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-3									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40

Maximum Channel Power difference	

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-5									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-6									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of Pre-Amplifier									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

B-A Direction

Maximum channel power difference (Long haul application at point S') Output of Muxer									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM-1									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM-2									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM -3									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-1									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-2									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									
Maximum channel power difference (Long haul application)Output of ILA-3									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-5									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-6									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of Pre-Amplifier									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Note: Similar tables can be added for 80 Channels

f. Maximum channel power difference at MPI R & R'

Maximum channel power difference at Muxer input point:

For 40 Channel

A-B direction:

Maximum channel power difference at point R' (Input of Muxer)									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Channel power difference									

B-A direction:

Maximum channel power difference at point R' (Input of Muxer)									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Channel power difference									

For 80 Channel

A-B direction:

Maximum channel power difference at point R' (Input of Muxer)									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#78	Chl#79	Chl#80
Channel power difference									

B-A direction:

Maximum channel power difference at point R' (Input of Muxer)									
Chl#	Chl#2	Chl#3	-	-	-	-	Chl#78	Chl#79	Chl#8
Channel power difference									

x. Inline Amplifier parametric measurements

Total Launched power

Total Receive power

Mean Channel output power

Mean channel input power

Maximum channel power difference at MPI S & S'

Maximum channel power difference at MPI R & R'

*** Same as Pre-amplifier**

xi. Cross talk measurements

a. Optical Transmit cross talk at the output of Muxer/Optical Amplifiers (MPI-S & S')

For 40 Channels:

Terminal A:

(Cross talk Long Haul Application at Booster out)														
Diturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous channel														
Next Channel														

(Cross talk Long Haul Application at Pre Amp out)														
Diturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous channel														
Next Channel														

Note : Similar tables are to be mandatorily filled for Terminal B.

Note: Similar tables to be filled in case of 80 channels

Note: Similar tables can be added in case of 200G Muxponder/Transponder

b. Optical signal cross talk at output of Demuxer (SDn)

For 40 Channel

A-B Direction :

Cross talk Demuxer output (Long Haul Application)															
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	-	-	-	-	-	Chl #35	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Adjacent Channel															
Non adjacent Channel															

B-A Direction :

Cross talk Demuxer output (Long Haul Application)															
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	-	-	-	-	-	Chl #35	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Adjacent Channel															
Non adjacent Channel															

Note : Similar tables are to be mandatorily filled for Terminal B.

Note: Similar tables to be filled in case of 80 channels

Note: Similar tables can be added in case of 200G Muxponder/Transponder

c. Cross talk at the Optical Line Amplifiers:

For 40 Channels:

A-B direction :

Cross talk Long Haul Application Output of Line Amplifier #1																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous channel																
Next Channel																
Cross talk Long Haul Application Output of Line Amplifier # 2																

Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous channel																
Next Channel																

Cross talk Long Haul Application Output of Pre Amplifier																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous channel																
Next Channel																

B-A Direction:

Cross talk Long Haul Application Output of Line Amplifier # 1																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous channel																
Next Channel																

Cross talk Long Haul Application Output of Line Amplifier # 2																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous channel																
Next Channel																

Cross talk Long Haul Application Output of Pre Amplifier																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #36	Chl #37	Chl #38	Chl #39	Chl #40
Previous channel																
Next Channel																

For 80 Channels:

A-B direction :

Cross talk Long Haul Application Output of Line Amplifier #1																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #76	Chl #77	Chl #78	Chl #79	Chl #80
Previous channel																
Next Channel																
Cross talk Long Haul Application Output of Line Amplifier #2																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #76	Chl #77	Chl #78	Chl #79	Chl #80
Previous channel																
Next Channel																

Cross talk Long Haul Application Output of Pre Amplifier																
Diturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #76	Chl #77	Chl #78	Chl #79	Chl #80
Previous channel																
Next Channel																

B-A Direction:

Cross talk Long Haul Application Output of Line Amplifier #1																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #76	Chl #77	Chl #78	Chl #79	Chl #80
Previous channel																
Next Channel																

Cross talk Long Haul Application Output of Line Amplifier #2																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #76	Chl #77	Chl #78	Chl #79	Chl #80

Previous channel																
Next Channel																

Cross talk Long Haul Application Output of Pre Amplifier																
Disturbing Channel	Chl #1	Chl #2	Chl #3	Chl #4	Chl #5	-	-	-	-	-	-	Chl #76	Chl #77	Chl #78	Chl #79	Chl #80
Previous channel																
Next Channel																

Note: Similar tables can be added in case of 200G Muxponder/Transponder

xii. Optical Amplifier characteristics (BA/PA/ILA)

a. MultiChl Gain Variation at Booster/Pre amplifiers:

A-B Direction:

Multi Chl Gain variation at Booster Amplifier (Long Haul Application)						
At the maximum input power at R'= -3 dB				At the minimum input power at S' = -8 dB		
Chl No.	Chl power at I/p of Amp (dBm)	Chl power at o/p of Amp (dBm)	Gain of Ampifier in (dB) G=Po-Pi	Chl power at I/p of Amp (dBm)	Chl power at o/p of Amp (dBm)	Gain of Ampifier in (dB) G=Po-Pi
1						
2						
3						
4						
5						
6						
-						
-						
-						
-						
-						

75						
76						
77						
78						
79						
80						
Multichannel gain variation= dB				Multichannel gain variation = dB		

Note: Similar tables to be mandatorily filled for OADM-1, OADM-2, OADM-3, Pre-Amplifier.

B - A Direction:

Multi Chl Gain variation at Booster Amplifier (Long Haul Application)						
At the maximum input power at R'= -3 dB				At the minimum input power at S' = -8 dB		
Chl No.	Chl power at I/p of Amp (dBm)	Chl power at o/p of Amp (dBm)	Gain of Ampifier in (dB) G=Po-Pi	Chl power at I/p of Amp (dBm)	Chl power at o/p of Amp (dBm)	Gain of Ampifier in (dB) G=Po-Pi
1						
2						
3						
4						
5						
6						
-						
-						
-						
-						
-						
75						
76						
77						
78						
79						
80						
Multichannel gain variation= dB				Multichannel gain variation = dB		

Note: Similar tables to be mandatorily filled for OADM-1, OADM-2, OADM-3, Pre-Amplifier.

b. Multi Chl Gain Tilt:

A-B direction:

Multi channel Gain Tilt at Booster Amplifier							
Chl. No.	Measurements @ -3 dB input			Measurements @ -8 dB inputs			Gain Tilt G1-G2 Gr1-Gr2 dB/dB Gr=Ref. Chl
	Chl power at i/p of Amp	Chl power at o/p of Amp	Gain (G1)of individual Chl	Chl power at i/p of mp	Chl power at o/p of Amp	Gain (G2)of individual Chl	
1							
2							
3							
4							
5							
6							
-							
-							
-							
-							
-							
75							
76							
77							
78							
79							
80							

Note: Similar tables to be mandatorily filled for OADM-1, OADM-2, OADM-3, Pre-Amplifier.

B –A Direction

Multi channel Gain Tilt at Booster Amplifier							
Chl. No.	Measurements @ -3 dB input			Measurements @ -8 dB inputs			Gain Tilt G1-G2 Gr1-Gr2 dB/dB Gr=Ref. Chl
	Chl power at i/p of Amp	Chl power at o/p of Amp	Gain (G1)of individual Chl	Chl power at i/p of mp	Chl power at o/p of Amp	Gain (G2)of individual Chl	

1							
2							
3							
4							
5							
6							
-							
-							
-							
-							
-							
75							
76							
77							
78							
79							
80							

Note: Similar tables to be mandatorily filled for OADM-1, OADM-2, OADM-3, Pre-Amplifier.

c. Multi Chl Gain –Change Difference at Optical Amplifier:

A-B Direction:

Multi Channel gain change difference Booster amplifier																					
ΔG	Values	GD1	GD2	GD3	GD4	GD5	GD6	GD7	GD8	GD9	GD 10	GD 11	GD 12	GD 13	GD 14	GD 15	GD 16	GD 17	GD 18	GD 19	GD 20
ΔG1																					
ΔG2																					
ΔG3																					
ΔG4																					
ΔG5																					
ΔG6																					
-																					
-																					
-																					
-																					
-																					
-																					
-																					
ΔG34																					

ΔG35																					
ΔG36																					
ΔG37																					
ΔG38																					
ΔG39																					
ΔG40																					
Multi Channel gain change difference Booster amplifier																					
ΔG	VALUES	GD21	GD22	GD23	GD24	GD25	GD26	GD27	GD28	GD29	GD30	GD31	GD32	GD33	GD34	GD35	GD36	GD37	GD38	GD39	GD40
ΔG1																					
ΔG2																					
ΔG3																					
ΔG4																					
ΔG5																					
ΔG6																					
-																					
-																					
-																					
-																					
-																					
-																					
-																					
ΔG34																					
ΔG35																					
ΔG36																					
ΔG37																					
ΔG38																					
ΔG39																					
ΔG40																					

Note: In case of 80 Channels table may be extended upto ΔG80

Note: Similar tables to be mandatorily filled for OADM-1, OADM-2, OADM-3, Pre-Amplifier.

B-A Direction:

Multi Channel gain change difference Booster amplifier																					
ΔG	Values	GD1	GD2	GD3	GD4	GD5	GD6	GD7	GD8	GD9	GD10	GD11	GD12	GD13	GD14	GD15	GD16	GD17	GD18	GD19	GD20
ΔG1																					
ΔG2																					
ΔG3																					

ΔG4																					
ΔG5																					
ΔG6																					
-																					
-																					
-																					
-																					
-																					
-																					
-																					
ΔG34																					
ΔG35																					
ΔG36																					
ΔG37																					
ΔG38																					
ΔG39																					
ΔG40																					

Multi Channel gain change difference Booster amplifier

ΔG	VALUES	GD21	GD22	GD23	GD24	GD25	GD26	GD27	GD28	GD29	GD30	GD31	GD32	GD33	GD34	GD35	GD36	GD37	GD38	GD39	GD40
ΔG1																					
ΔG2																					
ΔG3																					
ΔG4																					
ΔG5																					
ΔG6																					
-																					
-																					
-																					
-																					
-																					
-																					
-																					
ΔG34																					
ΔG35																					
ΔG36																					
ΔG37																					
ΔG38																					
ΔG39																					
ΔG40																					

Note: In case of 80 Channels table may be extended upto ΔG80

Note: Similar tables to be mandatorily filled for OADM-1, OADM-2, OADM-3, Pre-Amplifier.

d. Signal Spontaneous Noise Figure:

A-B Direction:

Signal Spontaneous Noise figure Long Haul Application Booster Amplifier								
Amp. No.	Booster	OADM #1	OADM #2	OADM #3	ILA #1	ILA #2	ILA #3	ILA #4
Noise figure								
Amp. No.	ILA #5	ILA #6	ILA #7	ILA #8	Pre Amp.			
Noise figutre								

B-A Direction:

Signal Spontaneous Noise figure Long Haul Application Booster Amplifier								
Amp. No.	Booster	OADM #1	OADM #2	OADM #3	ILA #1	ILA #2	ILA #3	ILA #4
Noise figure								
Amp. No.	ILA #5	ILA #6	ILA #7	ILA #8	Pre Amp.			
Noise figutre								

e. Maximum Power channel Difference (at point S'):

For 40 Channel

A-B Direction:

Maximum channel power difference (Long haul application at point S') Output of Muxer									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM-1									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM-2									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM -3									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-1									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-2									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-3									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-5									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-6									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of Pre-Amplifier									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

B-A Direction

Maximum channel power difference (Long haul application at point S') Output of Muxer									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM-1									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM-2									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of OADM -3									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-1									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-2									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									
Maximum channel power difference (Long haul application)Output of ILA-3									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									
Maximum channel power difference (Long haul application)Output of ILA-4									

Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-4									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-5									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of ILA-6									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Maximum channel power difference (Long haul application)Output of Pre-Amplifier									
Chl#1	Chl#2	Chl#3	-	-	-	-	Chl#38	Chl#39	Chl#40
Maximum Channel Power difference									

Note: Similar tables can be added for 80 Channels

xiii. Jitter & Wander

a. Input Jitter Tolerance :

Terminal A (Grey Interface):

10G STM-64 Interface:

Input jitter frequency	Input jitter tolerance on Chl.No.	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No
20kHz							
100kHz							
400kHz							
1MHz							
2MHz							
4 MHZ							
20 MHz							
80 MHz							

Terminal B (Grey Interface):

10G STM-64 Interface:

	Input jitter tolerance on Chl.No.	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No
20kHz							
100kHz							
400kHz							
1MHz							
2MHz							
4 MHZ							
20 MHz							
80 MHz							

OADM-1 (Grey Interface)

10G STM-64 Interface:

Input jitter frequency	Input jitter tolerance on Chl.No.	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No
20kHz							
100kHz							
400kHz							
1MHz							
2MHz							
4 MHZ							
20 MHz							
80 MHz							

OADM-2(Grey Interface):

10G STM-64 Interface:

Input jitter frequency	Input jitter tolerance on Chl.No.	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No	Input jitter tolerance on Chl. No
20kHz							
100kHz							
400kHz							
1MHz							
2MHz							
4 MHZ							
20 MHz							

80 MHz							

OADM-3 (Grey Interface):

10G STM-64 Interface:

Input jitter frequency	Input jitter tole rance on Chl.No.	Input jitter tole rance on Chl. No	Input jitter tole rance on Chl. No	Input jitter tole rance on Chl. No	Input jitter tole rance on Chl. No	Input jitter tole rance on Chl. No	Input jitter tole rance on Chl. No
20kHz							
100kHz							
400kHz							
1MHz							
2MHz							
4 MHZ							
20 MHz							
80 MHz							

b. Jitter Transfer:

Jitter input mask to transponders input: Comply with G.783

Terminal A (Transmit side):

100G Transponder interfaces								
Input jitter frequency	Jitter trans fer on self loop	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No	Jitter trans fer on 10G Chl.No.	Jitter trans fer on 10G Chl.No.
20kHz								
100kHz								
400kHz								

1MHz								
2MHz								
4 MHZ								
20 MHz								
80 MHz								

Terminal B (Transmit side):

100G Transponder interfaces								
Input jitter frequency	Jitter transfer on self loop	Jitter transfer on 10G Chl.No.	Jitter transfer on 10G Chl.No.	Jitter transfer on 10G Chl.No.	Jitter transfer on 10G Chl.No	Jitter transfer on 10G Chl.No.	Jitter transfer on 10G Chl.No.	Jitter transfer on 10G Chl.No.
20kHz								
100kHz								
400kHz								
1MHz								
2MHz								
4 MHZ								
20 MHz								
80 MHz								

OADM-1

100G Transponder interfaces					
Input jitter frequency	Jitter transfer on self loop	Jitter transfer on 10G Chl.No	Jitter transfer on 10G Chl.No	Jitter transfer on 10G Chl.No.	Jitter transfer on 10G Chl.No.
20kHz					
100kHz					
400kHz					
1MHz					
2MHz					
4 MHZ					
20 MHz					
80 MHz					

Note: Similar tables to be filled for OADM-2, OADM-3.

c. Jitter Generation

Jitter measurement is generally an end to end link test.

Configure the ONT tester for Jitter and wander measurement. Select the option Jitter Generation/ analysis mode. Set bit rate, type of interface, jitter measuring filters. The frequency vs amplitude mask shall be kept off in the Generator. Connect output optical port to the Rx port of the instrument. Select the proper filters and run the instrument. Allow the measurement to continue for 1 minute.

A – B Direction

100G Interfaces							
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p
20kHz to 80 MHz							
4Mhz to 80 MHz							

B – A Direction

100G Interfaces								
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p
20kHz to 80 MHz								
4Mhz to 80 MHz								

Terminal A to OAOM-1

100G Interfaces								
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p
20kHz to 80 MHz								
4Mhz to 80 MHz								

OADM-1 to Terminal A

100G Interfaces								
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p
20kHz to 80 MHz								
4Mhz to 80 MHz								

Terminal A to OAOM-2

100G Interfaces								
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p

20kHz to 80 MHz								
4Mhz to 80 MHz								

OADM-2 to Terminal A

10G Interfaces								
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p
20kHz to 80 MHz								
4Mhz to 80 MHz								

Terminal A to OAOM-3

100G Interfaces								
Jitter modulation frequency	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.
	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p
20kHz to 80 MHz								
4Mhz to 80 MHz								

OADM-3 to Terminal A

100G Interfaces								
Jitter modulatio	Chl.No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.	Chl. No.

n frequency	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p	Jitter UI p-p
20kHz to 80 MHz								
4Mhz to 80 MHz								

Note: Similar tables to be filled for Terminal B.

xiv. Optical Monitoring (OM)

Channel power at the DWDM receiver input after the demultiplexer

Terminal A

Chl. No.	Chl. 1	Chl. 5	Chl. 11	Chl. 17	Chl. 21	Chl. 26	Chl. 33	Chl. 40
Optical Input power by power meter at monitoring point								
Optical Input power through EMS/LCT								

Terminal B

Chl. No.	Chl. 1	Chl. 5	Chl. 11	Chl. 17	Chl. 21	Chl. 26	Chl. 33	Chl. 40
Optical Input power by power meter at monitoring point								
Optical Input power through EMS/LCT								

Total power at input of various stages of optical amplification

A-B Direction

Measurement port	Booster Amplifier input	OADM 1 input	OADM 2 input	OADM 3 input	ILA 1 input	ILA 2 input
Total Input Power reading						
Total Input Power reading (EMS)						
Measurement port	ILA 3 input	ILA 4 input	ILA 5 input	ILA 6 input	ILA 7 input	Pre Amplifier input
Total Input Power reading						

B-A Direction

Measurement port	Booster Amplifier input	OADM 1 input	OADM 2 input	OADM 3 input	ILA 1 input	ILA 2 input
Total Input Power reading						
Total Input Power reading (EMS)						
Measurement port	ILA 3 input	ILA 4 input	ILA 5 input	ILA 6 input	ILA 7 input	Pre Amplifier input
Total Input Power reading						

Total power at output of various stages of optical amplification

A-B Direction

Measurement port	Booster Amplifier output	OADM 1 output	OADM 2 output	OADM 3 output	ILA 1 output	ILA 2 output
Total Input Power reading						
Total Input						

Power reading (EMS)						
Measurement port	ILA 3 output	ILA 4 output	ILA 5 outnput	ILA 6 output	ILA 7 output	Pre Amplifier output
Total Input Power reading						

B-A Direction

Measurement port	Booster Amplifier output	OADM 1 output	OADM 2 output	OADM 3 output	ILA 1 output	ILA 2 output
Total Input Power reading						
Total Input Power reading (EMS)						
Measurement port	ILA 3 output	ILA 4 output	ILA 5 outnput	ILA 6 output	ILA 7 output	Pre Amplifier output
Total Input Power reading						

xv. Optical add/drop multiplex equipment characteristics

a. Optical Return Loss:

A-B Direction

OADM-1								
Chl.No.	Chl.No.1	Chl.No.2	Chl.No.3	Chl.No.4	Chl.No.5	Chl.No.6	Chl.No.7	Chl.No.8
R.L.								

Note: Similar Tables are to be filled mandatorily for OADM-2 & OADM-3.

B-A Direction

OADM-1								
Chl.No.	Chl.No.1	Chl.No.2	Chl.No.3	Chl.No.4	Chl.No.5	Chl.No.6	Chl.No.7	Chl.No.8
R.L.								

Note: Similar Tables are to be filled mandatorily for OADM-2 & OADM-3.

b. Insertion loss (Optional)

A-B Direction

OADM-1								
Chl. No.1			Chl. No.2			Chl. No.3		
Pi	Po	IL	Pi	Po	IL	Pi	Po	IL

OADM-1								
Chl. No.4			Chl. No.5			Chl. No.6		
Pi	Po	IL	Pi	Po	IL	Pi	Po	IL

OADM-1								
Chl. No.7			Chl. No.8			Chl. No.9		
Pi	Po	IL	Pi	Po	IL	Pi	Po	IL

Note: Similar Tables are to be filled mandatorily for OADM-2 & OADM-3.

B-A Direction

OADM-1								
Chl. No.1			Chl. No.2			Chl. No.3		
Pi	Po	IL	Pi	Po	IL	Pi	Po	IL

OADM-1								
Chl. No.4			Chl. No.5			Chl. No.6		
Pi	Po	IL	Pi	Po	IL	Pi	Po	IL

OADM-1								
Chl. No.7			Chl. No.8			Chl. No.9		
Pi	Po	IL	Pi	Po	IL	Pi	Po	IL

Note: Similar Tables are to be filled mandatorily for OADM-2 & OADM-3.

xvi. Supervisory Parameters:

Sl.	Parameters	Possibility

No.		
1.	Input power of the Booster Amplifier	Possible/Not possible
2.	Output power of the Booster Amplifier	Possible/Not possible
3.	Laser temperature of the Booster Amplifier (Optional)	Possible/Not possible
4.	Input power of the Pre-Amplifier	Possible/Not possible
5.	Output power of the Pre-Amplifier	Possible/Not possible
6.	Laser Temperature of the Pre-Amplifier (Optional)	Possible/Not possible
7.	Input power of OLA	Possible/Not possible
8.	Output power of OLA	Possible/Not possible
9.	Laser Temperature of OLA (Optional)	Possible/Not possible
10.	Input power of the Insert Channel	Possible/Not possible
11.	Output power of the Dropped Channel	Possible/Not possible
12.	Input power of the Transponder	Possible/Not possible
13.	Output power of the Transponder	Possible/Not possible
14.	Laser temperature of the Transponder (Optional)	Possible/Not possible
15.	Input power of the individual optical channel	Possible/Not possible
16.	Input power of OSC (Optional)	Possible/Not possible
17.	Output power of OSC (Optional)	Possible/Not possible
18.	Laser Temp. or Lase Bias-current of OSC (Optional)	Possible/Not possible
19.	B1 errors of individual Transponders/Mux-ponder	Possible/Not possible
20.	Total power at the input of Booster amplifier	Possible/Not possible
21.	Total power at the output of Booster amplifier	Possible/Not possible
22.	Total power at the input of Line amplifier	Possible/Not possible
23.	Total power at the output of Line amplifier	Possible/Not possible
24.	Total power at the input of Pre-amplifier	Possible/Not possible
25.	Total power at the output of Pre-amplifier	Possible/Not possible
26.	Bit error rate (BER) before FEC at OTU-2 line interface of the Transponders/Muxponders	Possible/Not possible

27.	Fan failure at OADM/ILA/OTM.	Possible/Not possible
28.	100G Transponder and 10X10G Muxponder, as per Annexure-III of the standard	Possible/Not possible

xvii. Performance Requirements:

Sl. No.	Parameters	Status
1.	Optical Channel Transport Unit Background Block Error (OTU_ BBE)	OK / Not OK
2.	Optical Channel Transport Unit Errored Second (OTU_ ES)	OK / Not OK
3.	Optical Channel Transport Unit Severely Errored Second (OTU_ SES)	OK / Not OK
4.	Optical Channel Transport Unit Unavailable Second(OTU_ UAS).	OK / Not OK
5.	Optical Channel Transport Unit Far End Error Background Block Error (ODU_FEBBE)	OK / Not OK
6.	Optical Channel Transport Unit Far End Errored Second (ODU_FEES)	OK / Not OK
7	Optical Channel Transport Unit Far End Severely Errored Second (ODU_FESES)	OK / Not OK
8.	Optical Channel Transport Unit Far End Unavailable Second(OTU_ FEUAS)	OK / Not OK
9.	Optical Channel Data Unit Path Monitoring Background Block Error (ODU_PM_BBE)	OK / Not OK
10.	Optical Channel Data Unit Path Monitoring Errored Second (ODU_PM_ES)	OK / Not OK
11.	Optical Channel Data Unit Path Monitoring Severely Errored Second (ODU_PM_SES)	OK / Not OK
12.	Optical Channel Data Unit Path Monitoring Unavailable Second (ODU_PM_UAS)	OK / Not OK
13.	Optical Channel Data Unit Path Monitoring Far End	OK / Not OK

	Error Background Block Error (ODU_PM_FEBBE)	
14.	Optical Channel Data Unit Path Monitoring Far End Errored Second (ODU_PM_FEES)	OK / Not OK
15.	Optical Channel Data Unit Path Monitoring Far End Severely Errored Second (ODU_PM_FESES)	OK / Not OK
16.	Optical Channel Data Unit Path Monitoring Far End Unavailable Second (ODU_PM_FEUAS)	OK / Not OK

xviii. Alarm

Sl. No.	Particulars of conditions	Detection report
1.	Input power failure of the Transponder/Mux-ponder interface (including Ethernet interface)	Ok / Not Ok
2.	Input power failure of the Amplifiers	Ok / Not Ok
3.	Output power failure of the Amplifiers	Ok / Not Ok
4.	Fan/s failure	Ok / Not Ok
5.	Output power out of range for OA,OADMs	Ok / Not Ok
6.	Input power out of range for OA,OADMs	Ok / Not Ok
7.	Loss of input at Optical Add/Drop Muliplex equipment	Ok / Not Ok
8.	Input channel failure at Optical Add/Drop Multiplex equipment	Ok / Not Ok
9.	Hardware mismatch alarm	Ok / Not Ok
10.	Low input power input to Transponder	Ok / Not Ok
11.	Low input power at OA, Optical Add/Drop multiplex equipment	Ok / Not Ok
12.	Degraded input at OA, Optical Add/Drop multiplex equipment	Ok / Not Ok
13.	Degraded output at OA,Optical Add/Drop multiplex equipment	Ok / Not Ok
14.	Degraded output of the dropped channel	Ok / Not Ok
15.	GMP related alarm for GE clients. (Optional, may be decided by the purchaser)	Ok / Not Ok

xix. OTU-k Related Alarms

1.	OTU-k Loss of Frame alarm (OTU -LOF).	OK / Not OK
2.	OTU-k Loss of Multiframe alarm (OTU -LOM).	OK / Not OK
3.	Loss of Payload alarm (LOS-P).	OK / Not OK
4.	Open Connection Indication alarm (OCI).	OK / Not OK
5.	OTU-k Degrade Defect alarm.	OK / Not OK
6.	OTU-k Trace Identifier Mismatch alarm (OTU-k TIM).	OK / Not OK
7.	OTU-k-AIS alarm	OK / Not OK
8.	OTU-k Backward Defect Indication alarm (OTU-BDI).	OK / Not OK
9.	OTU-k Payload Mismatch alarm.	OK / Not OK
10.	ODU-k AIS alarm at path layers .	OK / Not OK
11.	ODU-k Backward Defect Indication alarm (ODU-kp BDI) at path	OK / Not OK
12.	ODU-k Locked Defect alarm at path layers	OK / Not OK
13.	ODU-k signal degrade alarm (ODU-kp DEG)	OK / Not OK
14.	ODU-k loss of frame and multi frame. ODU-LOFLOM)	OK / Not OK
15.	ODU-k Trace Identifier Mismatch alarm (ODU-k TIM) at path level	OK / Not OK
16.	ODU-k Payload mismatch alarm at path level (ODU-kp PLM)	OK / Not OK

J. SUMMARY OF TEST RESULTS

TEC Standard No._____

TEC Test Guide No._____

Equipment name & Model No._____

Clause No.	*Compliance (Complied /Not Complied / Submitted/Not Submitted / Not Applicable)*	*Remarks / Test Report Annexure No.*

[Add as per requirement]

Date:

Place: *Signature & Name of TEC testing Officer /*

** Signature of Applicant / Authorized Signatory*

** Section J as given above is also to be submitted by the Applicant/ Authorised signatory as part of in-house test results along with Form-A. The Authorised signatory shall be the same as the one for Form 'A'.*

ANNEXURE-I

Table-1a: Parametric values of 40 Channel DWDM system @ OTU4 for Long Haul Application

Parametric values of 40 Channel DWDM system @ OTU4		
Parameters	**Units**	**Value**
No. Of Channels		40
Bit rate per channel		OTU4
No. of spans	Nos.	G.652D: 8 G.655: 8 G.657A: 8
Individual Transmitter output at Sn point		
Launched Power range	dBm	-11 ~ 5
Maximum Spectral Width	nm	0.5 nm (@-20 dB)
Extinction ratio - minimum	dB	12
Central Frequency	THz	193.1 +/- n x 0.1
Minimum Wavelength Spacing	GHz	100
Maximum Wavelength Deviation	pm	+/- 25 pm
Optical Interface at MPI - S_M&S_M		
Optical Trans side Cross talk	dB	< -22dB for adjacent channel < -25dB for non-adjacent channel
Mean channel output Power	dBm	
Channel output power -max	dBm	4
Channel output power- min	dBm	-2
Total launched power		
min	dBm	0@1 Channel
Max	dBm	17
Max. Channel power difference	dB	2.5
Optical Line Amplifier		
Multi-Channel gain variation	dB	< 1
Multi-Channel gain tilt	dB	<+/- 0.8

Multi-channel gain change difference	dB	2
Total received power		
min	dBm	-29
max	dBm	-3.5
Total Launched Power -min	dBm	0@1 Channel
max	dBm	17
Signal spontaneous Noise Figure	dB	7
Optical path(MPI-S_M ~ MPI-R_M)		
Maximum Discrete Reflectance	dB	< -27
Minimum Return Loss	dB	24
Optical interface at MPI-R_M& R_M		
Mean channel input Power		
max	dBm	-17

min	dBm	-25
Total Input Power Min	dBm	-29
max	dBm	-3.5
Channel Signal to Noise Ratio-min (S-FEC)	dB	15
Max. Channel power difference at MPI-R & R'	dB	2.5
Maximum differential group delay(1dB OSNR penalty)	ps	24
Optical Cross talk at individual Channel output ports	dB	< -22dB for adjacent channel < -25db for non-adjacent channel
Individual Receiver inputs at Rn Points		
Receiver sensitivity	dBm	-18
Receiver Overload	dBm	0
Receiver Reflectance	dB	-27
Receiver OSNR Tolerance (EOL)	dB	15
Minimum receiver wavelength	nm	1529
Maximum Receive wavelength	nm	1565

Table-1b: Parametric values of 40 Channel DWDM system @ OTU4 for Very Long Haul Application

Parametric values of 40 Channel DWDM system @ OTU4		
Parameters	**Units**	**Values**
No. Of Channels		40
Bit rate per channel		OTU4
No. of spans	Nos.	G.652D: 5 G.655: 5 G.657A: 5
Individual Transmitter output at Sn point		
Launched Power range	dBm	-11 ~ 5
Maximum Spectral Width	GHz	50 GHz

Extinction ratio - minimum	dB	12
Central Frequency	THz	193.1 +/- n x 0.1
Minimum Wavelength Spacing	GHz	100
Maximum Wavelength Deviation	pm	+/-25 pm
Optical Interface at MPI – Ss& Sm		
Optical Trans side Cross talk	dB	< - 22 dB for adjacent channel < -25 dB for non-adjacent channel
Mean channel output Power	dBm	
Max. mean channel output power	dBm	4
Mini. mean channel output power	dBm	-2
Total launched power min	dBm	0 @ 1 Channel
Max	dBm	17
Max. Channel power difference	dB	2.5
Optical Line Amplifier		
Multi-Channel gain variation	dB	< 1
Multi-Channel gain tilt	dB	< +/- 0.8
Multi-channel gain change difference	dB	2
Total received power min	dBm	-29
max	dBm	-3.5
Total Launched Power -min	dBm	0 @ 1 Channel
Max	dBm	17
Signal spontaneous Noise Figure	dB	7
Optical path(MPI-SM ~ MPI-RM)		
Maximum Discrete Reflectance	dB	< -27
Minimum Return Loss	dB	24
Optical interface at MPI-Rs & RM		
Mean channel input Power max	dBm	- 17
min	dBm	-28

Total Input Power Min	dBm	-29
max	dBm	-3.5
Channel Signal to Noise Ratio-min (S-FEC)	dB	15
Max. Channel power difference at MPI-R & R'	dB	5
Maximum differential group delay(1dB OSNR penalty)	ps	24
Optical Cross talk at individual Channel output ports	dB	< -22dB for adjacent channel < -25db for non-adjacent channel
Individual Receiver inputs at Rn Points		
Receiver sensitivity	dBm	-18
Receiver Overload	dBm	0
Receiver Reflectance	dB	-27
Receiver OSNR Tolerance (EOL)	dB	15
Minimum receive frequency	nm	1529
Maximum Receive frequency	nm	1565

Table-2a: Parametric values of 80 Channel DWDM system @ OTU4 Long Haul Application

Parametric values of 80 Channel DWDM system @ OTU4		
Parameters	**Units**	**Values**
No. Of Channels		80
Bit rate per channel		OTU4
No. of spans	Nos.	G.652D: 8 G.655: 8 G.657A: 8
Individual Transmitter output at Sn point		
Launched Power range	dBm	-11 ~ 5

Maximum Spectral Width	nm	0.5 nm (@-20 dB)
Extinction ratio - minimum	dB	12
Central Frequency	THz	193.1 +/- n x 0.05
Minimum Wavelength Spacing	GHz	50
Maximum Wavelength Deviation	pm	+/- 25 pm
Optical Interface at MPI - S_M&S_M		
Optical Trans side Cross talk	dB	< -22dB for adjacent channel < -25dB for non-adjacent channel
Mean channel output Power	dBm	
Channel output power -max	dBm	4
Channel output power- min	dBm	-2
Total launched power		
Min	dBm	0@1 Channel
Max	dBm	20
Max. Channel power difference	dB	2.5
Optical Line Amplifier		
Multi-Channel gain variation	dB	< 1
Multi-Channel gain tilt	dB	< +/-0.8
Multi-channel gain change difference	dB	2
Total received power		
min	dBm	-29
max	dBm	-3.5
Total Launched Power -min	dBm	0@1 Channel
Max	dBm	20
Signal spontaneous Noise Figure	dB	7
Optical path(MPI-S_M ~ MPI-R_M)		
Maximum Discrete Reflectance	dB	< -27
Minimum Return Loss	dB	24
Optical interface at MPI-R_M& R_M		
Mean channel input Power		

max	dBm	-17
min	dBm	-25
Total Input Power min	dBm	-29
Max	dBm	-3.5
Channel Signal to Noise Ratio-min (S-FEC)	dB	15
Max. Channel power difference at MPI-R & R'	dB	2.0
Maximum differential group delay(1dB OSNR penalty)	ps	24
Optical Cross talk at individual Channel output ports	dB	< -22dB for adjacent channel < -25db for non-adjacent channel
Individual Receiver inputs at Rn Points		
Receiver sensitivity	dBm	-18
Receiver Overload	dBm	0
Receiver Reflectance	dB	-27
Receiver OSNR Tolerance (EOL)	dB	15
Minimum receiver wavelength	nm	1529
Maximum Receive wavelength	nm	1565

Table-2b: Parametric values of 80 Channel DWDM system @ OTU4, Very Long-Haul applications

Parametric values of 80 Channel DWDM system @ OTU4		
Parameters	**Units**	**Values**
No. Of Channels		80
Bit rate per channel		OTU4
No. of spans	Nos.	G.652D: 5 G.655: 5 G.657A: 5
Individual Transmitter output at Sn		

point		
Launched Power range	dBm	-11 ~ 5
Maximum Spectral Width	GHz	0.5 nm (@-20 dB)
Extinction ratio - minimum	dB	12
Central Frequency	THz	193.1 +/- n x 0.05
Minimum Wavelength Spacing	GHz	50
Maximum Wavelength Deviation	pm	+/-25 pm
Optical Interface at MPI – Ss& SM		
Optical Trans side Cross talk	dB	< - 22 dB for adjacent channel < -25 dB for non-adjacent channel
Mean channel output Power	dBm	
Max. mean channel output power	dBm	4
Mini. mean channel output power	dBm	-2
Total launched powermin	dBm	0 @ 1 Channel
Max	dBm	20
Max. Channel power difference	dB	5
Optical Line Amplifier		
Multi-Channel gain variation	dB	< 1
Multi-Channel gain tilt	dB	< +/- 0.8
Multi-channel gain change difference	dB	2
Total received power min	dBm	-29
max	dBm	-3.5
Total Launched Power -min	dBm	0 @ 1 Channel
Max	dBm	20
Signal spontaneous Noise Figure	dB	7
Optical path (MPI-SM ~ MPI-RM)		
Maximum Discrete Reflectance	dB	< -27
Minimum Return Loss	dB	24
Optical interface at MPI-Rs & RM		
Mean channel input Power max	dBm	- 17
min	dBm	-28

Total Input Power Min	dBm	-29
max	dBm	-3.5
Channel Signal to Noise Ratio- min (S-FEC)	dB	15
Max. Channel power difference at MPI-R & R'	dB	5
Maximum differential group delay(1dB OSNR penalty)	ps	24
Optical Cross talk at individual Channel output ports	dB	< -22dB for adjacent channel < -25db for non-adjacent channel
Individual Receiver inputs at Rn Points		
Receiver sensitivity	dBm	-18
Receiver Overload	dBm	0
Receiver Reflectance	dB	-27
Receiver OSNR Tolerance (EOL)	dB	15
Minimum receive frequency	nm	1529
Maximum Receive frequency	nm	1565

Table 3: Parametric values of 40 Channel DWDM system @ 200G

Parametric values of 40 Channel DWDM system @ 200G		
Parameters	**Units**	**Values**
No. Of Channels		40
Bit rate per channel		200G
Modulation Scheme		8QAM/16QAM
No. of spans	Nos.	G.652D: 3 G.655: 3 G.657A: 3
Individual Transmitter output at Sn point		
Launched Power range	dBm	-10 ~ 1

Maximum Spectral Width	nm	0.5 nm (@-20 dB)
Extinction ratio - minimum	dB	12
Central Frequency	THz	193.1 + n x 0.1
Minimum Wavelength Spacing	GHz	100
Maximum Wavelength Deviation	pm	+/-25 pm
Optical Interface at MPI – Ss& SM		
Optical Trans side Cross talk	dB	< - 16 dB for adjacent channel <- 20 dB for non-adjacent channel
Mean channel output Power	dBm	
Maximum mean channel output power –	dBm	4
Minimum mean channel output power	dBm	-2
Total launched power		
min	dBm	0@1 Channel
Max		17
Max. Channel power difference	dB	5
Optical Line Amplifier		
Multi-Channel gain variation	dB	< 2
Multi-Channel gain tilt	dB	< +/- 2
Multi-channel gain change difference	dB	2
Total received power		
min	dBm	29
max	dBm	-3.5
Total Launched Power -min	dBm	0@1 channel
Max	dBm	17
Signal spontaneous Noise Figure	dB	7
Optical path(MPI-SM ~ MPI-RM)		
Maximum Discrete Reflectance	dB	< -27

Minimum Return Loss	dB	24
Optical interface at MPI-Rs & RM		
Mean channel input Power		
max	dBm	-17
min	dBm	-25
Total Input Power Min	dBm	-29
max	dBm	-3.5
Channel Signal to Noise Ratio- min (S-FEC)	dB	8QAM: 18 /16QAM: 20
Max. Channel power difference at MPI-R & R'	dB	2.5
Maximum differential group delay(1dB OSNR penalty)	Ps	24
Optical Cross talk at individual Channel output ports	dB	< -22dB for adjacent channel < -25db for non-adjacent channel
Individual Receiver inputs at Rn Points		
Receiver sensitivity	dBm	-18
Receiver Overload	dBm	0
Receiver Reflectance	dB	-27
Receiver OSNR Tolerance (EOL)	dB	8QAM: 18 /16QAM: 20
Minimum receivfrequency	nm	1529nm
Maximum Receive frequency	nm	1565nm

Table 4: Parametric values of 80 Channel DWDM system @ 200G

Parametric values of 80 Channel DWDM system @ 200G		
Parameters	**Units**	**Values**
No. Of Channels		80
Bit rate per channel		200G
Modulation Scheme		8QAM/16QAM
No. of spans	Nos.	G.652D: 3 G.655: 3

		G.657A: 3
Individual Transmitter output at Sn point		
Launched Power range	dBm	-10 ~ 1
Maximum Spectral Width	nm	0.5 nm (@-20 dB)
Extinction ratio - minimum	dB	12
Central Frequency	THz	193.1 +/- n x 0.05
Minimum Wavelength Spacing	GHz	50
Maximum Wavelength Deviation	GHz	+/-1.8
Optical Interface at MPI – Ss& SM		
Optical Trans side Cross talk	dB	< - 16 dB for adjacent channel < -22 dB for non-adjacent channel
Mean channel output Power	dBm	
Maximum mean channel output power –	dBm	4
Minimum mean channel output power	dBm	-2
Total launched power		
min	dBm	0@1 Channel
Max		20
Max. Channel power difference	dB	5
Optical Line Amplifier		
Multi-Channel gain variation	dB	< 2
Multi-Channel gain tilt	dB	< +/- 2
Multi-channel gain change difference	dB	2
Total received power		
min	dBm	-29
max	dBm	-3.5
Total Launched Power -min	dBm	0@1 Channel

Max	dBm	20
Signal spontaneous Noise Figure	dB	7
Optical path(MPI-SM ~ MPI-RM)		
Maximum Discrete Reflectance	dB	< -27
Minimum Return Loss	dB	24
Optical interface at MPI-Rs & RM		
Mean channel input Power		
max	dBm	-17
min	dBm	-25
Total Input Power Min	dBm	-29
max	dBm	-3.5
Channel Signal to Noise Ratio- min (S-FEC)	dB	8QAM: 18 /16QAM: 20
Max. Channel power difference at MPI-R & R'	dB	2.5
Maximum differential group delay(1dB OSNR penalty)	Ps	24
Optical Cross talk at individual Channel output ports	dB	< -22dB for adjacent channel < -25db for non-adjacent channel
Individual Receiver inputs at Rn Points		
Receiver sensitivity	dBm	-18
Receiver Overload	dBm	0
Receiver Reflectance	dB	-27
Receiver OSNR Tolerance (EOL)	dB	8QAM: 18 /16QAM: 20
Minimum receivfrequency	nm	1529nm
Maximum Receive frequency	nm	1565nm

New Table proposed: Parametric values of Flexible Channel DWDM system

Parametric values of Flexible Channel DWDM system		
Parameters	**Units**	**Values**
No. Of Channels		32/64 or other count wrt per channel spectral width

		utilization
Bit rate per channel		100G/200G/400G and above
Modulation Scheme		DP-QPSK/8QAM/16QAM/32QAM
Individual Transmitter output at Sn point		
Launched Power range	dBm	-10 ~ 1
Spectral width granularity	GHz	6.25
Maximum Spectral Width	GHz	150
Central Frequency	THz	193.1 +/- n x 6.25
Minimum Wavelength Spacing	GHz	50
Maximum Wavelength Deviation	GHz	+/-1.8
Optical Interface at MPI – Ss& SM		
Optical Trans side Cross talk	dB	< - 16 dB for adjacent channel < -22 dB for non-adjacent channel
Min and Maximum mean channel output power	dBm	As per amplifier output power and channel count.
Optical Line Amplifier		
Multi-Channel gain variation	dB	< 2
Multi-Channel gain tilt	dB	< +/- 2
Multi-channel gain change difference	dB	2
Total received power		
min	dBm	-29
max	dBm	-3.5
Total Launched Power -min		
Max	dBm	20 or more
Signal spontaneous Noise Figure	dB	7
Optical path(MPI-SM ~ MPI-RM)		
Maximum Discrete Reflectance	dB	< -27

Minimum Return Loss	dB	24
Receiver sensitivity	dBm	-12
Receiver Overload	dBm	0
Receiver Reflectance	dB	-27

Table-5

Parameters specified for STM-16 optical interfaces ITU-T G.957

	Unit	Values					
Digital signal Nominal bit rate	**kbit/s**	**STM-16 according to Recommendation G.707 2 488 320**					
Application code (Table 1)		I-16	S-16.1	S-16.2	L-16.1	L-16.2	L-16.3
Operating wavelength range	nm	1266 a)-1360	1260a) -1360	1430-1580	1280-1335	1500-1580	1500-1580
Transmitter at reference point 'S' -							
Source type		MLM	SLM	SLM	SLM	SLM	SLM
Spectral characteristics:							
– maximum RMS width (σ)	nm	4	–	–	–	–	–
– maximum –20 dB width	nm	–	1	< 1b)	1	< 1b)	< 1b)
– minimum side mode – suppression ratio	dB	–	30	30	30	30	30
Mean launched power:							
– maximum	dBm	−3	0	0	+3	+3	+3
– minimum	dBm	−10	−5	−5	−2	−2	−2
Minimum extinction ratio	dB	8.2	8.2	8.2	8.2	8.2	8.2

Optical path between S and R							
Attenuationrangec)	dB	0-7	0-12	0-12	10-24e)	10-24e)	10-24e)
Maximum dispersion	ps/nm	12	NA	b)	NA	1200-1600b),d)	b)
Minimum optical return loss of cable plant at S, including any connectors	dB	24	24	24	24	24	24
Maximum discrete reflectance Between S and R	dB	−27	−27	−27	−27	−27	−27
Receiver at reference point R							
Minimum sensitivityc)	dBm	−18	−18	−18	−27	−28	−27
Minimum overload	dBm	−3	0	0	−9	−9	−9
Maximum optical path penalty	dB	1	1	1	1	2	1
Maximum reflectance of receiver, measured at R	dB	−27	−27	−27	−27	−27	−27

Table-6

Table 8-3/G.959.1 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G intra-office applications							
Parameter	**Units**	**P1I1-2D1r**	**P1I1-2D1**	**P1I1-2D2r**	**P1I1-2D2**	**P1I1-2D3**	**P1I1-2D5**
G.691 Application code		I-64.1r	I-64.1	I-64.2r	I-64.2	I-64.3	I-64.5
Parameters given in		G.693	G.693	G.693			

Table 8-3/G.959.1 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G intra-office applications							
Parameter	**Units**	**P1I1-2D1r**	**P1I1-2D1**	**P1I1-2D2r**	**P1I1-2D2**	**P1I1-2D3**	**P1I1-2D5**
As code		VSR600-2R1	VSR2000-2R1	VSR2000-2L2			
General information	–						
Maximum number of channels	–	1	1	1	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	–				G.652	G.653	G.655
Interface at point MPI-S							
Operating wavelength range	nm				1500-1580	1500-1580	1500-1580
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

Table 8-3/G.959.1 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G intra-office applications							
Parameter	**Units**	**P1I1-2D1r**	**P1I1-2D1**	**P1I1-2D2r**	**P1I1-2D2**	**P1I1-2D3**	**P1I1-2D5**
Minimum mean output power	dBm				−5	−5	−5
Minimum extinction ratio	dB				8.2	8.2	8.2
Eye Mask	–				NRZ 10G 1550 nm region	NRZ 10G 1550 nm region	NRZ 10G 1550 nm region

Table 8-3/G.959.1 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G intra-office applications							
Parameter	**Units**	**P1I1-2D1r**	**P1I1-2D1**	**P1I1-2D2r**	**P1I1-2D2**	**P1I1-2D3**	**P1I1-2D5**
Optical path from point MPI-S to MPI-R							
Maximum attenuation	dB				7	7	7
Minimum attenuation	dB				0	0	0
Maximum chromatic dispersion	ps/nm				500	80	ffs
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

Table 8-3/G.959.1 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G intra-office applications							
Parameter	**Units**	**P1I1-2D1r**	**P1I1-2D1**	**P1I1-2D2r**	**P1I1-2D2**	**P1I1-2D3**	**P1I1-2D5**
Minimum sensitivity	dBm				−14	−13	−13
Maximum optical path penalty	dB				2	1	2
Maximum reflectance of optical network element	dB				−27	−27	−27

Table-7

Table 8-4/G.959.1 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications						
Parameter	**Units**	**P1S1-2D1**	**P1S1-2D2a**	**P1S1-2D2b**	**P1S1-2D3a P1S1-2D5a**	**P1S1-2D3b P1S1-2D5b**
G.691 Application code		S-64.1	S-64.2a	S-64.2b	S-64.3a S-64.5a	S-64.3b S-64.5b
General information	–					
Maximum number of channels	–	1	1	1	1	1
Bit rate/line coding of optical tributary signals	–	NRZ 10G	NRZ 10G	NRZ 10G	NRZ 10G	NRZ 10G
Maximum bit error ratio	–	10^{-12}	10^{-12}	10^{-12}	10^{-12}	10^{-12}
Fibre type	–	G.652	G.652	G.652	G.653, G.655	G.653, G.655
Interface at point MPI-S						
Operating wavelength range	nm	1290-1330	1530-1565	1530-1565	1530-1565	1530-1565
Source type	–		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	+5	-1	+2	-1	+2

Table 8-4/G.959.1 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications						
Parameter	**Units**	**P1S1-2D1**	**P1S1-2D2a**	**P1S1-2D2b**	**P1S1-2D3a P1S1-2D5a**	**P1S1-2D3b P1S1-2D5b**
Minimum mean output power	dBm	+1	-5	-1	-5	-1
Minimum extinction ratio	dB	6	8.2	8.2	8.2	8.2
Eye Mask	-	NRZ 10G 1310 nm region	NRZ 10G 1550 nm region	NRZ 10G 1550 nm region	NRZ 10G 1550 nm region	NRZ 10G 1550 nm region
Optical path from MPI-S to MPI-R						
Maximum attenuation	dB	11	11	11	11	11
Minimum attenuation	dB	6	7	3	7	3
Maximum chromatic dispersion	ps/nm	70	800	800	130	130
Minimum optical return loss at MPI-S	dB	14	24	24	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27	–27	–27
Maximum differential group delay	ps	30	30	30	30	30

Table 8-4/G.959.1 – Single-channel IrDI parameters and values for optical tributary signal class NRZ 10G short-haul applications						
Parameter	**Units**	**P1S1-2D1**	**P1S1-2D2a**	**P1S1-2D2b**	**P1S1-2D3a P1S1-2D5a**	**P1S1-2D3b P1S1-2D5b**
Interface at point MPI-R						
Maximum mean input power	dBm	–1	–8	–1	–8	–1
Minimum sensitivity	dBm	–11	–18	–14	–17	–13
Maximum optical path penalty	dB	1	2	2	1	1
Maximum reflectance of optical network element	dB	–14	–27	–27	–27	–27
NOTE – 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.						

Table-8

(Table 52-7/IEEE: 10GBASE-S transmit characteristics)

Description	**10GBASE-SW**	**10GBASE-SR**	**Unit**
Signaling speed (nominal)	9.95328	10.3125	GBd
Signaling speed variation from nominal (max)	±20	±100	ppm
Center wavelength (range)	840 to 860		nm
RMS spectral width[a](max)	See foot note b		
Average launch power (max)	See foot note c		
Average launch power[d] (min)	–7.3		dBm

Launch power (min) in OMA	See foot note b	
Average launch power of OFF transmitter (max)	–30	dBm
Extinction ratio (min)	3	dB
RIN12OMA (max)	–128	dB/Hz
Optical Return Loss Tolerance (max)	12	dB
Encircled flux	See foot note f	
Transmittereyemaskdefinition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.40, 0.45, 0.25, 0.28, 0.40}	
Transmitter and dispersion penalty (max)	3.9 dB	dB

a. RMS spectral width is the standard deviation of the spectrum.
b. Trade-offs are available between spectral width, center wavelength and minimum optical modulation amplitude. See Figure 52–3 and Table 52–8.
c. The 10GBASE-S launch power shall be the lesser of the class 1 safety limit as defined by 52.10.2 or the average receive power (max) defined by Table 52–9.
d. Average launch power (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.
e. Examples of an OFF transmitter are: no power supplied to the PMD, laser shutdown for safety conditions, activation of PMD_global_transmit_disable or other optional transmitter shut down conditions.
f. The encircled flux at 19 μm shall be greater than or equal to 86% and the encircled flux at 4.5 μm shall be less than or
g. The encircled flux at 19 μm shall be greater than or equal to 86% and the encircled flux at 4.5 μm shall be less than or equal to 30% when

measured into Type A1a (50/125 µm multimode) fiber per ANSI/TIA/EIA-455-203-2001.

h. TDP(max) and OMA(min) are at the respective wavelength and spectral width as specified in Table 52–8.

Table-9

(Table 52-9/IEEE: 10GBASE-S receive characteristics)

Description	10GBASE-S	Unit
Signaling speed (nominal) 10GBASE-SR 10GBASE-SW	10.3125 9.95328	GBd
Signaling speed variation from nominal (max)	±100	ppm
Center wavelength (range)	840 to 860	nm
Average receive power[a](max)	–1.0	dBm
Average receive power[b] (min)	–9.9	dBm
Receiver sensitivity (max) in OMA[c]	0.077 (–11.1)	mW (dBm)
Receiver Reflectance (max)	–12	dB
Stressed receiver sensitivity in OMA[d,e](max)	0.18 (–7.5)	mW (dBm)
Vertical eye closure penalty[f] (min)	3.5	dB
Stressed eye jitter[g] (min)	0.3	UI pk-pk
Receive electrical 3 dB upper cutoff frequency (max)	12.3	GHz

a. The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having a power level equal to the Average Receive Power (max) plus at least 1 dB.

b. Average receive power (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

c. Receiver sensitivity is informative.

d. Measured with conformance test signal at TP3 (see 52.9.9.2) for BER = 10–12.
e. The stressed sensitivity values in the table are for system level BER measurements which include the effects of CDR circuits. It is recommended that at least 0.4 dB additional margin be allocated if component level measurements are made without the effect of CDR circuits
f. Vertical eye closure penalty is a test condition for measuring stressed receiver sensitivity. It is not a required characteristic of the receiver.
g. Stressed eye jitter is a test condition for measuring stressed receiver sensitivity. It is not a required characteristic of the receiver.

Table-10

(Table 52–12/IEEE: 10GBASE-L transmit characteristics)

Description	10GBASE-LW	10GBASE-LR	Unit
Signaling speed (nominal)	9.95328	10.3125	GBd
Signaling speed variation from nominal (max)	±20	±100	ppm
Center wavelength (range)	1260 to 1355		nm
Side Mode Suppression Ratio (min)	30		dB
Average launch power (max)	0.5		dBm
Average launch power[a] (min)	–8.2		dBm
Launch power (min) in OMA minus TDP[b]	–6.2		dBm
Optical Modulation Amplitude[c](min)	–5.2		dBm
Transmitter and dispersion penalty (max)	3.2		dB
Average launch power of OFF transmitter[d] (max)	–30		dBm
Extinction ratio (min)	3.5		dB
RIN12OMA (max)	–128		dB/Hz
Optical Return Loss Tolerance (max)	12		dB
Transmitter Reflectance[e] (max)	–12		dB
Transmittereyemaskdefinition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.40, 0.45, 0.25, 0.28, 0.40}		

a. Average launch power (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

b. TDP is transmitter and dispersion penalty.

c. Even if the TDP < 1 dB, the OMA(min) must exceed this value.

d. Examples of an OFF transmitter are: no power supplied to the PMD, laser shutdown for safety conditions, activation of a PMD_global_transmit_disable or other optional transmitter shut down conditions.

e. Transmitter reflectance is defined looking into the transmitter.

Table-11

(Table 52–13/IEEE: 10GBASE-L receive characteristics)

Description	10GBASE-L	Unit
Signaling speed (nominal) 10GBASE-LR 10GBASE-LW	10.3125 9.95328	GBd
Signaling speed variation from nominal (max)	±100	ppm
Center wavelength (range)	1260 to 1355	nm
Average receive power[a] (max)	0.5	dBm
Average receive power[b] (min)	–14.4	dBm
Receiver sensitivity (max) in OMA[c]	0.055 (-12.6)	mW (dBm)
Receiver Reflectance (max)	–12	dB
Stressed receiver sensitivity (max) in OMA[d,e]	0.093 (–10.3)	mW (dBm)
Vertical eye closure penalty[f] (min)	2.2	dB
Stressed eye jitter[g](min)	0.3	UI pk-pk
Receive electrical 3 dB upper cutoff frequency (max)	12.3	GHz

a. The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having a power level equal to the Average Receive Power (max) plus at least 1 dB.

b. Average receive power (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

c. Receiver sensitivity is informative.

d. Measured with conformance test signal at TP3 (see 52.9.9.2) for BER = 10-12.

e. The stressed sensitivity values in the table are for system level BER measurements which include the effects of CDR circuits. It is recommended that at least 0.4 dB additional margin be allocated if component level measurements are made without the effect of CDR circuits.

f. Vertical eye closure penalty is a test condition for measuring stressed receiver sensitivity. It is not a required characteristic of the receiver.

g. Stressed eye jitter is a test condition for measuring stressed receiver sensitivity. It is not a required characteristic of the receiver.

Table-12

(Table 52-16-10GBASE-E Transmit characteristics)

Description	10GBASE-EW	10GBASE-ER	Unit
Signaling speed (nominal)	9.95328	10.3125	GBd
Signaling speed variation from nominal (max)	±20	±100	ppm
Center wavelength (range)	1530 to 1565		nm
Side Mode Suppression Ratio (min)	30		dB
Average receive power (max)	4.0		dBm
Average receive power [a] (min)	-4.7		dBm
Launch power (min) in OMA minus TDP [b]	-2.1		dBm
Average launch power of OFF transmitter [c] (max)	-30		dBm
Optical Modulation Amplitude [d] (min)	-1.7		dBm
Transmitter and dispersion penalty (max)	3.0		dB
Extinction ratio (min)	3		dB
RIN_{21} OMA [e] (max)	-128		dB/Hz
Optical Return Loss Tolerance	21		dB

(max)		
Transmittereyemaskdefinition (X1, X2, X3, Y1, Y2, Y3)	(0.25,0.40,0.45,0.25,0.28,0.40)	

a. Average launch power (min) is informative and not the principle indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.
b. TDP is transmitter and dispersion penalty.
c. Examples of an OFF transmitter are; no power supplied to the PMD, laser shutdown for safety conditions, activation of a PMD_global_transmit_disable or other optional transmitter shut-down conditions.
d. Even if the TDP<0.4 dB, the OMA(min) must exceed this value.
e. RIN measurement is made with a return loss at 21 dB.

Table-13

(Table 52-17-10GBASE-E receive characteristics)

Description	10GBASE-E	Unit
Signaling speed (nominal) 10GBASE-ER 10GBASE-EW	10.3125 9.95328	GBd
Signaling speed variation from nominal (max)	± 100	ppm
Center wavelength (range)	1530 to 1565	nm
Average receive power (max)	-1.0	dBm
Average receive power [a] (min)	-15.8	dBm
Maximum receive power (for damage)	4.0	dBm
Receiver sensitivity (max) in OMA [b]	0.039(-14.1)	mW (dBm)
Receiver Reflectance (max)	-26	dB
Stressed receiver sensitivity (max) in OMA[c,d]	0.074(-11.3)	mW (dBm)
Vertical eye closure penalty [e] (min)	2.7	dB
Stressed eye jitter (min) [f]	0.3	UI pk-pk
Receive electrical 3 dB upper cutoff frequency	12.3	GHz

(max)		

a. Average receive power (min) is informative and not the principle indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.
b. Receiver sensitivity is informative.
c. Measured with conformance test signal at TP3 (see 52.9.9.2) for BER = 10-12
d. The stressed sensitivity values in the table are for system level BER measurements which includes the effects of CDR circuits. It is recommended that at least 0.4dB additional margin be allocated if component level measurements are made without the effects of CDR circuits.
e. Vertical eye closure penalty is a test condition for measuring stressed receiver sensitivity. It is not a required characteristic of the receiver.
f. Stressed eye jitter is a test condition for measuring stressed receiver sensitivity. It is not a required characteristic of the receiver.

Table-14

(Table 52-18-10GBASE-E link power budgets a, d)

Parameter	10GBASE-E		Unit
Power budget	15.0		dB
Operating distance	30	40	km
Channel insertion loss [d, e]	10.9	10.9	dB
Maximum Discrete Reflectance (max)	-26		dB
Allocation for penalties	3.6	4.1	dB
Additional insertion loss allowed	0.5	0.0	dB

a. Budget numbers are rounded to nearest 0.1 dB.
b. Link penalties are built into the transmitter specifications by testing the PMD with a maximum dispersion fiber.

c. Links longer than 30 km are considered engineered links. Attenuation for such links needs to be less than that guaranteed by B1.1 or B1.3 single mode fiber.
d. Operating distance used to calculate the channel insertion loss are that maximum values specified in Table 52-15.
e. A wavelength of 1565 nm and 3dB transmitter and dispersion penalty (TDP) is used to calculate channel insertion loss and allocation for penalties.

Table-15

(100G DWDM side fixed Module specifications)

Parameters and Optical Module Type	**Unit**	**Value for 40000ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent-QPSK(HDFEC/SDFEC)**
Line code format	-	Single Carrier Coherent-DP-QPSK(HDFEC)
Transmitter parameter specifications at point S		
Center frequency	THz	191.21 to 196.1
Maximum mean launched power	dBM	+5
Minimum mean launched power	dBM	-5
Center frequency deviation	GHz	±2.5
Maximum -3 dB spectral width	GHz	37.5
Dispersion tolerance (back-to-back)	Ps/nm	40000
Receiver parameter specifications at point R		
Receiver type	-	PIN
Operating wavelength range	nm	1529 to 1565
OSNR B2B Cut off Value	dB	15
Receiver sensitivity	dBm	-18
Minimum receiver overload	dBm	0

Maximum reflectance	dB	-27

Table-16

(100G DWDM side fixed Module specifications)

Parameter and Optical Module Type	**Unit**	**Value for 55000ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent-QPSK(SDFEC)**
Line code format	-	Single Carrier Coherent-QPSK(SDFEC)
Transmitter parameter specifications at point S		
Center frequency	THz	192.1 to 196.05
Maximum mean launched power	dBM	0
Minimum mean launched power	dBM	-5
Center frequency deviation	GHz	±2.5
Maximum -3 dB spectral width	nm	0.4
Dispersion tolerance (back-to-back)	Ps/nm	55000
Receiver parameter specifications at point R		
Receiver Type	-	PIN
Operating Wavelength range	nm	
Receiver Sensitivity	dBm	-16
Minimum receiver overload	dBm	0
Maximum reflectance	dB	-27

Table-17

(200G DWDM side fixed Module specifications)

Parameters and Optical Module Type	Unit	Value for 20000ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent-8QAM (SDFEC)
Line code format	-	Single Carrier Coherent-8QAM (SDFEC)
Transmitter parameter specifications at point S		
Center frequency	THz	191.2 to 196.1
Maximum mean launched power	dBM	0
Minimum mean launched power	dBM	-10
Center frequency deviation	GHz	±2.5
Maximum -3 dB spectral width	GHz	50
Dispersion tolerance (back-to-back)	Ps/nm	20000
Receiver parameter specifications at point R		
Receiver type	-	PIN
Operating wavelength range	nm	1529 to 1565
OSNR B2B cut-off	dB	18
Receiver sensitivity	dBm	-16
Minimum receiver overload	dBm	0
Maximum reflectance	dB	-27

Table-18

(200G DWDM side fixed Module specifications)

Parameters and Optical Module Type	Unit	Value for 16000ps/nm-C Band-Tunable Wavelength-Single Carrier Coherent-16QAM (SDFEC)
Line code format	-	Single Carrier Coherent-16QAM (SDFEC)
Transmitter parameter specifications at point S		
Center frequency	THz	191.2 to 196.1
Maximum mean launched power	dBM	0
Minimum mean launched power	dBM	-10
Center frequency deviation	GHz	±2.5
Maximum -3 dB spectral width	GHz	50
Dispersion tolerance (back-to-back)	Ps/nm	16000
Receiver parameter specifications at point R		
Receiver type	-	PIN
Operating wavelength range	nm	1529 to 1565
OSNR B2B cut-off	dB	21
Receiver sensitivity	dBm	-15
Minimum receiver overload	dBm	-3
Maximum reflectance	dB	-27

Table 19

(40GClient-Side Pluggable Optical Module specifications)

Parameter Optical Module Type	Unit	40GBase-LR4-10Km-CFP	40GBase-ER4-40Km-CFP
Line Code Format	-	NRZ	NRZ

Target transmission distance	Km	10	40
Signalling Speed/Lane	Gbit/s	10.3125	10.3125
Signalling Speed Accuracy	ppm	-100 to 100	-100 to 100
Minimum Lane Center Wavelength	nm	1264.5	1264.5
		1284.5	1284.5
		1304.5	1304.5
		1324.5	1324.5
Maximum Lane CenterWavelength	nm	1277.5	1277.5
		1297.5	1297.5
		1317.5	1317.5
		1337.5	1337.5
Total Average Launch Power(Min)	dBm	-1	5.1
Total Average Launch Power(Max)	dBm	8.3	9.8
Transmit OMA per Lane(Min)	dBm	-4	0.5
Transmit OMA per Lane(Max)	dBm	3.5	5
Average Launch Power per Lane (Min)	dBm	-7	-1.1
Average Launch Power per Lane (Max)	dBm	2.3	4.5
Optical Extinction Ratio (Min)	dB	3.5	7
Side Mode Suppression Ratio (Min)	dB	30	30
Receiver type	-	PIN	PIN
Signalling Speed per Lane	Gbit/s	10.3125	10.3125
Signalling Speed Accuracy	ppm	-100 to 100	-100 to 100
Minimum Lane Centre Wavelength	nm	1264.5	1264.5
		1284.5	1284.5
		1304.5	1304.5
		1324.5	1324.5
Maximum Lane Centre Wavelength	nm	1277.5	1277.5
		1297.5	1297.5

		1317.5	1317.5
		1337.5	1337.5
Average Receiver Power per Lane (Min)	dBm	-13.7	-18
Average Receiver Power per Lane (Max)	dBm	2.3	3.8
Minimum receiver overload (OMA) per Lane	dBm	2.3	-1
Receiver sensitivity (OMA) per Lane	dBm	-13.7	-19.5
Maximum reflectance	dB	-26	-26

Table-20

(100GClient-Side Pluggable Optical Module specifications, 100GE Services)

Parameter Optical Module Type	Unit	100GBase-LR4-10Km-CFP	100GBase-ER4-40Km-CFP
Line Code Format	-	NRZ	NRZ
Target transmission distance	Km	10	40
Transmitter parameter specifications at point S			
Signalling Speed/Lane	Gbit/s	25.78125	25.78125
Signalling Speed Accuracy	ppm	-100 to 100	-100 to 100
Minimum Lane Centre Wavelength	nm	1294.53	1294.53
		1299.02	1299.02
		1303.54	1303.54
		1308.09	1308.09
Maximum Lane Centre Wavelength	nm	1296.59	1296.59
		1301.09	1301.09
		1305.63	1305.63
		1310.19	1310.19
Total Average Launch	dBm	1.7	3.1

Power(Min)			
Total Average Launch Power (Max)	dBm	10.5	8.9
Transmit OMA per Lane (Min)	dBm	-1.3	0.1
Transmit OMA per Lane (Max)	dBm	4.5	4.5
Average Launch Power per Lane (Min)	dBm	-4.3	-2.9
Average Launch Power per Lane (Max)	dBm	4.5	2.9
Optical Extinction Ratio (Min)	dB	4	8
Side Mode Suppression Ratio (Min)	dB	30	30
Receiver parameter specifications at point R			
Receiver type	-	PIN	PIN
Signalling Speed per Lane	Gbit/s	25.78125	25.78125
Signalling Speed Accuracy	ppm	-100 to 100	-100 to 100
Minimum Lane Centre Wavelength	nm	1294.53	1294.53
		1299.02	1299.02
		1303.54	1303.54
		1308.09	1308.09
Maximum Lane Centre Wavelength	nm	1296.59	1296.59
		1301.09	1301.09
		1305.63	1305.63
		1310.19	1310.19
Average Receiver Power per Lane (Min)	dBm	-10.6	-20.9
Average Receiver Power per Lane (Max)	dBm	4.5	4.5
Minimum receiver overload	dBm	4.5	4.5

(OMA) per Lane			
Receiver sensitivity	dBm	-8.6	-21.4
Maximum reflectance	dB	-26	-26

Note: The OMA values are designed to ensure normal equipment operation. They are not provided for equipment commissioning. In practical, equipment commissioning is performed based on the average receiver power per lane and total average launched power. It is recommended that the total average launched power be used as the reference for equipment commissioning.

Table-21

(100G Client-side pluggable optical module specifications, 100GE services-)

Parameter	*Unit*	*Value*
Optical Module Type		*100G BASE-10×10G-10 km-CFP*
Line code format	-	NRZ
Optical source type	-	SLM
Target transmission distance	-	10 km (6.2 mi.)
Transmitter parameter specifications at point S		
Signaling Speed per Lane	Gbit/s	10.3125
Signaling Speed Accuracy	Ppm	-100 to 100
Minimum Lane Center Wavelength	Nm	1521
		1529
		1537
		1545
		1553
		1561

Parameter	*Unit*	*Value*
Optical Module Type		*100G BASE-10×10G-10 km-CFP*
		1569
		1577
		1585
		1593
Maximum Lane Center Wavelength	Nm	1525
		1533
		1541
		1549
		1557
		1565
		1573
		1581
		1589
		1597
Total Average Launch Power (Min)	dBm	4.2
Total Average Launch Power (Max)	dBm	13.5
Average Launch Power per Lane (Min)	dBm	-5.8
Average Launch Power per Lane (Max)	dBm	3.5

Parameter	*Unit*	*Value*
Optical Module Type		*100G BASE-10×10G-10 km-CFP*
Transmit OMA per Lane (Min)	dBm	-2.8
Transmit OMA per Lane (Typ)	dBm	-0.8
Transmit OMA per Lane (Max)	dBm	3.5
Optical Extinction Ratio (Min)	dB	2.5
Side Mode Suppression Ratio (Min)	dB	30
Receiver parameter specifications at point R		
Receiver type	-	PIN
Signaling Speed per Lane	Gbit/s	10.3125
Signaling Speed Accuracy	ppm	-100 to 100
Minimum Lane Center Wavelength	nm	1521
		1529
		1537
		1545
		1553
		1561
		1569
		1577
		1585
		1593
Maximum Lane Center	nm	1525

Parameter	*Unit*	*Value*
Optical Module Type		*100G BASE-10×10G-10 km-CFP*
Wavelength		1533
		1541
		1549
		1557
		1565
		1573
		1581
		1589
		1597
Receiver Power per Lane (Min)	dBm	-10.8
Receiver Power per Lane (Max)	dBm	3.5
Minimum receiver overload (OMA) per Lane	dBm	3.5
Receiver Sensitivity (OMA) per Lane	dBm	-8.8
Maximum reflectance	dB	-26

Parameter	*Unit*	*Value*
Optical Module Type		*100G BASE-10×10G-10 km-CFP*

NOTE

The OMA values are designed to ensure normal equipment operation. They are not provided for equipment commissioning. In practical, equipment commissioning is performed based on the average receiver power per lane and total average launched power. It is recommended that the total average launched power be used as the reference for equipment commissioning.

Table-22

(100G Client-side pluggable optical module specifications,100GE/OTU4 services)

Parameter	*Unit*	*Value*
Optical Module Type		*(100G BASE-4×25G)/(OTU4-4×28G)-10 km-CFP*
Line code format	-	NRZ
Optical source type	-	SLM
Target transmission distance	-	10 km (6.2 mi.)
Transmitter parameter specifications at point S		
Signaling Speed per Lane	Gbit/s	100GE: 25.78125 OTU4: 27.952493
Signaling Speed Accuracy	ppm	100GE: -100 to 100 OTU4: -20 to 20
Minimum Lane Center Wavelength	nm	1294.53
		1299.02
		1303.54
		1308.09
Maximum Lane Center Wavelength	nm	1296.59
		1301.09
		1305.63
		1310.19
Total Average Launch Power (Min)	dBm	100GE: 1.7 OTU4: 3.5
Total Average Launch Power (Max)	dBm	100GE: 10.5 OTU4: 8.9

Parameter	*Unit*	*Value*
Optical Module Type		*(100G BASE-4×25G)/(OTU4-4×28G)-10 km-CFP*
Average Launch Power per Lane (Min)	dBm	100GE: -4.3 OTU4: -2.5
Average Launch Power per Lane (Max)	dBm	100GE: 4.5 OTU4: 2.9
Transmit OMA per Lane (Min)	dBm	-1.3 (Only for 100GE)
Transmit OMA per Lane (Max)	dBm	4.5 (Only for 100GE)
Eye pattern mask	-	100GE: IEEE 802.3ba - compliant OTU4: ITU-T G.959 – compliant
Optical Extinction Ratio (Min)	dB	100GE: 4 OTU4: 7
Side Mode Suppression Ratio (Min)	dB	30
Receiver parameter specifications at point R		
Receiver type	-	PIN
Signaling Speed per Lane	Gbit/s	100GE: 25.78125 OTU4: 27.952493
Signaling Speed Accuracy	ppm	100GE: -100 to 100 OTU4: -20 to 20
Minimum Lane Center Wavelength	nm	1294.53
		1299.02

Parameter	*Unit*	*Value*
Optical Module Type		*(100G BASE-4×25G)/(OTU4-4×28G)-10 km-CFP*
		1303.54
		1308.09
Maximum Lane Center Wavelength	nm	1296.59
		1301.09
		1305.63
		1310.19
Receiver Power per Lane (Min)	dBm	100GE: -10.6 OTU4: -8.8
Receiver Power per Lane (Max)	dBm	100GE: 4.5 OTU4: 2.9
Minimum receiver overload (OMA) per Lane	dBm	4.5 (Only for 100GE)
Receiver sensitivity (OMA) per Lane	dBm	-8.6 (Only for 100GE)
Receiver equivalent sensitivity per Lane	dBm	-10.3 (Only for OTU4)
Minimum receiver overload per Lane	dBm	2.9 (Only for OTU4)
Maximum reflectance	dB	-26

Parameter	*Unit*	*Value*
Optical Module Type		*(100G BASE-4×25G)/(OTU4-4×28G)-10 km-CFP*
NOTE: The OMA values are designed to ensure normal equipment operation. They are not provided for equipment commissioning. In practical, equipment commissioning is performed based on the average receiver power per lane and total average launched power. It is recommended that the total average launched power be used as the reference for equipment commissioning.		

Note: Purchaser will have a choice for any one or all of them subject to the condition that they all meet the conditions of reachability upto10kms for client side pluggable.

ANNEXURE-II

Minimum Equipment for Type Approval:

The minimum equipment required for type approval shall be as follows:

1. **DWDM Point-to-point & Linear Add/Drop System:**

S. No.	Item	Quantity
1	Terminals (inclusive of transponders for all channels & MUX/De-MUX for both directions of traffic along with protection related redundant equipment)	2 nos. of TE equipped for 16 channels. Four wavelengths for extreme ends and Four wavelengths in center and other Four can be configured over 80 channels Grid.
2	In-Line Amplifiers	• 4 nos. for Longhaul equipment • 2 nos. for Very Longhaul equipment. (If OADM not offered for testing, there shall be 7 & 4 ILAs for longhaul and very longhaul application codes respectively).
3	OADM (inclusive of transponders for both directions of added/dropped traffic) for linear-chain DWDM system	• 3 Nos. equipped for a total of 3 bi-directional channels in both fibre directions for Long Haul • 2 nos. equipped for a total of 3 bi-directional channels in both fibre-directions for Very Longhaul equipment. Two wavelengths from extreme ends and anyone additional wavelength which can be configured over 80-channels Grid. All three

		wavelengths can be re-configured to other wavelengths for testing purpose. (Applies only to the applied application code).
4	Common equipment with an EMS & LCT along with software.	1 no. each

Note 1: The system offered is for 40/80 Channels. In case equipment offered for testing is not fully equipped and loaded for lesser configuration for Type Approval, the number of channels tested shall be mentioned in Type Approval Certificate.

Note 2: In case the equipment is not fully loaded, the manufacturer will submit a certificate of undertaking that "The system shall be able to perform satisfactorily without any degradation in fully loaded condition.". A certificate of undertaking from the manufacturer shall be acceptable.

2. DWDM Ring:

a. Hub Ring Topology

SN	Items	Current Configuration
1.	Ring Head-end	1 no. TE equipped with 16 wavelengths (8 Wavelength in each direction) (Including Transponders, Mux De-Mux etc). To have 3 Add/Drop channels on each OADM. Head-end will be demonstrated with total 16 bi-directional channels (8 channels in each direction) loaded with Mux-Ponders / Transponnders. All wavelengths can be dropped on OADMs.
2.	In-line Amplifiers	4 Nos. for Long Haul Applications
3.	OADM	3 Nos. equipped for a total of 3 bi-directional channels in both fibre directions for Long Haul 2 nos. equipped for a total of 3 bi-directional channels in both fibre-directions for Very Longhaul equipment. Two wavelengths from extreme ends and anyone additional wavelength which can be configured over 80-channels Grid. All three wavelengths can be re-configured to other wavelengths for testing purpose.
4.	Common equipment with an EMS and LCT along with software	1 no. each

Note 1: The system offered is for 40/80 Channels. In case equipment offered for testing is not fully equipped and loaded for lesser configuration for Type Approval, the number of channels tested shall be mentioned in Type Approval Certificate.

Note 2: In case the equipment is not fully loaded, the manufacturer will submit a certificate of undertaking that "The system shall be able to perform satisfactorily without any degradation in fully loaded condition.". A certificate of undertaking from the manufacturer shall be acceptable.

b. 2-Fiber Closed Ring

Sl. No.	Item	Quantity
1	Ring 'Head-end' (inclusive of transponders for all channels & MUX/De-MUX both directions of traffic along with protection related redundant equipment)	ROADM with total 16 bi-directional channels (8 in each direction) in place of Ring Head-end for closed ring topology Head-end TE will be replaced with OADM having total 16 bi-directional channels (8 channels in each direction).
2	In-Line Amplifiers	• 4 nos. for Longhaul equipment • 2 nos. for Very Longhaul equipment. (If OADM not offered for testing, there shall be 7 & 4 ILAs for longhaul and very longhaul application codes respectively).
3	OADM (inclusive of transponders both directions of added/dropped traffic)	• 3 Nos. equipped for a total of 3 bi-directional channels in both fibre directions for Long Haul • 2 nos. equipped for a total of 3 bi-directional channels in both fibre-directions for Very Longhaul equipment. Two wavelengths from extreme ends

		and anyone additional wavelength which can be configured over 80-channels Grid. All three wavelengths can be re-configured to other wavelengths for testing purpose.(Applies only to the applied application code).
4	Common equipment with an EMS & LCT along with software.	1 no. each

Note 1: The system offered is for 40/80 Channels. In case equipment offered for testing is not fully equipped and loaded for lesser configuration for Type Approval, the number of channels tested shall be mentioned in Type Approval Certificate.

Note 2: In case the equipment is not fully loaded, the manufacturer will submit a certificate of undertaking that "The system shall be able to perform satisfactorily without any degradation in fully loaded condition.". A certificate of undertaking from the manufacturer shall be acceptable.

3.Mesh Topology:

SN	Items	Recommended Configuration
1.	OADM	5 Nos. Equipped for a total of 3 bi-directional channels towards star node for Long Haul Remark: Additional wavelength can be configured for point to point nodes.
2.	In-line Amplifiers	4 Nos. for Long Haul Applications
3.	Common equipment with an EMS and LCT along with software	1 no. each

Note 1: The system offered is for 40/80 Channels. In case equipment offered for testing is not fully equipped and loaded for lesser configuration for Type Approval, the number of channels tested shall be mentioned in Type Approval Certificate.

Note 2: In case the equipment is not fully loaded, the manufacturer will submit a certificate of undertaking that "The system shall be able to perform satisfactorily without any degradation in fully loaded condition.". A certificate of undertaking from the manufacturer shall be acceptable.

The details for minimum equipment required for type approval are elaborated as follows:

For 40/80 channels for 100G:

Long haul application for 100G:

1. DWDM Multiplexer &Demultiplexer at each terminal : 2 nos. each
2. Optical Line Amplifiers : 4 nos.
3. Optical Add /Drop Mux along with channel add/drop RX & TX-Transponders: 3 Nos. (Total 05 Nos. OADMs for Mesh configuration with no TE required)
4. Muxponder/ Transponders / 100GE Ethernet Transponders (Combination of all three) : 50 nos
5. Optical fibre 22dB loss irrespective of length: 8 spools for 8 spans

Very Long haul application 100G:

1. DWDM Multiplexer &Demultiplexer at each terminal : 2 nos. each
2. Optical Line Amplifiers : 2 nos.
3. Optical Add /Drop Mux along with channel add/drop RX & TX Transponders: 2 nos. (Total 05 Nos. OADMs for Mesh configuration with no TE required).
4. Muxponder/ Transponders / 100GE Ethernet Transponders (Combination of all three) :44 nos
5. Optical fibre 28dB loss irrespective of length: 5 spools for 5 spans

For 40/80 Channels for 200G

Long haul application for 200G:

1. DWDM Multiplexer &Demultiplexer at each terminal : 2 nos. each
2. Optical Line Amplifiers : 2 nos.
3. Optical Add /Drop Mux along with channel add/drop RX & TX-Transponders: 2 nos.

4. Muxponder/ Transponders : 50 nos
5. Optical fibre 25dB loss irrespective of length: 6 spools for 6 spans

Very Long haul application 200G:

1. DWDM Multiplexer &Demultiplexer at each terminal : 2 nos. each
2. Optical Line Amplifiers : 1 nos.
3. Optical Add /Drop Mux along with channel add/drop RX & TX Transponders: 1nos.
4. Muxponder/Transponders:44 nos
5. Optical fibre 28dB loss irrespective of length: 3 spools for 3 spans

Note 1: The TAC can be applied against any two of the DWDM network topologies- point-to-point, linear add/drop & ring. The same shall be outlined on the TAC.

Note 2: The TAC can be applied for any of the application codes – Longhaul and Very Longhaul.

Note 3: No QM-333 environmental tests shall be conducted on the EMS Server/LCT PC.

ANNEXURE-III

100G Transponder, 10X10G and 200G Muxponder alarms

100G Transponder Alarms	10*10G Muxponder Alarms	200G Muxponder Alarms
OCh_FDI	OCh_FDI	OTUC-LOF
OCh_FDI_O	OCh_FDI_O	ODUCk-AIS
OCh_FDI_P	OCh_FDI_P	ODUCk-SF
OCh_LOS_P	OCh_LOS_P	ODUCk-SD
OCh_OCI	OCh_OCI	
OCh_SSF	OCh_SSF	
OCh_SSF_O	OCh_SSF_O	
OCh_SSF_P	OCh_SSF_P	
ODU4_PM_AIS	ODU2_LOFLOM	
ODU4_PM_BDI	ODU2_PM_AIS	
ODU4_PM_DEG	ODU2_PM_BDI	
ODU4_PM_LCK	ODU2_PM_DEG	
ODU4_PM_OCI	ODU2_PM_LCK	
ODU4_PM_SSF	ODU2_PM_OCI	
ODU4_PM_TIM	ODU2_PM_SSF	
ODU4_TCMn_AIS	ODU2_PM_TIM	
ODU4_TCMn_BDI	ODU2_TCMn_AIS	
ODU4_TCMn_DEG	ODU2_TCMn_BDI	
ODU4_TCMn_LCK	ODU2_TCMn_DEG	
ODU4_TCMn_LTC	ODU2_TCMn_LCK	
ODU4_TCMn_OCI	ODU2_TCMn_LTC	
ODU4_TCMn_SSF	ODU2_TCMn_OCI	
ODU4_TCMn_TIM	ODU2_TCMn_SSF	
OPA_FAIL_INDI	ODU2_TCMn_TIM	
OPU4_PLM	ODU4_PM_AIS	
OTU4_BDI	ODU4_PM_BDI	
OTU4_DEG	ODU4_PM_DEG	

OTU4_LOF	ODU4_PM_LCK	
OTU4_LOM	ODU4_PM_OCI	
OTU4_SSF	ODU4_PM_SSF	
OTU4_TIM	ODU4_PM_TIM	
OUT_PWR_HIGH	ODU4_TCMn_AIS	
OUT_PWR_LOW	ODU4_TCMn_BDI	
	ODU4_TCMn_DEG	
	ODU4_TCMn_LCK	
	ODU4_TCMn_LTC	
	ODU4_TCMn_OCI	
	ODU4_TCMn_SSF	
	ODU4_TCMn_TIM	
	ODUFLEX_LOFLOM	
	ODUFLEX_PM_AIS	
	ODUFLEX_PM_BDI	
	ODUFLEX_PM_DEG	
	ODUFLEX_PM_LCK	
	ODUFLEX_PM_OCI	
	ODUFLEX_PM_SSF	
	ODUFLEX_PM_TIM	
	ODUFLEX_TCMn_AIS	
	ODUFLEX_TCMn_BDI	
	ODUFLEX_TCMn_DEG	
	ODUFLEX_TCMn_LCK	
	ODUFLEX_TCMn_LTC	
	ODUFLEX_TCMn_OCI	
	ODUFLEX_TCMn_SSF	
	ODUFLEX_TCMn_TIM	
	OPA_FAIL_INDI	
	OPU2_CSF	
	OPU2_MSIM	
	OPU2_PLM	

	OPU4_PLM	
	OPUFLEX_CSF	
	OPUFLEX_MSIM	
	OPUFLEX_PLM	
	OTU2_AIS	
	OTU2_BDI	
	OTU2_DEG	
	OTU2_LOF	
	OTU2_LOM	
	OTU2_SSF	
	OTU2_TIM	
	OTU4_AIS	
	OTU4_BDI	
	OTU4_DEG	
	OTU4_LOF	
	OTU4_LOM	
	OTU4_SSF	
	OTU4_TIM	
	OUT_PWR_HIGH	
	OUT_PWR_LOW	