अनंतिम टेस्ट गाइड
टीईसी ४८०६१:२०२४

(सं: टीईसी/टीजी/आईटी/एलएसडब्लू-००१/०५ मार्च २०१४को अधिक्रमित करता है)

PROVISIONAL TEST GUIDE
TEC 48061:2024

(Supersedes No. TEC/TG/IT/LSW-001/05 Mar-2014)

लैन स्विच

LAN Switch

Standard No. TEC 48060:2024

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र
खुर्शीदलाल भवन, जनपथ, नई दिल्ली–११०००१, भारत

TELECOMMUNICATION ENGINEERING CENTRE

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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 pertains to detailed test schedule and procedure as required for evaluating conformance / functionality / requirements / performance of LAN Switch as per Standard for GR 48060:2024.

CONTENTS

A. HISTORY SHEET

Sl.No.	Standard / document *No.*	Title	Remarks
1.	TEC/TG/IT/LSW-001/05 Mar-14	TSTP for LAN Switch	
2.	TEC 48061:2024	Test Guide for LAN Switch	1. Incorporating the updations in TEC GR 48060:2023 and TEC GR 48060:2024 2. Conversion of TSTP to Test Guide 3. Compendium document is appended as Annexure-I.

B. INTRODUCTION

This document enumerates detailed test schedule and procedure for evaluating conformance / functionality / requirements / performance of LAN Switch as per TEC Standard. No TEC 48060:2024.

C. General Information:

Sn.	General Information	Details *(to be filled by testing team)*	
1	Name and Address of the Applicant		
2	Date of Registration		
3	Name and No. of TEC Standard /Applicant's Spec. against which the approval sought		
4	Details of Equipment		
	Type of Equipment	Model No.	Serial No.
(i)			
(ii)			
5	Any other relevant Information:-		

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

S. no.	Name	Designation	Organization	Signature
1.				
2.				

E. List of the Test Instruments:

S.no.	Name of the test instrument	Make /Model *(to be filled by testing team)*	Validity of calibration *(to be filled by testing team)*
1			dd/mm/yyy
2			
3			
4			
5			
6			
7			
8			

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:

**: Please note that Compendium document is appended as Annexure-I at the end of this Test-Guide*

Title:		**Test Procedure For Type Approval for LAN Switch**		
GR No:		**TEC 48060: 2024**		**July-2024**
Clause No		**Clause**	**Type of test**	**Compliance**
			Physical Verification / Declaration / Documentation / Report from Accredited Test Lab / Functional verification / Information / Lab Test (Test Reference)	**Complied / Not Complied / Submitted / Not Submitted / Not Applicable (Indicate Annexure No for Test Results)**
1		**Introduction**		
1.1		The basic function of a LAN switch is to forward Ethernet frames from one port to another. In the path determination function, a switch creates dynamic tables based on addresses learnt on the network. The creation and dynamic update of this switching table is part of the intelligence of the switch. Since the switching occurs in the hardware using Application Specific Integrated Circuits (ASICs), the latency of a switch is very low as compared to shared media repeaters.	Information	
1.2		Scope: A LAN switch is a local area networking device operating at Layer 2 (and in some cases Layer 3) of the seven layer ISO-OSI model. This document specifies the technical, operational and other Generic requirements of different kinds of LAN Switches that shall be required in service provider networks for Internet, Intranet and other applications environments.	Information	
1.3		The RFC documents of the IETF are subject to periodic revision. Hence where ever RFC's are mentioned in this document, the offered product shall meet either the referred RFC or its previous version or its previous draft or its updated version. Wherever a feature of the RFC is mentioned, product shall comply with the part of the RFC specifying the feature.	Information	
1.4		The interpretation of the clauses of the RFC's shall be as per RFC 2119	Information	

2		**Description** LAN Switch to be used in service provider network can be categorised in four type based upon features and redundancy requirements as follows	Information	
	i.	High functionality & high redundancy - suitable for aggregation network. This is described in Category I	Information	
	ii.	High functionality & low redundancy - suitable for Metro Ethernet Edge Node (Metro Ethernet Switches). This is described in Category II	Information	
	iii.	Low functionality & high redundancy - suitable for Data Centre application. This is described in Category III	Information	
	iv.	Low functionality & low redundancy - suitable for Intranet etc. This is described in Category IV	Information	
	v	Low functionality & low redundancy Industrial Grade switches- Suitable for the outdoor. This is described in Category V.	Information	
3		Functional Requirements	Information	
		PART-1 CAPACITY REQUIREMENTS		
3.1		Capacity Metrics Requirements:-	Information	
		Category: I (Aggregation). Type: A (High Range). Minimum Backplane Capacity (Full Duplex): 960Gb. Packets forwarding rate (Million PPS): 1500. Min. MAC address support: 125K	Information	
		Category: I (Aggregation). Type: B (Low Range). Minimum Backplane Capacity (Full Duplex): 160 Gb. Packets forwarding rate (Million PPS): 250. Min. MAC address support: 50K	Information	
		Category: II (Metro Ethernet Aggregation). Type: A (High Range). Minimum Backplane Capacity (Full Duplex): 960Gb. Packets forwarding rate (Million PPS): 1000. Min. MAC address support: 512K	Information	
		Category: II (Metro Ethernet Aggregation). Type: B (Medium Range). Minimum Backplane Capacity (Full Duplex): 240 Gb. Packets forwarding rate (Million PPS): 300. Min. MAC address support: 64K	Information	
		Category: II (Metro Ethernet Aggregation). Type: C (Low Range). Minimum Backplane Capacity (Full Duplex): 40 Gb. Packets forwarding rate (Million PPS): 60. Min. MAC address support: 16K	Information	
		Category: II (Metro Ethernet Access). Type: D (High Range). Minimum Backplane Capacity (Full Duplex): 30 Gb. Packets forwarding rate (Million PPS): 40. Min. MAC address support: 16K	Information	

		Category: II (Metro Ethernet Access). Type: E (Low Range). Minimum Backplane Capacity (Full Duplex): 15 Gb. Packets forwarding rate (Million PPS): 20. Min. MAC address support: 8K	Information	
		Category: III. Type: A (High Range). Minimum Backplane Capacity (Full Duplex): 3 Tb. Packets forwarding rate (Million PPS): 4400. Min. MAC address support: 100000	Information	
		Category: IV. Type: A (High end). Minimum Backplane Capacity (Full Duplex): 52 Gb. Packets forwarding rate (Million PPS): 77. Min. MAC address support: 16K, Min. VLANs: 1000	Information	
		Category: IV. Type: B (Low end). Minimum Backplane Capacity (Full Duplex): 28 Gb. Packets forwarding rate (Million PPS): 44. Min. MAC address support: 8000, Min. VLANs: 255.	Information	
		Category: V: Industrial Grade L2 Switches. Type A Field Switch. Minimum Backplane Capacity (Full Duplex): 12 Gb. Packets forwarding rate (Million PPS): 17. Min. MAC address support: 16K. Min. VLANs: 4K Note: The packet forwarding rate for the High Range of Category I and III Switches is at 128 bytes per Ethernet frame and for Category II, IV , V and low range of Category I is at 64 bytes per Ethernet frame	Information	
		PART-2 REQUIREMENTS FOR CATEGORY-I LAN SWITCHES		
3.2		**Functional Requirements of LAN Switch for Aggregation Network (Category I):-**	Information	
	i.	The LAN switch shall support non-disruptive software upgrades	Declaration	
	ii.	The LAN switch shall support a console port or auxiliary port for the purpose of local and remote configuration and diagnostics	Functional Verification	
	iii.	The LAN switch shall support extensive debugging capabilities to assist in hardware and software problem resolution	Declaration	
	iv.	The LAN switch shall support the adequate memory to meet the full configuration requirement	Declaration	
	v.	The switching fabric / backplane shall be non-blocking supporting wire speed interface. The chassis shall be fully configured for concerned Category. The switch shall support a wire speed L2 switching and wire speed L3 routing capabilities under full load conditions	Declaration	

	vi.	The individual interface on LAN Switch shall support 1,488,100 packets per second (pps) on Gigabit Ethernet in Full Duplex; 148,810 pps on 100 Mbps Full Duplex Ethernet; 14,881 pps on 10 Mbps Full Duplex Ethernet at Minimum Frame size of 64 Bytes on Ethernet	Declaration	
	vii.	The LAN switch shall support built in power diagnostics system to detect hardware failures	Declaration	
	viii.	The LAN Switch shall be capable of working with - 44 V to 57 V DC (High Range). The exact power requirement shall be indicated by Tendering authority. The switch should also be capable of working with 220 V AC with a variance of +/- 20% as the supply is always through UPS	Declaration	
	ix.	High range Switch shall be modular in design (chassis based) while medium and low range switches can be chassis based or stackable switches. It shall be able to interconnect networks which support different media and topology. It shall be scalable to take care of future expansion.	Declaration	
	x.	The performance of device shall not be degraded upon enabling of one or more features	Declaration	
	xi.	All the interfaces on the devices shall be supported as integrated interfaces and shall not require any external converters / adapters	Declaration	
	xii	The line interface slots in the devices shall be universal	Declaration	
	Xiii.	Core LAN Switch shall support IPv4 Routing, IPv6 Routing & L2 Bridging in hardware for optimal performance.	Declaration	
3.2.1		Availability / Redundancy: LAN Switch shall have the following features to ensure high availability and redundancy	Information	
	i.	All mission critical modules must be identified and provided in full redund¬ant configuration for high reliability	Declaration	
	ii.	A single point failure on the equipment shall not result in equipment or network management system downtime	Declaration	
	iii.	The LAN switch shall support hot standby dual operating software image and dual configuration files for redundancy	Declaration	
	iv.	Comprehensive hardware and software fault isolation and recovery features shall be supported	Declaration	
	v.	The LAN Switch shall support dynamic online configuration	Functional Verification	
	vi.	The LAN Switch shall support non-disruptive hot-swap of modules	Declaration	

	vii	The LAN switch shall support hot-Pluggable redundant, hot-standby power supplies.	Functional Verification	
	viii.	All type of interfaces shall be supplied on at least two cards mounted in different physical slots of chassis	Physical Verification	
	ix.	Wherever the redundant interface(s) have been asked, the same shall be provided using interface(s) on different cards mounted in different physical slots of chassis	Declaration	
	x.	The interface modules shall support Online Insertion and Removal capability	Declaration	
	xi.	The LAN switch shall support fast convergence on the backbone links and uplinks	Declaration	
	xii.	Switch should have redundant controller for working in hot standby configuration.	Functional Verification	
	xiii.	The fans provided shall be in redundant configuration.	Physical Verification	
	xiv.	The CPU shall support non-stop forwarding and stateful switchover in case of active CPU failure in hot standby mode with subsequent redundancy	Declaration	
	xv	The switch shall support Ethernet linear protection based on ITU-T G.8031, and Ethernet Ring Protection as per G.8032.	Functional Verification	
3.2.2		Protocols:- It shall support the following protocols	Information	
	i.	Spanning Tree Protocol (IEEE 802.1d):-	Lab. Test - Refer test No. - 16 of compendium	
	a.	The Switching Module shall possess redundant load balancing capability to support fault-tolerant connections to other switches or shared media segments to protect against a primary link failure. If the primary link fails, the backup path shall be automatically activated to maintain network connectivity and throughput.		
	b.	An LAN Switch shall be able to prioritize BPDUs in the data plane (by providing dedicated queues) and in the control plane (by providing dedicated CPU queues for BPDUs)		
	c.	An LAN Switch shall be able to drop BPDUs if those BPDUs have a root bridge identifier which is lower (better) than the current Spanning Tree root. This function shall be configurable on a per port basis		
	d.	An LAN Switch shall be able to drop BPDUs regardless of the BPDU content. This function shall be configurable on a per port basis		
	ii.	Link-layer discovery protocol (LLDP) (802.1ab) or similar protocol	Lab. Test - Refer test No. - 16 of compendium	
	iii.	Logical Link Control (LLC) (IEEE 802.2).	Lab. Test - Refer test No. - 16 of compendium	
	iv.	Flow Control (IEEE 802.3x).	Lab. Test - Refer test No. - 16 of compendium	

	v.	SNMP v3	Lab. Test - Refer Test No. - 19 of compendium	
	vi.	TFTP	Functional Verification	
	vii.	Telnet	Functional Verification	
	viii.	SSH	Functional Verification	
	ix.	It shall support Port trunking capability at Layer 2	Functional Verification	
	x.	Link Aggregation as per IEEE802.3ad to allow link resilience. Load balancing over IEEE 802.3ad Aggregated Links shall also be supported	Functional Verification	
	xi.	IEEE 802.1q tagging and stacking support	Lab. Test -Refer Test No.- 16 of compendium	
	xii.	IEEE 802.1w VLAN RST (Rapid Spanning Tree) and IEEE 802.1s VLAN MST (Multiple Spanning Tree). Minimum two instances of Multiple Spanning Tree shall be supported	Lab. Test -Refer Test No.- 16 of compendium	
3.2.3		Layer-3 Features: The LAN switch shall support the following layer 3 capabilities. Requirement of the same shall be indicated by the tendering authority	Information	
	i.	Multicast Multi-layer switching	Declaration	
	ii.	IP routing protocols: - RIP, RIPv2, OSPF, BGP	Lab. Test -Refer Test No.- 16 of compendium	
	iii.	Intelligent Queuing based on IP ToS bits for scalability	Functional Verification	
	iv.	IP precedence classification	Functional Verification	
	v.	Diffserv support	Functional Verification	
	vi.	Multicast features such as PIM-Sparse / dense	Functional Verification	
	vii.	QoS classification of packets	Functional Verification	
	viii.	Support for standby routing protocol to ensure L2 and L3 redundancy per VLAN	Functional Verification	
	ix.	For supporting the Web cache redirection, the LAN Switch shall support L4 Switching (optional).	Declaration	
	x.	Shall support at least 2,50,000 IPv4 Routes & 64,000 IPv6 Routes for High range & 64K IPv4 Routes, 16K IPv6 Routes for Low Range Switches.	Declaration	
	xi.	LAN switch should support multi-VRFs and ability to route them across the entire network	Functional Verification	
	xii.	LAN switch should support Layer-2 & Layer-3 MPLS and all major related TE features	Functional Verification	

3.2.4		VLAN features:- The LAN switch shall support the following VLAN features	Information	
	i.	VLAN shall be possible to be created among ports of different types as well as ports on the interface cards	Functional Verification	
	ii.	The LAN Switch shall support VLAN Bridge (for outer tag only) as per 802.1ad	Lab. Test -Refer Test No.- 16 of compendium	
	iii.	The LAN Switch shall support user isolation per outer VLAN tag. This behavior shall be configurable on a per VLAN basis	Functional Verification	
	iv.	VLAN shall be possible to be created among ports of different types as well as ports on the interface cards.	Functional Verification	
	v.	4000 VLANs (as per IEEE 802.1q) shall be supported	Lab. Test -Refer Test No.- 16 of compendium	
	vi.	VLAN ingress filtering to Prevent VLAN leakage	Functional Verification	
	vii.	VLAN Tag overlapping	Functional Verification	
	viii.	VLAN CoS preservation	Functional Verification	
	ix.	VLAN CoS differentiation	Functional Verification	
	x.	It shall support 802.1q Tagging Support in the following manner	Information	
	a.	Tagged only, which is an 802.1q trunk	Lab. Test -Refer Test No.- 16 of compendium	
	b.	Untagged		
	c.	Hybrid, tagged and untagged frames		
	d.	Tag insertion, removal and swapping		
	xi.	LAN Switch shall support the disabling of MAC learning on a per VLAN basis	Functional Verification	
	xii.	An LAN Switch shall be able to rely on IGMP Snooping to install bridge table entries for multicast entries while MAC learning is disabled in the Multicast VLAN	Lab. Test -Refer Test - 16 of compendium	
3.2.5		Multicast capabilities: The LAN Switch shall support Internet Group Management Protocol (IGMP) v2 and v3 as described in RFC 2236 and RFC 3376.	Lab. Test -Refer Test No.- 16 of compendium	
	A.	The following IGMP capabilities shall be supported		
	i.	Fast leave - terminates the multicast session immediately, rather than using the standard group- specific query to check if other group members are present on the network		
	ii.	The IGMP Query Engine shall handle functions like Query Generation, Processing of Membership Reports, Join and Leave Messages		
	iii.	Proxy summarization of IGMP messages, reducing the number of IGMP messages processed by upstream devices in the network		

	iv.	IGMP filtering: filter group membership reports from a particular host or range of hosts, filter to prevent a host from transmitting multicast streams into the network.		
	v.	It shall provide static join Function is to reduce the latency of the channel zapping by bringing the Multicast streams further down in the network, closer to the video service termination point		
	vi.	IGMP Message Shaping		
	vii.	IGMP Message Filtering		
	viii.	IGMP Fast Leave processing to ensure removal of a multicast group as soon as an IGMP leave message is received on that interface		
	ix.	IGMP Snooping dynamic mode to support any multicast address		
	x.	IGMP snooping static mode support to specify a range of multicast addresses		
	xi.	IGMP Snooping with Port Replication to ensure multicast flooding suppression and ensure multicast flooding only to those ports which IGMP join messages have been received		
	xii.	Multicast Security:- Unknown Multicast Filtering (UMF): Filtering of multicast packets with an unknown destination address		
	xiii.	The LAN Switch shall support IGMP snooping. Snooping function on per port and per VLAN basis with the following capabilities		
	a.	The LAN Switch shall have the capability to learn on a per VLAN basis the location of multicast routers through listening and updating their forwarding tables based on IGMP general queries		
	b.	The LAN Switch shall support IGMP snooping with the capability to learn both the multicast source IP address and the destination group address and the destination group address based on the multicast group IP address		
	c.	The LAN Switch shall provide statistics on all active group and sources and per a VLAN and port basis		
	d.	The LAN Switch shall provide statistics on the multicast routers		
	xiv	The LAN Switch shall support an IGMP v3 transparent snooping function on a per VLAN basis		
	xv.	Create and delete MAC-level Group Filter entries, enabling in turn and selective multicast forwarding from network-facing VLANs to user-facing ports.		

	xvi.	Upon detecting topology changes, the LAN Switch shall be able to issue an IGMP proxy query solicitation, i.e. an IGMP Group Leave with group address '0.0.0.0'. (This will indicate to the IGMP router) it immediately needs to send Group Specific queries, which will populate the L2 multicast filters in the LAN Switch, in order to speed up network convergence).		
	B.	LAN switch shall support anycast capabilities.	Declaration	
3.2.6		QoS:- The LAN switch shall support the following QoS features per port and for each VLAN	Information	
	a.	Filtering	Declaration	
	b.	Broadcast suppression	Declaration	
	c.	Link load balancing	Declaration	
	d.	Rate limiting of bandwidth on the switch ports	Declaration	
	e.	Traffic prioritization	Functional Verification	
	f.	Traffic Shaping	Functional Verification	
	g.	Rate limiting of bandwidth: shall support User bandwidth from 1Mb/s to 1Gbps in 1Mb/s increment	Functional Verification	
	h.	The LAN Switch shall support at least 4 traffic classes scalable to 6 for Ethernet frames, and shall support configurable mapping to these classes from the 8 possible values of the Ethernet priority field	Functional Verification	
	i.	The LAN Switch shall support drop precedence within at least 2 traffic classes and shall support configurable mapping to both the classes as well as drop precedence from the 8 possible values of the Ethernet priority field	Functional Verification	
	j.	The LAN Switch(s) shall support scheduling of the interface queues according to their assigned priority and weight. The number of priorities shall be at least 2; however multiple queues shall be assigned to the same priority. Queues assigned to the same priority shall be scheduled according to a weighted algorithm (like WFQ or equivalent) with weights assigned through provisioning. This mechanism provides support for mapping diffserv PHBs (e.g. EF, AF, BE, LE) to the Ethernet queues	Functional Verification	
	k.	The LAN Switch shall support at least 4 queues scalable to 6 per interface, one per traffic class	Functional Verification	
	l.	The LAN Switch shall support scheduling of queues according to strict priority with the number of priority levels being 2 or more	Declaration	
	m.	The LAN Switch shall support setting the maximum size/depth of all queues	Declaration	
	n.	Policy based bandwidth classification	Functional Verification	
	o.	Bandwidth management reports and statistics	Declaration	
	p.	Bandwidth management policies	Declaration	

	q.	Policy based QoS	Functional Verification	
	r.	Congestion avoidance mechanism WRED and WFQ	Functional Verification	
	s.	IEEE 802.1p priority marking. All 8 values shall be supported	Functional Verification	
3.2.7		Management and Security:- The switch shall support the following management and security features	Information	
	i.	SNMP Manageability: Shall support SNMP v3. RMON (Remote Monitoring) MIB I, II shall also be supported. The public and private MIB shall be provided to service provider	Lab. Test - Refer Test No. 19 of compendium	
	ii.	Access Security: The switches shall have password protection features on Telnet access to the box. The LAN Switch shall support Secure Shell Access	Functional Verification	
	iii.	Console and Out-of-band management: The switch shall have console management access along with provision for remote out-of-band management. Switch CLI access control shall be on the basis of user name and password for separate users	Functional Verification	
	iv.	FTP / TFTP: The switch shall support FTP / TFTP access to its configuration/boot files	Declaration	
	v.	LAN switch should support TACACS+ and RADIUS authentication for centralized AAA and control	Declaration	
	vi.	Configuration Software: The switch shall support configuration management through a GUI based software configuration utility. Configuration management through the console is also required. Support of configuration on web interface shall be available	Functional Verification	
	vii.	The LAN switch shall be manageable from a standards based NMS platform. The LAN switch NMS application shall be capable of running on a standards based NMS platform. Network management software shall be standards based and shall support protocols like SNMP V3 and RMON. Support for standard MIBs is mandatory	Declaration	
	viii.	The LAN switch shall support Network Time Protocol (NTP) / SNTP as per RFC 4330 for synchronizing with a centralised NTP server	Functional Verification	
	ix.	LAN Switch should support Layer 2 traceroute	Functional Verification	
	x.	The LAN switch shall support DHCP server agent and relay functionalities	Functional Verification	
3.2.8		Other parameters:- LAN switch shall provide the following features	Information	
	i.	LAN Switch shall not allow port to port traffic to prevent the by passing of network policy enforcement point by the users	Declaration	

	ii.	Shall support per VLAN MAC Learning to ensure MAC addresses are learnt only from a VLAN perspective and automatic / manual disabling of MAC addresses learning for the VLAN where there are less than two ports in that VLAN	Functional Verification	
	iii.	Shall support L2 Learning parameters: source learning per Port / VLAN / Source address	Functional Verification	
	iv.	It shall be possible to enabled L2 Aging on every port	Declaration	
	v.	It shall be possible to set per port dynamic MAC learning limit	Declaration	
	vi.	It shall be possible to set per port static MAC configuration	Physical Verification	
	vii.	Shall support standard MTU Frame Sizes from 64 bytes to 1500 and Jumbo frames of at least 9000 bytes on all ports	Declaration	
		PART-3 REQUIREMENTS FOR CATEGORY-II LAN SWITCHES		
3.3		**Functional Requirements of LAN Switch for Metro Ethernet Aggregation / Distribution Network (Category II):-**	Information	
	i.	The LAN switch shall support a console port or auxiliary port for the purpose of local and remote configuration and diagnostics	Functional Verification	
	ii.	The LAN switch shall support extensive debugging capabilities to assist in hardware and software problem resolution	Declaration	
	iii.	The LAN switch shall support the adequate memory to meet the full configuration requirement	Declaration	
	iv.	The individual port on LAN Switch shall support 1,488,100 packets per second (pps) on Gigabit Ethernet in Full Duplex; 148,810 pps on 100 Mbps Full Duplex Ethernet; 14,881 pps on 10 Mbps Full Duplex Ethernet at Minimum Frame size of 64 Bytes on Ethernet	Declaration	
	v.	The LAN switch shall support built in power diagnostics system to detect hardware failures	Declaration	
	vi.	The LAN Switch shall be capable of working with 220 V AC with variance of +/- 20% as the supply is always through UPS. LAN Switch shall also be capable of working with - 44 V to -57 V DC	Declaration	
	vii.	The performance of device shall not be degraded upon enabling of one or more features	Declaration	
	viii.	All the interfaces on the devices shall be supported as integrated interfaces and shall not require any external converters/ adapters	Physical Verification	
	ix.	The line interface slots in the devices shall be universal	Declaration	
	x.	High Range shall be chassis based and Medium/Low range shall be Chassis based or	Functional Verification	

		stackable or standalone.		
	xi.	The switch shall support ITU-T standard for Phy level distribution of precision frequency	Declaration	
	xii.	The switch shall support ELine, E-LAN and E-Tree Services as specified in the MEF standards	Lab. Test -Refer Test No.- 16 of compendium	
	xiii.	The switch should support multilevel priority scheduling for voice and video applications with minimal jitter, latency and packet loss	Functional Verification	
	xiv.	The performance of device shall not be degraded upon enabling of one or more features	Declaration	
3.3.1		Availability / Redundancy: - LAN Switch shall have the following features to ensure high availability and redundancy	Information	
	i.	Comprehensive hardware and software fault isolation and recovery features shall be supported	Declaration	
	ii.	The LAN Switch shall support dynamic online configuration	Declaration	
	iii.	The High chassis based LAN Metro Switch shall support non-disruptive hot-swap of interface modules.	Declaration	
	iv.	The fans used shall be in redundant configuration.	Physical Verification	
	v.	For High range chassis switches, all type of interfaces shall be supplied on at least two cards mounted in different physical slots of chassis.	Physical Verification	
	vi	For High range chassis based switches the removal or addition of any cards shall not disrupt traffic on other cards.	Declaration	
	vii.	A single point failure on the high/medium range chassis based switches shall not result in network or network management system downtime.	Declaration	
	viii.	High / Medium Range chassis based switches shall support redundant control and fabric modules such that failure of any one module should not degrade the services	Physical Verification	
	ix.	The switch shall support PW Redundancy with MAC withdrawal	Declaration	

	x.	The High / Medium Range switches shall support transmission of a multicast join message from a receiver toward a source on a primary path, while also transmitting a secondary multicast join message from the receiver toward the source on a backup path to minimize convergence times in the event of node or link failures on the primary path.	Declaration	
	xi.	The switch shall support Ethernet linear protection based on ITU-T G.8031, and Ethernet Ring Protection as per G.8032	Lab Test - Refer Test No. - 16 of compendium	
3.3.2		Protocols: - It shall support the following protocols	Information	
	i.	Spanning Tree Protocol (IEEE 802.1d):-	Lab Test - Refer Test No. - 16 of compendium	
	a.	The Switching Module shall support fault-tolerant connections to other switches or shared media segments to protect against a primary link failure. If the primary link fails, the backup path shall be automatically activated to maintain network connectivity and throughput.		
	b.	An LAN Switch shall be able to prioritize BPDUs in the data plane (by providing dedicated queues) and in the control plane (by providing dedicated CPU queues for BPDUs).		
	c.	An LAN Switch shall be able to drop BPDUs if those BPDUs have a root bridge identifier which is lower (better) than the current Spanning Tree root. This function shall be configurable on a per port basis		
	d.	An LAN Switch shall be able to drop BPDUs regardless of the BPDU content. This function shall be configurable on a per port basis		
	ii.	Link-layer discovery protocol (802.1ab) or similar protocol	Lab. Test -Refer Test No.- 16 of compendium	
	iii.	Logical Link Control (IEEE 802.2)	Functional Verification	
	iv.	Flow Control (IEEE 802.3x)	Functional Verification	
	v.	SNMP v3	Lab. Test - Refer Test No. 19 of compendium	
	vi.	TFTP	Functional Verification	
	vii.	Telnet	Functional Verification	
	viii.	SSH	Functional Verification	
	ix.	It shall support Port trunking capability at Layer 2	Functional Verification	
	x.	Link Aggregation as per IEEE 802.3ad to allow link resilience. load balancing over IEEE 802.3ad Aggregated Links shall also be supported	Functional Verification	
	xi.	IEEE 802.1q tagging and stacking support	Lab. Test -Refer Test No.- 16 of compendium	

	xii.	IEEE 802.1w VLAN RST (Rapid Spanning Tree) and IEEE 802.1s VLAN MST (Multiple Spanning Tree). Minimum two instances of Multiple Spanning Tree shall be supported	Lab. Test -Refer Test No.- 16 of compendium	
	xiii.	The switch shall support both IPv4 and IPv6 routing protocols	Lab. Test -Refer Test No.- 16 of compendium	
	xiv.	LAN Switch shall support VRRP (Virtual Router Redundancy Protocol) as described in RFC 5798 for both IPv4 and IPv6 networks	Functional Verification	
3.3.3		VLAN features: The Metro Aggregation Switch shall support the following VLAN features	Information	
	i.	VLAN shall be possible to be created among ports of different types as well as ports on the interface cards	Functional Verification	
	ii.	The LAN Switch shall support VLAN Bridge (for outer tag only) as per 802.1ad	Lab. Test -Refer Test No.- 16 of compendium	
	iii.	The LAN Switch shall support user isolation per outer VLAN tag. This behaviour shall be configurable on a per VLAN basis	Functional Verification	
	iv.	4000 VLANs (as per IEEE 802.1q) shall be supported	Functional Verification	
	v.	VLAN ingress filtering to Prevent VLAN leakage	Declaration	
	vi.	VLAN Tag overlapping	Functional Verification	
	vii.	VLAN CoS preservation	Functional Verification	
	viii.	VLAN CoS differentiation	Functional Verification	
	ix.	It shall support 802.1Q Tagging Support in the following manner	Information	
	a.	Tagged Only, which is an 802.1Q trunk	Functional Verification	
	b.	Untagged	Functional Verification	
	c.	Hybrid, tagged and untagged frames	Functional Verification	
	d.	tag insertion, removal and swapping	Functional Verification	
	e.	capability of insertion and removal of second tag	Functional Verification	
	f.	The switch shall support Encapsulation translation and rewrites: Push, pop and translate for 802.1Q / - IEEE 802.1ad tags	Functional Verification	
	g.	The switch shall support local VLAN and ports cross- connect and multipoint or point-to-multipoint with Hierarchical Virtual Private LAN service (H-VPLS: VPLS bridged topologies with pseudowires) or locally defined bridge domains	Declaration	
	x.	Virtual Private LAN Services (VPLS), Hierarchical VPLS (H-VPLS), Virtual Private Wire Service (VPWS), Ethernet over MPLS (EoMPLS), and multisegment pseudowire	Declaration	

		stitching		
3.3.4		Multicast capabilities: The LAN Switch shall support Internet Group Management Protocol (IGMP) v2 and v3 as described in RFC 2236 and RFC 3376.	Lab. Test -Refer Test No.- 16 of compendium	
		The following IGMP capabilities shall be supported		
	i.	Multicast capabilities in IPv4		
	a.	The LAN Switch shall provide statistics on all active group and sources and per a VLAN and port basis		
	b.	The LAN Switch shall support an IGMP v3 transparent snooping function		
	c.	Source-based and shared distribution trees, Protocol Independent Multicast sparse mode (PIM-SM), PIM Source Specific Multicast (PIM SSM), Automatic route processing (AutoRP), Multiprotocol BGP (MBGP) and Multicast Source Discovery Protocol (MSDP) shall be applicable for category I and III high range chassis based L3 switches only.		
	d.	The High/Medium Range switches shall support transmission of a multicast join message from a receiver toward a source on a primary path, while also transmitting a secondary multicast join message from the receiver toward the source on a backup path to minimize convergence times in the event of node or link failures on the primary path		
	ii.	LAN switch shall also support anycast capabilities	Declaration	
3.3.5		QoS:- The switch shall support the following QoS features per port and per VLAN	Information	
	i.	Filtering	Functional Verification	
	ii.	Broadcast suppression	Functional Verification	
	iii.	Link load balancing	Functional Verification	
	iv.	Rate limiting of bandwidth on the switch ports	Functional Verification	
	v.	Traffic prioritization	Functional Verification	
	vi.	Traffic Shaping	Functional Verification	
	vii.	Rate limiting of bandwidth: shall support User bandwidth from 1Mb/s to 1Gbps in 1Mb/s increment	Functional Verification	
	viii.	Tendering authority shall indicate the actual no of queues. No of queues are required for per flow treatment of traffic, which is required in case there is no other device (e.g. BRAS) is doing the same	Declaration	
	ix.	The LAN Switch shall support scheduling of queues according to strict priority with the number of priority levels being 2 or more	Functional Verification	

	x.	The LAN Switch shall support setting the maximum size / depth of all queues	Functional Verification	
	xi.	Policy based bandwidth classification	Functional Verification	
	xii.	Bandwidth management reports and statistics	Functional Verification	
	xiii.	Bandwidth management policies	Functional Verification	
	xiv.	Policy based QoS	Functional Verification	
	xv	Congestion avoidance mechanism WRED, WFQ.	Functional Verification	
	xvi.	IEEE 802.1p priority marking. All 8 values shall be supported	Lab. Test -Refer Test No.- 16 of compendium	
	xvii.	The switch shall support tiered QoS (Hierarchical Quality of Service).	Functional Verification	
3.3.6		Management and Security The switch shall support the following management and security features	Information	
	i.	IEEE 802.3ah: Ethernet Link OAM (EFM OAM)	Lab. Test -Refer Test No.- 16 of compendium	
	iii.	IEEE 802.1ag: Connectivity Fault Management (CFM)	Lab. Test -Refer Test No.- 16 of compendium	
	iv.	ITU-T Y.1731: OAM functions and mechanisms for Ethernet based networks	Lab. Test -Refer Test No.- 16 of compendium	
	v.	Ethernet SLA monitoring: Performance Management using CFM and Y.1731 Mechanisms.	Lab. Test -Refer Test No.- 16 of compendium	
	vi.	MPLS / MPLS-TP OAM (label switched path [LSP] ping, LSP traceroute and Virtual Circuit Connectivity Verification [VCCV])	Functional Verification	
	vii.	SNMP Manageability: Shall support SNMP version 3. RMON (Remote Monitoring) MIB I, II shall also be supported. The public and private MIB shall be provided to service provider	Lab. Test -Refer Test No.- 19 of compendium	
	viii.	Access Security: The switches shall have password protection features on Telnet access to the box. The LAN Switch shall support Secure Shell Access	Functional Verification	
	ix.	Console and Out-of-band management: The switch shall have console management access along with provision for remote out-of-band management. Switch CLI access control shall be on the basis of user name and password for separate users	Physical Verification	
	x.	FTP / TFTP: The switch shall support FTP / TFTP access to its configuration/boot files	Declaration	

	xi.	Configuration Software: The switch shall support configuration management through a GUI based software configuration utility. Configuration management through the console is also required. Support of configuration on web interface shall be available	Declaration	
	xii.	The LAN switch shall be manageable from a standards based NMS platform. The LAN switch NMS application shall be capable of running on a standards based NMS platform. Network management software shall be standards based and shall support protocols like SNMP V3 and RMON. Support for standard MIBs is mandatory	Declaration	
	xiii.	The LAN switch shall support Network Time Protocol (NTP) / SNTP as per RFC 4330 for synchronizing with a centralised NTP server	Functional Verification	
3.3.7		Other parameters: LAN switch shall provide the following features	Information	
	i.	LAN Switch shall not allow port to port traffic to prevent the by passing of network policy enforcement point by the users	Declaration	
	ii.	Per VLAN MAC Learning to ensure MAC addresses are learnt only from a VLAN perspective and automatic/ manual disabling of MAC addresses learning for the VLAN where there are less than two ports in that VLAN	Functional Verification	
	iii.	shall support L2 Learning parameters as below: Source learning per Port / VLAN / Source address	Functional Verification	
	iv.	It shall be possible to enabled L2 Aging on every port	Functional Verification	
	v.	It shall be possible to set per port dynamic MAC learning limit	Functional Verification	
	vi.	It shall be possible to set per port static MAC configuration	Functional Verification	
	vii.	Shall support Frame Sizes from 64 byte to 1600 and to 9200 (not on FE) byte on all ports	Declaration	
	viii.	LAN Switch shall work as simple DHCP relay.	Functional Verification	
	ix	LAN Switch shall support IP SLA	Functional Verification	
	x	It shall support Policy Based Routing (PBR)	Functional Verification	
	xi	It shall support Captive Portal redirection, per port downloadable ACL, CoA (Optional)	Functional Verification	
		PART-4 REQUIREMENTS FOR CATEGORY-III LAN SWITCHES		
3.4		**Functional Requirements of LAN Switch for Data Centre Aggregation (Category III):-**	Information	
	i.	The LAN switch shall support non-disruptive software upgrades	Declaration	
	ii.	The LAN switch shall support a console port or auxiliary port for the purpose of local and remote configuration and diagnostics	Functional Verification	

	iii.	The LAN switch shall support extensive debugging capabilities to assist in hardware and software problem resolution	Declaration	
	iv.	The LAN switch shall support the adequate memory to meet the full configuration requirement	Declaration	
	v.	The switching fabric /backplane shall be non-blocking supporting wire speed interface. The chassis shall be fully configured for concerned Category. The switch shall support a wire speed L2 switching and wire speed L3 routing capabilities under full load conditions	Declaration	
	vi.	The individual interface on LAN Switch shall support 1,488,100 packets per second (pps) on Gigabit Ethernet in Full Duplex; 148,810 pps on 100 Mbps Full Duplex Ethernet; 14,881 pps on 10 Mbps Full Duplex Ethernet at Minimum Frame size of 64 Bytes on Ethernet	Declaration	
	vii.	The LAN switch shall support built in power diagnostics system to detect hardware failures	Declaration	
	viii.	The LAN Switch shall be capable of working with 220 V AC with variance of +/- 20% as the supply is always through UPS. LAN Switch shall also be capable of working with -44 V to 57 V DC.	Declaration	
	ix.	LAN Switch shall be modular in design (chassis based) and shall be able to interconnect networks which support different media and topology.	Declaration	
	x.	The performance of device shall not be degraded upon enabling of one or more features	Declaration	
	xi.	The removal or addition of any cards shall not disrupt traffic on other cards	Declaration	
	xii.	All the interfaces on the devices shall be supported as integrated interfaces and shall not require any external converters / adapters	Functional Verification	
	xiii.	No data interfaces shall be provided in the Control Card / module	Physical Verification	
	xiv	The line interface slots in the devices shall be universal	Declaration	
	xv.	Data Center Switch should have capability to support creation of 3 or more separate logical devices within the switch. Each such logical device/logical switch should be able to maintain its own unique set of running software, processes, VLANs, VRFs, having its own configuration, and being managed by a separate administrator	Functional Verification	
	xvi.	Stateful Switchover and Nonstop Forwarding to ensure that in case of failure of active CPU module the redundant CPU should start switching L2 / L3 traffic in less than 1 sec	Declaration	
	xvii	The switch should support roll back to earlier configurations (check pointing / mile stoning of multiple configurations) for ease of restoration in case of problems. Each logical device context should be able to maintain its own set of configuration checkpoints	Functional Verification	

	xviii.	The DC switch shall support multiple chassis's architecture. It should support link aggregation across 2 physical switches.	Functional Verification	
	xix	The Data Center Core Switch should support converged traffic through standards based Fibre Channel over Ethernet protocol (INCITS FC-BB-5). Interoperability issues, if any, shall be resolved by the vendor for the tendering authority will specify the interoperability requirements for the FCOE	Declaration	
3.4.1		Availability / Redundancy:- LAN Switch shall have the following features to ensure high availability and redundancy	Information	
	i.	All mission critical modules must be identified and provided in full redundant	Declaration	
	ii.	Configuration for high reliability	Declaration	
	iii.	A single point failure on the equipment shall not result in equipment or network management system downtime	Declaration	
	iv.	Comprehensive hardware and software fault isolation and recovery features shall be supported	Declaration	
	v.	The LAN Switch shall support dynamic online configuration	Declaration	
	vi.	The LAN Switch shall support non-disruptive hot-swap of modules	Declaration	
	vii.	The LAN switch shall support hot standby dual operating software image and dual configuration files for redundancy	Declaration	
	viii.	All type of interfaces shall be supplied on at least two cards mounted in different physical slots of chassis	Physical Verification	
	ix.	A single point failure on the equipment shall not result in network or network management system downtime	Declaration	
	x.	Wherever the redundant interface(s) have been asked, the same shall be provided using interface(s) on different cards mounted in different physical slots of chassis	Declaration	
	xi.	The LAN switch shall support hot-Pluggable redundant, load sharing power supplies (in load sharing modes).	Functional Verification	
	xii.	The interface modules shall support Online Insertion and Removal capability	Declaration	
	xiii.	The LAN switch shall support fast convergence on the backbone links and uplinks	Declaration	
	xiv.	The fans used shall be in redundant configuration.	Physical Verification	
	xv.	The Switch should support key Layer 2 data center interconnect technologies - MAC-in-MAC or MPLS.	functional Verification	
3.4.2		Protocols:- It shall support the following protocols	Information	
	i.	Spanning Tree Protocol (IEEE 802.1d):-		

	a.	The Switching Module shall possess redundant load balancing capability to support fault-tolerant connections to other switches or shared media segments to protect against a primary link failure. If the primary link fails, the backup path shall be automatically activated to maintain network connectivity and throughput.	Lab. Test -Refer Test No.- 16 of compendium	
	b.	An LAN Switch shall be able to prioritize BPDUs in the data plane (by providing dedicated queues) and in the control plane (by providing dedicated CPU queues for BPDUs).		
	c.	An LAN Switch shall be able to drop BPDUs if those BPDUs have a root bridge identifier which is lower (better) than the current Spanning Tree root. This function shall be configurable on a per port basis		
	d.	An LAN Switch shall be able to drop BPDUs regardless of the BPDU content. This function shall be configurable on a per port basis		
	ii.	Logical Link Control (IEEE 802.2)	Lab. Test -Refer Test No.- 16 of compendium	
	iii.	Flow Control (IEEE 802.3x)	Lab. Test - Refer Test No. 16 of compendium	
	iv.	SNMP v3	Lab. Test - Refer Test No. 19 of compendium	
	v.	TFTP	Functional Verification	
	vi.	Telnet	Functional Verification	
	vii.	SSH	Functional Verification	
	viii.	It shall support Port trunking capability at Layer 2	Functional Verification	
	ix.	Link Aggregation as per IEEE802.3ad to allow link resilience load balancing over IEEE 802.3ad Aggregated Links shall also be supported	Functional Verification	
	x.	IEEE 802.1Q tagging support	Lab. Test -Refer Test No.- 16 of compendium	
	xi.	IEEE 802.1w VLAN RST (Rapid Spanning Tree) and IEEE 802.1s VLAN MST (Multiple Spanning Tree). Minimum two instances of Multiple Spanning Tree shall be supported.	Lab. Test -Refer Test No.- 16 of compendium	
3.4.3		Layer-3 Features: The LAN switch shall support the following layer 3 capabilities. Requirement of the same shall be indicated by the tendering authority	Information	
	i.	IP routing protocols - RIP2 & OSPF and shall be supported for both IPv4 and IPv6	Lab. Test -Refer Test No.- 16 of compendium	
	ii.	Intelligent Queuing based on IP ToS bits for scalability	Functional Verification	

	iii.	IP precedence classification	Functional Verification	
	iv.	Diffserv support	Functional Verification	
	v.	QoS classification of packets	Functional Verification	
	vi.	Above protocols shall also be supported for IPv6	Declaration	
	vii.	VRRP for IPv6 interfaces shall be supported for instant failover.	Declaration	
	viii.	The LAN Switch shall support a minimum of 1,25,000 Layer 3 IPv4 and IPv6 Routes together	Functional Verification	
3.4.4		VLAN features: The LAN switch shall support the following VLAN features	Information	
	i.	VLAN shall be possible to be created among ports of different types as well as ports on the interface cards	Functional Verification	
	ii.	The LAN Switch shall support VLAN Bridge (for outer tag only) as per 802.1ad	Lab. Test -Refer Test No.- 16 of compendium	
	iii.	The LAN Switch shall support user isolation per outer VLAN tag. This behaviour shall be configurable on a per VLAN basis	Functional Verification	
	iv.	VLAN shall be possible to be created among ports of different types as well as ports on the interface cards	Functional Verification	
	v.	4000 VLANs (as per IEEE 802.1Q) shall be supported	Functional Verification	
	vi.	Private VLAN on layer-2	Declaration	
3.4.5		Multicast capabilities: The LAN switch shall support the following multicast capabilities	Information	
	i.	IGMP v2 and v3 as described in RFC 2236 and RFC 3376	Lab. Test -Refer Test No.- 16 of compendium	
	ii.	PIM-SM and PIM-SSM	Declaration	
	iii.	Support for Multicast capabilities in IPv4	Declaration	
	iv.	LAN switch shall support anycast capabilities	Declaration	
3.4.6		QoS:- The LAN switch shall support the following QoS features per port and for each VLAN:-	Information	
	i.	Filtering	Functional Verification	
	ii.	Broadcast/Multicast suppression	Functional Verification	
	iii.	Link Load balancing in IPv4 and IPv6 (using Anycast).	Functional Verification	
	iv.	Rate limiting of bandwidth on the switch ports	Functional Verification	
	v.	Traffic prioritization	Functional Verification	
	vi.	Traffic Shaping	Functional Verification	
	vii.	Rate limiting of bandwidth: shall support User bandwidth from 1Mb/s to 1Gbps in 1Mb/s	Functional	

		increment	Verification	
	viii.	Bandwidth management reports and statistics	functional Verification	
	ix.	Bandwidth management policies	functional Verification	
	x.	Policy based QoS	functional Verification	
	xi.	IEEE 802.1p priority marking. All 8 values shall be supported	functional Verification	
3.4.7		Management and Security: The switch shall support the following management and security features	Information	
	i.	SNMP Manageability: Shall support SNMP ver 3. RMON (Remote Monitoring) MIB I, II shall also be supported. The public and private MIB shall be provided to service provider	Lab. Test - Refer Test No. 19 of compendium	
	ii.	Access Security: The switches shall have password protection features on Telnet access to the box. The LAN Switch shall support Secure Shell Access	Functional Verification	
	iii.	Console and Out-of-band management: The switch shall have console management access along with provision for remote out-of-band management. Switch CLI access control shall be on the basis of user name and password for separate users	Functional Verification	
	iv.	FTP / TFTP: The switch shall support FTP / TFTP access to its configuration/boot files	Declaration	
	v.	Configuration Software: The switch shall support configuration management through a GUI based software configuration utility. Configuration management through the console is also required. Support of configuration on web interface shall be available	Declaration	
	vi.	The LAN switch shall be manageable from a standards based NMS platform. The LAN switch NMS application shall be capable of running on a standards based NMS platform. Network management software shall be standards based and shall support protocols like SNMP V3 and RMON. Support for standard MIBs is mandatory	Declaration	
	vii.	The LAN switch shall support Network Time Protocol (NTP) / SNTP as per RFC 2030 for synchronizing with a centralised NTP server	Functional Verification	
	viii.	Trace Route feature (MAC Trace in layer-2 and IP trace in Layer-3 as optional features).	Functional Verification	
	ix.	Should support port mirroring over L2 / L3 networks - both local and remote	Functional Verification	
	x.	Should support integrated security features like DHCP snooping, Dynamic ARP Inspection (IPv4 only), IP Source Guard and uRPF (unicast Reverse Path Forwarding), Neighbour Spoofing in IPv6	Functional Verification	
	xi.	Should support layer 2 traceroute	Functional	

			Verification	
	xii.	DC Switch should support Private VLAN	Functional Verification	
	xiii.	DC Switch should support MAC Address Filtering based on source and destination address	Functional Verification	
		PART-5 REQUIREMENTS FOR CATEGORY-IV LAN SWITCHES		
3.5		**Functional Requirements of LAN Switch for Intranet Application / CPE (Category IV):-**	Information	
	i.	The LAN switch shall support a console port or auxiliary port for the purpose of local and remote configuration and diagnostics	Functional Verification	
	ii.	The LAN switch shall support extensive debugging capabilities to assist in hardware and software problem resolution	Declaration	
	iii.	The LAN switch shall support the adequate memory to meet the full configuration requirement.	Declaration	
	iv.	The individual interface on LAN Switch shall support 1,488,100 packets per second (pps) on Gigabit Ethernet in Full Duplex; 148,810 pps on 100 Mbps Full Duplex Ethernet; 14,881 pps on 10 Mbps Full Duplex Ethernet at Minimum Frame size of 84 Bytes on Ethernet	Declaration	
	v.	The LAN switch shall support built in power diagnostics system to detect hardware failures	Declaration	
	vi.	The LAN Switch shall be capable of working with 180 - 250V, 50 Hz AC power supply. It shall have over voltage protection. The exact power requirement shall be indicated by Tendering authority	Declaration	
	vii.	The performance of device shall not be degraded upon enabling of one or more features.	Declaration	
	viii.	Switch shall support optionally PoE/POE+ as per standard IEEE 802.3af/802.2at with following Power Budget Requirements a. 24 Port Switch (PoE) _- 370W, 8-Port Switch (PoE) – 120 W b. 24 port Switch(PoE+) – 740W c. 48 Port (PoE/PoE+) – 740W	Functional Verification	
	ix.	Each Port on PoE/PoE+ Switch should be flexibly configurable as PoE or PoE+ or Non POE.	Functional Verification	
	x.	PoE based switches should support persistent PoE on each port which ensures the Power supply to be made available to PoE connected device in case of switch undergoing reboot. In Chassis based Switches, the removal or addition of any cards shall not disrupt traffic	Declaration	

		on other cards.		
	xi	All the interfaces on the devices shall be supported as integrated interfaces and shall not require any external converters / adapters	Physical Verification	
	xii	Shall support Redundant Power Supplies.	Functional Verification	
	xiii	LAN Switch shall be standalone fixed configuration or stackable	Functional Verification	
3.5.1		Availability / Redundancy	Information	
	i.	Comprehensive hardware and software fault isolation and recovery features shall be supported	Declaration	
	ii	The LAN Switch shall support dynamic online configuration	Declaration	
	iii.	Switches can be of fanless design or in case of design with fans it shall be in redundant configuration.	Physical Verification	
3.5.2		Protocols:- It shall support the following protocols	Information	
	i.	Spanning Tree Protocol (IEEE 802.1d)	Lab. Test - Refer Test No. 16 of compendium	
	a.	The Switching Module shall possess redundant load balancing capability to support fault-tolerant connections to other switches or shared media segments to protect against a primary link failure. If the primary link fails, the backup path shall be automatically activated to maintain network connectivity and throughput. On Ethernet, this shall be done via a standard protocol called the Spanning Tree Protocol (IEEE 802.1D).		
	b.	An LAN Switch shall be able to prioritize BPDUs in the data plane (by providing dedicated queues) and in the control plane (by providing dedicated CPU queues for BPDUs).		
	c.	An LAN Switch shall be able to drop BPDUs if those BPDUs have a root bridge identifier which is lower (better) than the current Spanning Tree root. This function shall be configurable on a per port basis		
	d.	An LAN Switch shall be able to drop BPDUs regardless of the BPDU content. This function shall be configurable on a per port basis		
	ii.	Flow Control (IEEE 802.3x)	Lab. Test -Refer Test No.- 16 of compendium	
	iii.	SNMP v3	Lab. Test -Refer Test No.- 19 of compendium	
	iv.	TFTP	Functional Verification	
	v.	Telnet	Functional	

			Verification	
	vi.	SSH	Functional Verification	
	vii.	It shall support Port trunking capability at Layer 2	Functional Verification	
	viii.	Link Aggregation as per IEEE 802.3ad to allow link resilience. Load balancing over IEEE 802.3ad Aggregated Links shall also be supported	Functional Verification	
	ix.	IEEE 802.1Q tagging support	Lab. Test -Refer Test No.- 16 of compendium	
	x.	IEEE 802.1w VLAN RST (Rapid Spanning Tree) and IEEE 802.1s VLAN MST (Multiple Spanning Tree). Minimum two instances of Multiple Spanning Tree shall be supported	Lab. Test -Refer Test No.- 16 of compendium	
3.5.3		VLAN features: VLAN shall be possible to be created among ports of different types as well as ports on the interface cards. (In case of Chassis based Switch)	functional Verification	
3.5.4		**Layer-3 Features:** (Optional) The LAN switch shall support the following layer 3 capabilities. Requirement of the same shall be indicated by the tendering authority. i IP routing protocols – Static Routing and OSPF shall be supported for both IPv4 and IPv6. ii PIM (Protocol Independent Multicast)-Sparse Mode (PIM-SM), and Source Specific Multicast (PIM-SSM).	functional Verification	
3.5.5		**Multicast capabilities:** The LAN switch shall support Internet Group Management Protocol (IGMP) v2 and v3 as described in RFC 2236 & RFC 3376.	Lab. Test -Refer Test No.- 16 of compendium	
3.5.6		QoS:- The LAN switch shall support the following QoS features per port and for each VLAN	Information	
	i.	Filtering	Functional Verification	
	ii.	Broadcast suppression	Functional Verification	
	iii.	Link load balancing	Functional Verification	
	iv.	Rate limiting of bandwidth on the switch ports	Functional Verification	
	v.	Traffic prioritization	Functional Verification	
	vi.	Traffic Shaping	Functional Verification	
	vii.	Rate limiting of bandwidth: shall support User bandwidth from 1Mb/s to 1Gbps in 1Mb/s increment	Functional Verification	
	viii.	Policy based bandwidth classification	Functional Verification	
	ix.	Bandwidth management reports and statistics	Functional	

			Verification	
	x.	Bandwidth management policies	Functional Verification	
	xi.	IEEE 802.1p priority marking. All 8 values shall be supported	Functional Verification	
	xii.	IPv6 ACL or QoS	Functional Verification	
3.5.7		Management and Security The switch shall support the following management and security features.	Information	
	i.	SNMP Manageability: Shall support SNMP ver 3. RMON (Remote Monitoring) MIB I, II shall also be supported. The public and private MIB shall be provided to service provider	Lab. Test - Refer Test No. 19 of compendium	
	ii.	Access Security: The switches shall have password protection features on Telnet access to the box. The LAN Switch shall support Secure Shell Access	Functional Verification	
	iii.	Console and Out-of-band management: The switch shall have console management access along with provision for remote out-of-band management. Switch CLI access control shall be on the basis of user name and password for separate users	Functional Verification	
	iv.	FTP / TFTP: The switch shall support FTP / TFTP access to its configuration/boot files	Declaration	
	v.	Configuration Software: The switch shall support configuration management through a GUI based software configuration utility. Configuration management through the console is also required. Support of configuration on web interface shall be available	Declaration	
	vi.	The LAN switch shall be manageable from a standards based NMS platform. The LAN switch NMS application shall be capable of running on a standards based NMS platform. Network management software shall be standards based and shall support protocols like SNMP V3 and RMON. Support for standard MIBs is mandatory	Declaration	
	vii.	The LAN switch shall support Network Time Protocol (NTP) / SNTP as per RFC 4330 for synchronizing with a centralised NTP server	Functional Verification	
	viii.	The LAN switch shall support both IPv4 and IPv6 host and management	Lab. Test -Refer Test No. - 16 of compendium	
		PART-6 REQUIREMENTS FOR CATEGORY-V Industrial Grade SWITCHES		
3.6		Functional Requirements of Industrial Grade switches (Category V):-	Information	

	I	The Industrial Grade switch shall support a console port or auxiliary port for the purpose of local and remote configuration and diagnostics.	Functional Verification	
	II	The Industrial Grade switch shall support extensive debugging capabilities to assist in hardware and software problem resolution.	Declaration	
	III	The Industrial Grade switch shall support the adequate memory to meet the full configuration requirement.	Declaration	
	IV	The individual interface on LAN Switch shall support 1,488,100 packets per second (pps) on Gigabit Ethernet in Full Duplex; 148,810 pps on 100 Mbps Full Duplex Ethernet; 14,881 pps on 10 Mbps Full Duplex Ethernet at Minimum Frame size of 84 Bytes on Ethernet.	Declaration	
	V	The Industrial Grade DIN Rail switch shall be -48v DC operating. It shall have over voltage protection. For AC feed industrial grade AC to DC compatible adapter shall be used.	Declaration	
	VI	Operating temperature -40Deg C to +70Deg C.	Declaration	
	VII	The performance of device shall not be degraded upon enabling of one or more features.	Declaration	
	VIII	All the interfaces on the devices shall be supported as integrated interfaces and shall not require any external converters / adapters.	Declaration	
	IX	Shall support dual feed Power Supply.	Functional Verification	
	X	Shall support Fan less design & low power consumption.	Declaration	
	XI	Industrial Grade switch shall be standalone fixed configuration.	Declaration	
	XII	Switch shall support Non-PoE or PoE/POE+ as per standard IEEE 802.3af/802.2at respectively.	Declaration	
	XIII	For the PoE/PoE+ switches PoE budget must sufficient to provide per port as per PoE/PoE+ standard.	Declaration	

	XIV	PoE based switches should support persistent PoE on each port.	Functional Verification	
3.6.1		**Protocols:- It shall support the following protocols:**		
		i. Spanning Tree Protocol (IEEE 802.1d) ii. Flow Control (IEEE 802.3x) iii. SNMP v3 iv. TFTP v. Telnet vi. SSH vii. It shall support Port trunking capability at Layer 2. viii. Link Aggregation as per IEEE 802.3ad to allow link resilience. Load balancing over IEEE 802.3ad Aggregated Links shall also be supported. ix. IEEE 802.1Q tagging support. x. IEEE 802.1w VLAN RST (Rapid Spanning Tree) and IEEE 802.1s VLAN MST (Multiple Spanning Tree). Minimum two instances of Multiple Spanning Tree shall be supported.	Functional Verification	
3.6.2		**VLAN features:** VLAN shall be possible to be created among ports of different types.	Functional Verification	
3.6.3		Switch should support minimum of 128 Layer 3 IPv4 and IPv6 Routes together	Declaration	
3.6.4		**Multicast capabilities:** The LAN switch shall support Internet Group Management Protocol (IGMP) v2 and v3 as described in RFC 2236 & RFC 3376.	Functional Verification	
3.6.5		**QoS:-** The Industrial Grade switch shall support the following QoS features per port and for each VLAN:-		
		i Filtering ii Broadcast suppression iii Link load balancing iv Rate limiting of bandwidth on the switch ports v Traffic prioritization vi Traffic Shaping	Functional Verification	

		vii Rate limiting of bandwidth: shall support User bandwidth from 1Mb/s to 1Gbps in 1Mb/s increment. viii Policy based bandwidth classification ix Bandwidth management policies x IEEE 802.1p priority marking. All 8 values shall be supported. xi IPv6 ACL or QoS.		
3.6.6		**Management and Security:** The switch shall support the following management and security features. i. **SNMP Manageability:** Shall support SNMP ver 3. RMON (Remote Monitoring) MIB I, II shall also be supported. The public and private MIB shall be provided to service provider. ii. **Access Security:** The switches shall have password protection features on Telnet access to the box. The Industrial Grade switch shall support Secure Shell Access. iii. **Console and Out-of-band management:** The switch shall have console management access along with provision for remote out-of-band management. Switch CLI access control shall be on the basis of user name and password for separate users. iv. **FTP / TFTP:** The switch shall support FTP / TFTP access to its configuration/boot files. v. **Configuration Software:** The switch shall support configuration management through a GUI based software configuration utility. Configuration management through the console is also required. Support of configuration on web interface shall be available. vi. The LAN switch shall be manageable from a standards based NMS platform. The LAN switch NMS application shall be capable of running on a standards based NMS platform. Network management software shall be standards based and shall support protocols like SNMP V3 and RMON.	Functional Verification	

		vii. The LAN switch shall support Network Time Protocol (NTP) / SNTP as per RFC 4330 for synchronizing with a centralised NTP server. viii. The LAN switch shall support both IPv4 and IPv6 host and management.		
3.6.7		Other features: i. The LAN Switches shall support dying gasp as per IEEE802.3ah ii. It should support 6KV surge on each Ethernet port iii. It shall be IPv6 ready Logo certified iv It shall support Port Security based on 802.1x v The switch should have max (No PoE Load) Power Consumption of 15 W.	Declaration	
	PART-7 IPv6 REQUIREMENTS FOR ALL CATEGORY OF LAN SWITCHES			
3.7		IPv6 Protocol Requirements: The following IPv6 protocols shall be met by all category of LAN switches	Information	
3.7.1		IP Routing Protocols [Applicable to LAN Switches with Layer-3 capabilities]:-	Information	
	i.	RIPng for IPv6 as per RFC 2080	Lab. Test -Refer Test No. - 16 of compendium	
	ii.	OSPFv3 for IPv6 as per RFC 5340	Lab. Test -Refer Test No. - 16 of compendium	
	iii.	IPv6 Static Routing	Lab. Test -Refer Test No. - 16 of compendium	
	iv.	IPv6 Route Redistribution	Declaration	
3.7.2		General IPv6 support	Information	
	i.	IPv6 Address types: Unicast (Unique Local IPv6 address as per RFC 4193), Anicast and Multicast	Declaration	
	ii.	ICMPv6 as per RFC 2463	Declaration	
	iii.	IPv6 Neighbor Discovery as per RFC 2461	Declaration	
	iv.	IPv6 stateless auto configuration as per RFC 4862	Lab. Test -Refer Test No. - 16 of compendium	
	v.	IPv6 MTU path discovery as per RFC 8201	Lab. Test -Refer Test No. - 16 of compendium	

	vi.	IPv6 ping	Functional Verification	
	vii.	ICMPv6 redirect	Declaration	
	vii.	ICMPv6 rate limiting	Declaration	
	ix.	IPv6 neighbor discovery duplicate address detection	Declaration	
	x.	IPv6 default router preference as per RFC 2711	Declaration	
	xi.	IPv6 access control	Declaration	
	xii.	Syslog over IPv6	Declaration	
	xiii.	IP SLAs for IPv6	Declaration	
	xiv.	IPv6 Specification as per RFC 8200	Lab. Test -Refer Test No. - 16 of compendium	
	xv.	IPv6 Scoped Address Architecture as per RFC 4007	Declaration	
	xvi	ICMPv6 for IPv6 Specification as per RFC 4443		
3.7.3		Pv6 QoS	Information	
	i.	Packet classification as per RFC 2474	Declaration	
	ii.	Traffic shaping	Declaration	
	iii.	Traffic policing	Declaration	
	iv.	Packet marking/re-marking as per RFC 2475	Declaration	
	v.	IPv6 QoS queuing	Declaration	
	vi.	Weighted random early detection (WRED)- based drop	Declaration	
	vii.	Assured Forwarding PHB Group shall be as per RFC 2597	Declaration	
	viii.	LAN switch shall support An Expedited Forwarding PHB as per RFC 3246	Declaration	
3.7.4		IPv6 Services	Information	
	i.	Standard access control lists for IPv6	Declaration	
	ii.	Secure Shell (SSH) support over IPv6	Declaration	
	iii.	IPv6 MIB support	Declaration	
	iv.	SNMP over IPv6	Declaration	
	v.	Stateless DHCPv6	Declaration	
	vi.	DHCPv6 prefix delegation	Declaration	
	vii.	DHCP for IPv6 relay agent	Declaration	
	viii.	DHCPv6 prefix delegation via AAA	Declaration	
	ix.	DHCPv6 Server Stateless Auto Configuration	Declaration	
	x.	DHCPv6 Client Information Refresh Option	Declaration	
	xi.	DHCPv6 relay agent notification for prefix delegation	Declaration	
	xii.	DHCPv6 relay- reload persistent interface ID option	Declaration	
	xiii.	DHCP - DHCPv6 Individual Address Assignment	Declaration	
	xiv.	LAN switch shall support Dynamic Host Configuration Protocol for IPv6 (DHCPv6) as per RFC 8415	Lab. Test -Refer Test No. - 16 of compendium	
	xv.	DNS Extensions to Support IP Version 6 as per RFC 3596	Declaration	
	xvi.	LAN switch shall support DHCP IPv6 Prefix Delegation RFC 3633	Declaration	

	xvii.	LAN switch shall support DNS Configuration options for DHCPv6 as per RFC 3646	Lab. Test -Refer Test No. - 16 of compendium	
	xviii.	LAN switch shall support Stateless DHCP Service for IPv6 as per RFC 3736	Declaration	
	xix.	IP Forwarding Table MIB as per RFC 4292	Declaration	
	xx.	Management Information Base for the Internet Protocol as per RFC 4293	Declaration	
	xxi.	Dynamic Host Configuration Protocol version 6 (DHCPv6) options as per RFC 3319.	Declaration	
3.7.5		IPv6 Multicast	Information	
	i.	IPv6 Multicast Listener Discovery (MLD) protocol versions 1 and 2	Lab. Test -Refer Test No. - 16 of compendium	
	ii.	IPv6 PIM sparse mode (PIM-SM)	Lab. Test -Refer Test No. - 16 of compendium	
	iii.	IPv6 PIM Source Specific Multicast (PIM-SSM)	Lab. Test -Refer Test No. - 16 of compendium	
	iv.	IPv6 multicast scope boundaries	Declaration	
	v.	IPv6 multicast MLD access group	Declaration	
	vi.	IPv6 multicast PIM accept register	Declaration	
	vii.	IPv6 multicast PIM embedded RP support	Declaration	
	viii.	IPv6 multicast RPF flooding of bootstrap router (BSR) packets	Declaration	
	ix.	IPv6 multicast routable address hello option	Declaration	
	x.	IPv6 multicast static multicast routing (mroute)	Declaration	
	xi.	IPv6 multicast SSM mapping for MLDv1 SSM	Declaration	
	xii.	IPv6 multicast IPv6 BSR−ability to configure RP mapping	Declaration	
	xiii.	IPv6 multicast MLD group limits	Declaration	
	xiv.	IPv6 Multicast Address Assignments as per RFC 2375	Declaration	
	xv.	IPv6 Multicast Listener Discovery (MLD) protocol, versions 1 and 2 as per RFC 2710	Lab. Test -Refer Test No. - 16 of compendium	
	xvi.	MLDv2 for IPv6 as per RFC 3810	Lab. Test -Refer Test No. - 16 of compendium	
	xvii.	Embedding the Rendezvous Point (RP) Address in an IPv6 Multicast Address as per RFC 3956	Declaration	
4		**Interconnectivity & Interoperability Requirements**	Information	
4.1		Interface Requirements for Category I:- The LAN switch shall support interfaces as indicated below	Information	
	i.	10/100/1000 Base-T Ethernet Electrical Interface (IEEE 802.3u).	Lab. Test -Refer Test No. - 1 & 10 of compendium	

	ii.	1000 Base TX, SX, LX, Gigabit Ethernet Interfaces (IEEE 802.3z).	Lab. Test -Refer Test No. - 11, 12 & 13 of compendium	
	iii.	10 Gigabit Ethernet interface, IEEE 802.3au	Lab. Test -Refer Test No. - 11, 12 & 13 of compendium	
	iv	100 Gigabit Ethernet interface (for High range switches), IEEE802.ba/802.bj/802.bm/802.cd/802.ck/802.cu/802.ct/.	Relevant Lab test of compendium	
	v.	Full duplex capabilities on all ports	Declaration	
4.2		Interface Requirements for Category II:- The LAN switch shall support interfaces as indicated below	Information	
	i.	10/100/1000 Base-T Ethernet Electrical Interface (IEEE 802.3u)	Lab. Test -Refer Test No.- 1 & 10 of compendium	
	ii.	1000 Base TX, SX, LX, Gigabit Ethernet Interfaces (IEEE 802.3z)	Lab. Test -Refer Test No. - 11, 12 & 13 of compendium	
	iii.	Full duplex capabilities on all ports	Declaration	
	iv.	10 Gigabit Base SX, LX, ZX on XFP/SFP/SFP+ interfaces (IEEE 802.3ae).	Lab. Test -Refer Test No. - 11, 12 & 13 of compendium	
	v	100 Gigabit Ethernet interface (for High range switches), IEEE802.ba/802.bj/802.bm/802.cd/802.ck/802.cu/802.ct/.	Relevant Lab test of compendium	
4.3		Interface Requirements for Category III:- The LAN switch shall support interfaces as indicated below	Information	
	i.	10/100/1000 Base-T Ethernet Electrical Interface (IEEE 802.3u)	Lab. Test -Refer Test No.- 1 & 10	
	ii.	1000 Base TX, SX, LX, Gigabit Ethernet Interfaces (IEEE 802.3z)	Lab. Test -Refer Test No. - 11, 12 & 13 of compendium	
	iii.	10 Gigabit Ethernet interface, IEEE 802.3au (not on low range)	Lab. Test -Refer Test No. - 11, 12 & 13 of compendium	
	iv.	Full duplex capabilities on all ports	Declaration	
	v	100 Gigabit Ethernet interface, IEEE802.ba/802.bj/802.bm/802.cd/802.ck/802.cu/802.ct/.	Relevant Lab test of compendium	
4.4		Interface Requirements for Category IV:- The LAN switch shall support interfaces as indicated below	Information	

	i.	10/100/1000 Base-T Electrical Interface (IEEE 802.3u)	Lab. Test -Refer Test No.- 1 & 10 of compendium	
	ii.	1000 Base TX, SX, LX, Gigabit Ethernet Interfaces (IEEE 802.3z)	Lab. Test -Refer Test No. - 11, 12 & 13 of compendium	
	iii.	10 Gigabit Base SX, LX, ZX on XFP/SFP/SFP+ interfaces (IEEE 802.3ae).	Lab. Test -Refer Test No. - 11, 12 & 13 of compendium	
	iv.	Full duplex capabilities on all ports	Declaration	
4.5		Interface Requirements for Category V:- The LAN switch shall support interfaces as indicated below:		
	i.	10/100/1000 Base-T Electrical Interface (IEEE 802.3u)	Relevant Lab test of compendium	
	ii.	1000 Base TX, SX, LX, Gigabit Ethernet Interfaces (IEEE 802.3z)	Relevant Lab test of compendium	
	iii.	Full duplex capabilities on all ports.	Relevant Lab test of compendium	
		As per requirement the type and number of ports and driving distance shall be specified by tendering authority		
4.6		All LAN Switches should optionally support SDN interfaces like SNMP/NETCONF/REST API via Domain Controller or equivalent.	Declaration	
5		Qualitative Requirements:-	Information	
5.1	a.	The manufacturer shall furnish the MTBF value. Minimum value of MTBF shall be 500,000 hours. The calculations shall be based on the guidelines given in either QA document No. QM-115 {January 1997} "Reliability Methods and Predictions" or any other international standards.	Declaration	
5.2	b	The equipment shall be manufactured in accordance with international quality management system ISO 9001:2015 or any other equivalent ISO certificate for which the manufacturer should be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer would be required to be submitted.	Declaration	
5.3		The equipment shall conform to the requirements for Environment specified in TEC QA standards QM-333 {Issue- March, 2010} "Standard for Environmental testing of Telecommunication Equipments" or any other equivalent international standard, for operation, transportation and storage. The applicable tests shall be for environmental category "D" including vibration and corrosion (salt mist).	Declaration	

6		Electromagnetic Compatibility (EMC) Requirements	Certificate from Accredated Lab.	
7		Safety Requirements		
		The equipment shall conform to relevant safety requirements as per IS/IEC 62368-1:2018 or Latest as prescribed under Table no. 1 of the TEC document 'SAFETY REQUIREMENTS OF TELECOMMUNICATION EQUIPMENT": TEC10009: 2024. The manufacturer/supplier shall submit a certificate in respect of compliance to these requirements.	Declaration	
8		**Security Requirements**		
8.1		**Category I:-** The LAN switch must support the following security features	Information	
	a.	IP Filtering.	Functional Verification	
	b.	Trap and syslog messaging on security violation.	Declaration	
	c.	Controlled SNMP Access through implementation of Access Lists on the LAN switch to ensure SNMP access only to the SNMP manager or the NMS workstation.	Functional Verification	
	d.	Port mirroring should support;-	Information	
	i.	At least 10 sessions.	Declaration	
	ii.	Option to filter incoming / outgoing traffic	Functional Verification	
	iii.	At least concentration ratio of 1:5 and	Functional Verification	
	iv.	Support for SPAN (Switch Port Analyser) / RSPAN (Remote Switch Port Analyser).	Declaration	
	e.	Security mechanism to prevent unauthorized users from accessing the console port.	Declaration	
	f.	Port level security mechanism to prevent unauthorized nodes from accessing the switch.	Declaration	
	g.	LAN Switch should support DHCP Snooping and IP Source Guard in IPv4 & IPv6. It should also support ARP Security in IPv4.	Functional Verification	
	h.	Should support MAC based filtering to allow or deny access to a host.	Functional Verification	
	i.	LAN Switch should support Private VLAN.	Declaration	
8.2		**Category II:-** The LAN switch must support the following security features	Information	
	i.	Security through ACL filters for Layer 2 and Layer 3 traffic, MAC address limits and storm control for broadcast, multicast and unknown unicast.	Functional Verification	

	ii.	Authentication, authorization and accounting (AAA); TACACS+; Secure Shell (SSH) Protocol; 802.1ad Layer 2 Control Protocol (L2CP); bridge-protocol-data-unit (BPDU) filtering; MAC limiting per Ethernet flow point (EFP) or bridge domain; unicast, multicast, and broadcast storm control blocking on any interface or port; Unknown Unicast Flood Blocking (UUFB); Dynamic Host Configuration Protocol (DHCP) snooping; and Unicast Reverse Path Forwarding (URPF).	Declaration	
	iii.	Trap and syslog messaging on security violation.	Functional Verification	
	iv.	Controlled SNMP Access through implementation of Access Lists on the LAN switch to ensure SNMP access only to the SNMP manager or the NMS workstation.	Functional Verification	
	v.	Port mirroring should support:-	Information	
	a.	At least 10 sessions.	Declaration	
	b.	Option to filter incoming / outgoing traffic.	Functional Verification	
	c.	At least concentration ratio of 1:5.	Functional Verification	
	d.	Support for SPAN (Switch Port Analyser).	Declaration	
	e.	Security mechanism to prevent unauthorized users from accessing the console port.	Declaration	
	f.	Port level security mechanism to prevent unauthorized nodes from accessing the switch.	Declaration	
	vi.	Filtering: The LAN Switch shall be capable of filtering L2 / L3 traffic configurable on per PVC per Service and per Session basis at least for the following parameters:-	Information	
	a.	Broadcast Traffic / broadcast storm control	Declaration	
	b.	Source MAC/IP address	Functional Verification	
	c.	IP address	Functional Verification	
	d.	Source and destination IP address range	Functional Verification	
	e.	Destination layer 4 port number	Functional Verification	
	f.	Maximum MAC address	Declaration	
	g.	Protection from ARP spoofing attacks	Declaration	
	h.	Ether type	Declaration	
	vii.	It shall be possible to create VLAN or Flow with TCP / IP parameters per service, for data, video and O&M traffic for service differentiation	Declaration	
	viii.	LAN Switch shall implement MAC / IP address based control. It shall be possible to limit the number of MAC / IP addresses per port and to bind the MAC / IP addresses to a port.	Declaration	
	ix.	MAC Security Related Features	Information	

	a.	The LAN Switch shall be able to filter and discard all Ethernet frames received on bridged ports in the upstream direction with a MAC destination address (DA) different than the broadband network gateway MAC address. This feature shall be configurable	Functional Verification	
	b.	The LAN Switch shall not learn MAC address from bridge port X if the same MAC address appears in the learning table pointing to bridge port Y (ports X and Y on the same LAN Switch and same VLAN), except in the case where the aggregation network forwards according to MAC Learning table. The LAN Switch shall prevent broadband network gateway MAC address spoofing. OR	Functional Verification	
	c.	The LAN Switch shall support unique MAC address per user to prevent spoofing and provide traceability. Solution shall prevent duplicate MAC addresses in the network and be traceable to the customer line. If a virtual / translated MAC address is used it shall be based on public Organizationally Unique Identifier (OUI) address space.	Declaration	
	d.	In order to prevent MAC address flooding DoS attack, the LAN Switch shall be able to limit the number of source MAC addresses learnt from a bridged port. This limit shall be configurable per bridged port.	Functional Verification	
	e.	LAN Switch shall allow the list of allowable MAC destination address.	Functional Verification	
	f.	Proxy ARP shall be implemented in the LAN Switch such that all ARP requests from subscribers shall be given the MAC address of the Router that provides L3 aggregation of that VLAN. The ARP address that the LAN Switch responds with should be unique per VLAN.	Functional Verification	
8.3		**Category III:-** The LAN switch must support the following security features	Information	
	i.	IP Filtering	Functional Verification	
	ii.	Trap and syslog messaging on security violation	Declaration	
	iii.	Controlled SNMP Access through implementation of Access Lists on the LAN switch to ensure SNMP access only to the SNMP manager or the NMS workstation.	Functional Verification	
	iv.	Port mirroring	Functional Verification	
	v.	Security mechanism to prevent unauthorized users from accessing the console port.	Declaration	
	vi.	Port level security mechanism to prevent unauthorized nodes from accessing the switch.	Declaration	
8.3.1		FCOE support confirming to latest ANSI / INCITS 462- 2010 FC-BB-5 standards	Declaration	

8.3.2		Multiple Data Center: Extension of Ethernet should be supported by core switch MAC-in-MAC encapsulation or MPLS encapsulation.	Functional Verification	
8.3.3		Support of secured and encrypted communication within the data center switches (desirable features).	Declaration	
8.4		**Category IV:-** The LAN switch must support the following security features	Information	
	i.	Trap and syslog messaging on security violation.	Declaration	
	ii.	Controlled SNMP Access through implementation of Access Lists on the LAN switch to ensure SNMP access only to the SNMP manager or the NMS workstation.	Functional Verification	
	iii.	Port mirroring.	Functional Verification	
	iv.	Security mechanism to prevent unauthorized users from accessing the console port.	Functional Verification	
	v.	Port level security mechanism to prevent unauthorized nodes from accessing the switch.	Declaration	
8.5		**Category V:-** The LAN switch must support the following security features:	Information	
	I	Trap and syslog messaging on security violation.	Functional Verification	
	Ii	Controlled SNMP Access through implementation of Access Lists on the LAN switch to ensure SNMP access only to the SNMP manager or the NMS workstation.	Functional Verification	
	iii	Port mirroring.	Functional Verification	
	iv	Security mechanism to prevent unauthorized users from accessing the console port.	Functional Verification	
	v	Port level security mechanism to prevent unauthorized nodes from accessing the switch.	Functional Verification	
8.6		The LAN switches shall meet the latest security certification requirements mandated by DoT	Declaration	
9		Other Mandatory Requirements	Information	
9.1		The system hardware / software shall not 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 system	Declaration	
9.2		Wherever, the standardized documents like ITU-T, IEEE, QA and TEC documents are referred, the latest issue and number with the amendments shall be applicable	Declaration	
9.3		LAN switch shall support the Lawful Interception as per the latest guidelines / document of DoT	Declaration	
9.4		Power Supply: The equipment power supply requirements are given for each of the category. In addition, it shall meet the following requirements	Information	

	i.	The equipment shall be able to function over the range specified in this GR without any degradation in performance	Declaration	
	ii.	The equipment shall be protected in case of voltage variation beyond the range specified and also against input reverse polarity	Declaration	
	iii.	The derived DC voltages shall have protection against short circuit, over voltage and overload	Declaration	
9.5		It should have the capacity of combining multiple physical switches into one logical switch	Functional Verification	
9.6		Engineering Requirements (ER):- The system shall meet the following engineering requirements	Information	
	a.	The equipment shall adopt state of the art technology	Declaration	
	b.	The actual dimensions and weight of the equipment shall be furnished by the manufacturers	Declaration	
	c.	All connectors shall be reliable, low loss and standard type so as to ensure failure free operations over long operations	Declaration	
	d.	All cables shall be of Gigabit Ethernet ready standards	Declaration	
	e.	The equipment shall have	Declaration	
	i.	Proper earthing arrangement	Declaration	
	ii.	Protection against short circuit / open circuit	Declaration	
	iii.	Protection against accidental operations for all switches/ controls provided in the front panel	Declaration	
	iv.	Protection against entry of dust, insects and lizards	Declaration	
9.7		Operational Requirements (OR):- The system shall meet the following maintenance & operational requirements	Information	
	a.	The equipment shall be designed for continuous operation	Declaration	
	b.	The manufacturer shall ensure satisfactory performance without any degradation at an altitude upto 3000 meters above mean sea level	Declaration	
	c.	Suitable visual indications for healthy, unhealthy conditions and for non-urgent alarms shall be provided	Physical Verification	
	d.	The design of the equipment shall not allow plugging of a module in the wrong slot or upside down	Declaration	
	e.	The removal or addition of any interface cards shall not disrupt traffic on other cards	Declaration	
	f.	Special tools required for wiring shall be provided along with the equipment	Declaration	
	g.	A single point failure on the chassis based LAN Switch shall not result in network or network management system downtime	Declaration	

	h.	In the event of a bug found in the software, the manufacturer shall provide patches and firmware replacement if involved, free of cost. Compatibility of the existing hardware shall be main¬tained with future software/firmware	Declaration	
	i.	In the event of a full system failure, a trace area shall be maintained in non-volatile memory for analysis and problem resolution	Declaration	
	j.	Necessary alarms (indicators) for indication of faults at various levels of hardware shall be provided on the individual modules	Declaration	
	k.	A power down condition shall not cause loss of connection configuration data storage	Declaration	
	l.	The Hardware and software components shall not pose any problems in the normal functioning of all network elements wherever interfacing with service provider network for voice, data and transmission systems, as the case shall be	Declaration	
	m.	Live Insertion and hot swap of modules shall be possible to ensure maximum network availability and easy maintainability	Declaration	
10		**Desirable / Optional Requirements**	Information	
		This chapter describes the desirable/optional requirements for the LAN switches. The exact requirement shall be specified by the purchaser at the time of tendering		
10.1		DOCUMENTATION:- This section describes the general requirements for documentation to be provided. This shall be applicable to all categories and categories of routers. All technical documents shall be in English language both in CD-ROM and in hard copy. The documents shall comprise of	Information	
	1	System description documents	Documentation	
	2	Installation, Operation and Maintenance documents	Documentation	
	3	Training documents	Documentation	
	4	Repair manual	Documentation	
10.1.1		System description documents: The following system description documents shall be supplied along with the system	Information	
	a.	Over-all system specification and description of hardware and software	Documentation	
	b.	Equipment layout drawings	Documentation	
	c.	Cabling and wiring diagrams	Documentation	
	d.	Schematic drawings of all circuits in the system with timing diagrams wherever necessary	Documentation	
	e.	Detailed specification and description of all Input / Output devices	Documentation	
	f.	Adjustment procedures, if there are any field adjustable units	Documentation	

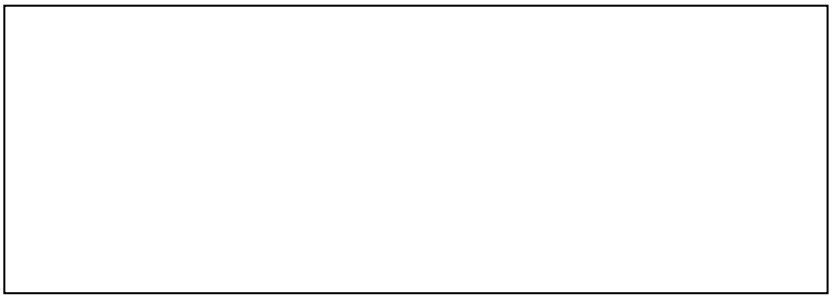
	g.	Spare parts catalogue - including information on individual component values, tolerances, etc. enabling procurement from alternative sources	Documentation	
	h.	Detailed description of software describing the principles, functions and interactions with hardware, structure of the program and data	Documentation	
	i.	Detailed description of each individual software package indicating its functions and its linkage with the other packages, hardware, and data	Documentation	
	j.	Program and data listings	Documentation	
	k.	Graphical description of the system. In addition to the narrative description a functional description of the system using the functional Specification	Documentation	
10.1.2		System operation documents: The following system operation documents shall be available	Information	
	a.	Installation manuals and testing procedures	Documentation	
	b.	Precautions for installation, operations and maintenance	Documentation	
	c.	Operating and Maintenance manual of the system	Documentation	
	d.	Safety measures to be observed in handling the equipment	Documentation	
	e.	Man-machine language manual	Documentation	
	f.	Fault location and trouble shooting instructions including fault dictionary	Documentation	
	g.	Test jigs and fixtures required and procedures for routine maintenance, preventive maintenance and unit / card / sub-assembly replacement	Documentation	
	h.	Emergency action procedures and alarm dictionary	Documentation	
10.1.3		Training Documents	Information	
	a.	Training manuals and documents necessary for organizing training in installation, operation and maintenance and repair of the system shall be made available	Documentation	
	b.	Any provisional document, if supplied, shall be clearly indicated. The updates of all provisional documents shall be provided immediately following the issue of such updates	Documentation	
	c.	The structure and scope of each document shall be clearly described	Documentation	
	d.	The documents shall be well structured with detailed cross-referencing and indexing enabling easy identification of necessary information.	Documentation	
	e.	All diagrams, illustrations and tables shall be consistent with the relevant text	Documentation	
10.1.4		Repair Manual	Documentation	
	a.	List of replaceable parts used	Documentation	
	b.	Detailed ordering information for all the replaceable parts	Documentation	
	c.	Procedure for trouble shooting and sub-assembly replacement	Documentation	

	d.	Test fixtures and accessories for repair	Documentation	
	e.	Systematic trouble shooting charts (fault tree) for all the probable faults with their remedial actions	Documentation	
10.2		INSTALLATION	Information	
	a.	All necessary interfaces, connectors, connecting cables and accessories required for satisfactory installation and convenient operations shall be supplied. Type of connectors, adopters to be used shall be in conformity with the interfaces defined in this GR.	Declaration	
	b.	It shall be ensured that all testers, tools and support required for carrying out the stage by stage testing of the equipment before final commissioning of the network shall be supplied along with the equipment	Declaration	
	c.	All installation materials, consumables and spare parts to be supplied	Declaration	
	d.	All literature and instructions required for installation of the equipment, testing and bringing it to service shall be made available in English language	Declaration	
	e.	For the installations to be carried out by the supplier, the time frames shall be furnished by the supplier including the important milestones of the installation process well before commencing the installations	Declaration	
10.3		SOFTWARE MAINTENANCE	Information	
	a.	All the software updates shall be provided on continuous basis. These updates shall include new features and services and other maintenance updates	Declaration	
	b.	The software for the support of all protocols and interfaces mentioned in this GR shall be ensured in the devices	Declaration	
10.4		Additional Functional Requirements for Category I	Information	
	i.	The high & medium End LAN switch shall support the ability for multiple chassis's to behave as a single virtual chassis using virtual technology. It should support link aggregation across 2 physical switches	Functional Verification	
	ii.	Switch should support Service modules like IPS, firewall and wireless control - either internally or externally	Declaration	
	iii.	The LAN Switch should support Stateful Switchover of user traffic and Non-stop Forwarding to ensure that in case of failure of active CPU module the redundant CPU should start forwarding L2 / L3 traffic in less than 1 sec	Declaration	
	iv.	The LAN switch shall support the IP routing protocols BGP & ISIS layer 3 capabilities	Functional Verification	
	v.	The High and Medium End LAN Switches should have a modular OS or network structure for high availability, fault tolerance and fault isolation	Declaration	

10.5		Additional Functional Requirements for Category II	Information	
	i.	The switch should support Layer 2 transport: EoMPLS pseudo wire aggregation and switching, H-VPLS (VPLS mesh in the core with access facing attachment circuit pseudowires) and point-to-multipoint multicast distribution with H-VPLS (VPLS bridged topologies with pseudo- wire split horizon enabled or disabled).	Functional Verification	
	a.	The switch should support Layer 3 transport: IP, MPLS (IP over MPLS and IP Multicast over VPLS pseudo- wires) and MPLS or IP Multicast VPN transport support for retail and wholesale triple play (data, voice and video) services	Functional Verification	
	b.	The switch shall support flexible service mapping with dot1q trunk, dot1q tunnel, EoMPLS xconnect, attachment circuit functionality under same physical port simultaneously	Functional Verification	
	c.	The switch should support multiplexing of multiple service instances from different physical ports into same bridge-domain, which could be associated to same EoMPLS pseudo wire	Functional Verification	
	ii.	The switch shall support MPLS TE / FRR and IPFRR to ensure high availability and redundancy	Functional Verification	
	iii.	Protocols	Information	
	a.	MPLS and MPLS TE (including TE-FRR).	Functional Verification	
	b.	Label Distribution Protocol (LDP), Targeted LDP (T- LDP), Resource Reservation Protocol (RSVP), Differentiated Services (DiffServ)-aware traffic engineering, MPLS L3VPN	Functional Verification	
	c.	Virtual Private LAN Services (VPLS), Hierarchical VPLS (H-VPLS), Virtual Private Wire Service (VPWS), Ethernet over MPLS (EoMPLS), and multisegment pseudowire stitching	Functional Verification	
	iv.	VLAN Features: It shall support 802.1Q Tagging Support in the following manner: The switch shall support Point-to-point Ethernet transport based on Ethernet over MPLS (EoMPLS) pseudowire (with backup pseudowire support for redundancy)	Functional Verification	
10.6		Additional Functional Requirement for Category III:- The LAN switch shall support the IP routing protocols BGP & ISIS layer 3 capabilities.	Functional Verification	
10.7		Additional Functional Requirement for Category IV: High End LAN Switch shall support the following optional layer 3 capabilities.	Information	
	i.	IP routing protocols - Static Routing.	Functional Verification	
	ii.	Intelligent Queuing based on IP ToS bits for scalability.	Functional Verification	
	iii.	IP precedence classification	Functional Verification	
	iv.	Diffserv support.	Functional Verification	
	v.	QoS classification of packets	Functional	

			Verification	
	vi.	VRRP IPv6 interfaces should be supported for instant failover.	Declaration	
	vii.	The LAN Switch should support a minimum of 1000 Layer 3 IPv4 and IPv6 Routes together	Declaration	
10.8		Guidelines for tendering authority	Information	
10.9		Minimum Equipments Required for Type approval	Information	

I. TEST SETUP & PROCEDURES:

1. Test No.	
2. Test Details	*Name and Other relevant details*
3. Test Instruments Required	1. <Name> 2.
4. Test Setup	
5. Test Procedure	*Testing Steps may be written here….* 1) …… 2) …… 3) ……
6. Test Limits	(if any)
7. Expected Results	1. **……**<values>**……** 2. **……**<values>**……** 3. Other tests (test name)

Further Test Setup & Procedures may be added as per requirement

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
(Compendium of Test Guides of IT)

COMPENDIUM OF
TEST SETUP AND TEST PROCEDURES
FOR PRODUCTS WHOSE
SPECIFICATIONS ARE RELEASED FROM 'IT' DIVISION

Telecommunication Engineering Centre
Department of Telecommunications
Khurshid Lal Bhavan, Janpath
New Delhi-110 001
India

Telecommunication Engineering Centre
(Department of Telecommunications)

Compendium of Test setup and test procedures for products whose specifications are released from 'IT' division

History Sheet

S.No.	No	Remarks
1	Compendium of Tests	1st issue March 2014
2.	Compendium of Tests	2nd issue September 2014
3.	Compendium of Tests	3rd issue November 2014
4.	Compendium of Tests	4th issue December 2014
5.	Compendium of Tests	5th issue April 2015
6.	Compendium of Tests	6th issue April 2016 after incorporation of detailed protocol tests as per RFC's
7.	Compendium of Tests	7th issue July 2024 after incorporating additional interfaces

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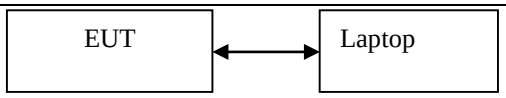
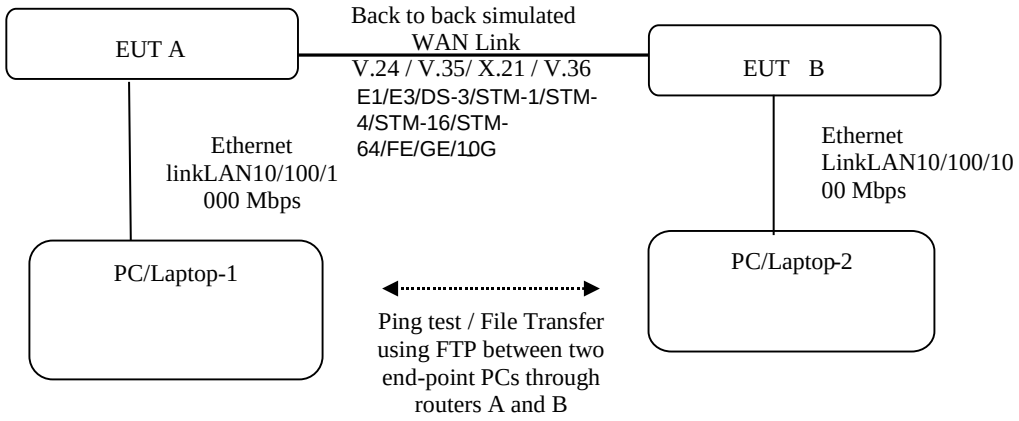
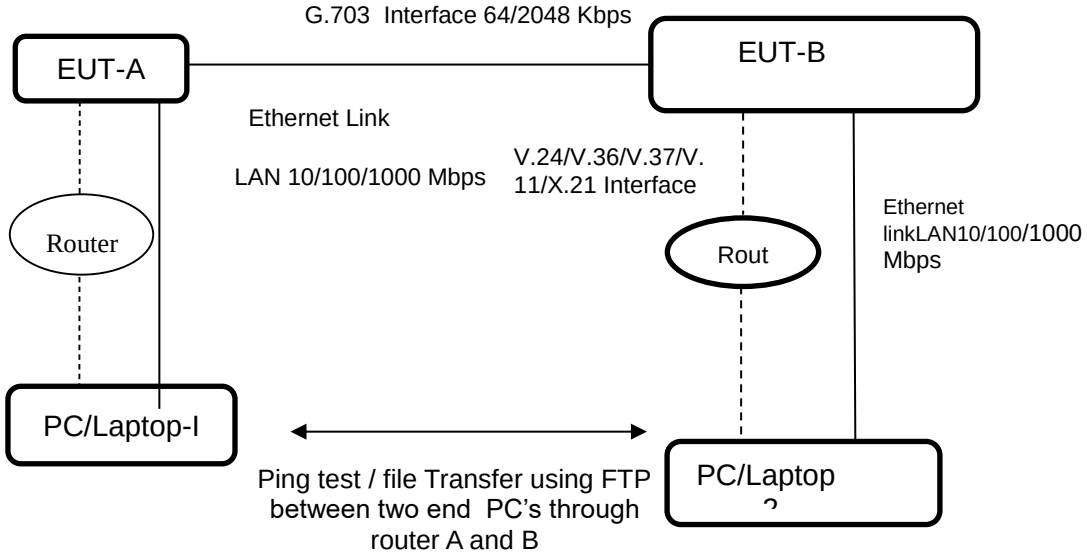
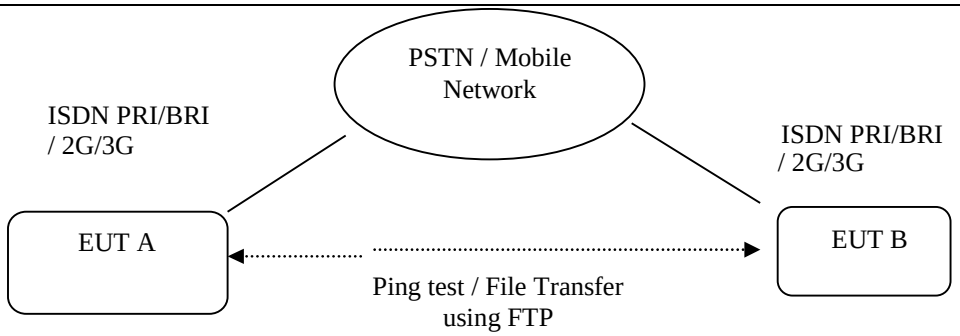
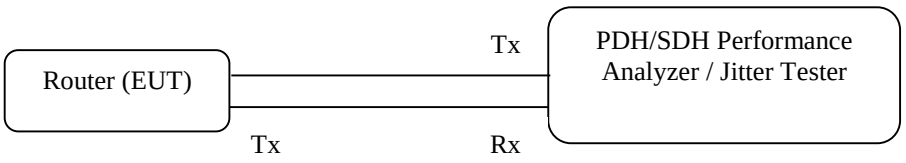
38.	Test for Eye pattern for Optical Interfaces	132
39.	Test for Frequency Stability in Hold over mode	133
40.	Test for Bit Slip measurement	134
41.	Test for Junction Test	135

Test No.	1
Test Details	Test for 10/100/1000 Auto-negotiation Ethernet Interface
Test Instruments Required	1. Laptop
Test Setup	
Test Procedure	1. Set the Laptop Ethernet interface speed to 10Mbps and see whether the EUT is syncing with the Laptop. I.e. the Ethernet interface lamp of the Laptop shall glow. 2. Repeat the above for 100Mbps 3. Repeat the same for 1000Mbps [In case required]
Expected Results	Enclose the Screen Capture Results

Test No.	2
Test Details	Test for the Availability of Service
Test Instruments Required	1. PC / Laptop – 2 Nos
	
Test Procedure	1. Connect the V.24 / V.35 /V.36/X.21/ E1 / E3 / DS-3 / STM-1 / STM-4/STM16/STM-64/FE/GE/10G interface as the case may be as shown in the setup. 2. Connect the PC/Laptop to the 10/100/1000Mbps LAN link as shown 3. Configure the Interface IP of the EUT as well as the PC/Laptop 4. Carry out the Ping test from PC/Laptop-1 to PC/Laptop-2 and see whether it is reachable as well as there are no packet drop 5. Carry out file transfer from PC/Laptop-1 to PC/Laptop-2 6. In case of Nx64, repeat the test at different speeds
Expected Results	Enclose the Ping Results

Test No.	3
Test Details	Test for the Availability of Service (Devices without Ethernet Interface)
Test Instruments Required	1. PC / Laptop – 2 Nos 2. Router or Interface converter in case the EUT do not have the 10/100/1000 Ethernet interface
Test Setup	
Test Procedure	1. Connect the EUT as shown in the setup. 2. Connect the PC/Laptop to the 10/100/1000 Mbps LAN link as shown 3. In case of V.24/V.36/V.37/ V.11/X.21 Interface, same may be connected to the PC/Laptop through a Router acting as interface converter. 4. Configure the Interface IP of the HSL Driver if required, Routers as well as the PC/Laptop 5. Carry out the Ping test from PC/Laptop-1 to PC/Laptop-2 and see whether it is reachable as well as there are no packet drop 6. Carry out file transfer from PC/Laptop-1 to PC/Laptop-2 7. In case of Nx64, repeat the test at different speeds. 8. Carry out Telnet check also.
Expected Results	Enclose the Results/screenshots

Test No.	4
Test Details	PRI/BRI / 2G/3G wave functional test
Test Instruments Required	1. PSTN / 2G/3G connectivity
Test Setup	
Test Procedure	1. Connect EUT A and EUT B through PSTN in case of PRI/BRI. 2. Connect EUT A and EUT B through Mobile Network in case of 2G/3G. In such case EUT shall be equipped with 2G/3G interface cards along with SIM 3. Test for Ping and File Transfer from EUT A to EUT B
Expected Results	Enclose the Ping Results

Test No.	5	
Test Details	Test for Output Jitter	
Test Instruments Required	1. PDH/SDH Performance Analyser or Jitter Tester	
Test Setup	PDH/SDH Interface in loopback mode Rx  	
Test Limits	Limits for Output Jitter [Maximum Permissible Jitter at Output Interfaces] for PDH interfaces (64Kbps, 2, 34, 45, 140Mbps)	Refer Table 1/G.823
	Limits for Output Jitter [Maximum Permissible Jitter at Output Interfaces] for SDH interfaces (STM-1, STM-4, STM-16, STM-64)	Refer Table 1/G.825

Standards Reference	**Table 1/G.823**

Table 1/G.823 – Maximum permissible jitter at traffic interfaces

Interface	Measurement bandwidth, –3 dB frequencies (Hz)	Peak-to-peak amplitude (UIpp) (Note 3)
64 kbit/s	20 to 20 k	0.25
(Note 1)	3 k to 20 k	0.05
2048 kbit/s	20 to 100 k	1.5
	18 k to 100 k (Note 2)	0.2
8448 kbit/s	20 to 400 k	1.5
	3 k to 400 k (Note 2)	0.2
34 368 kbit/s	100 to 800 k	1.5
	10 k to 800 k	0.15
139 264 kbit/s	200 to 3.5 M	1.5
	10 k to 3.5 M	0.075

NOTE 1 – For the codirectional interface only.

NOTE 2 – For 2048 kbit/s and 8448 kbit/s interfaces within the network of an operator, the high-pass cut-off frequency may be specified to be 700 Hz (instead of 18 kHz) and 80 kHz (instead of 3 kHz) respectively. However, at interfaces between different operator networks, the values in the table apply, unless involved parties agree otherwise.

NOTE 3 –

64 kbit/s 1 UI = 15.6 µs
2048 kbit/s 1 UI = 488 ns
8448 kbit/s 1 UI = 118 ns
34 368 kbit/s 1 UI = 29.1 ns
139 264 kbit/s 1 UI = 7.18 ns

	Table 1/G.825

Table 1/G.825 – Maximum permissible jitter at network interfaces

Interface	Measurement bandwidth, –3 dB frequencies (Hz)	Peak-to-peak amplitude (UIpp)
STM-1e (Notes 1, 2)	500 to 1.3 M	1.5
	65 k to 1.3 M	0.075
STM-1 (Note 4)	500 to 1.3 M	1.5
	65 k to 1.3 M	0.15
STM-4 (Note 4)	1 k to 5 M	1.5
	250 k to 5 M	0.15
STM-16 (Note 4)	5 k to 20 M	1.5
	1 M to 20 M	0.15

Table 1/G.825 – Maximum permissible jitter at network interfaces (*concluded*)

Interface	Measurement bandwidth, –3 dB frequencies (Hz)	Peak-to-peak amplitude (UIpp)
STM-64 (Note 4)	20 k to 80 M	1.5
	4 M to 80 M	0.15 (Note 3)

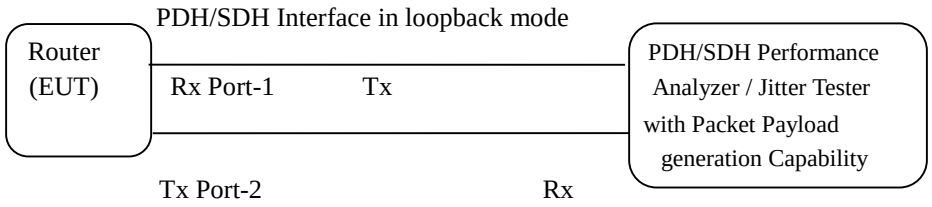
NOTE 1 – Electrical format CMI-encoded, according to G.703.

NOTE 2 – For networks deployed with G.813 Option II clocks or G.812 Type II, III or IV clocks, STM-1 requirements apply to STM-1e.

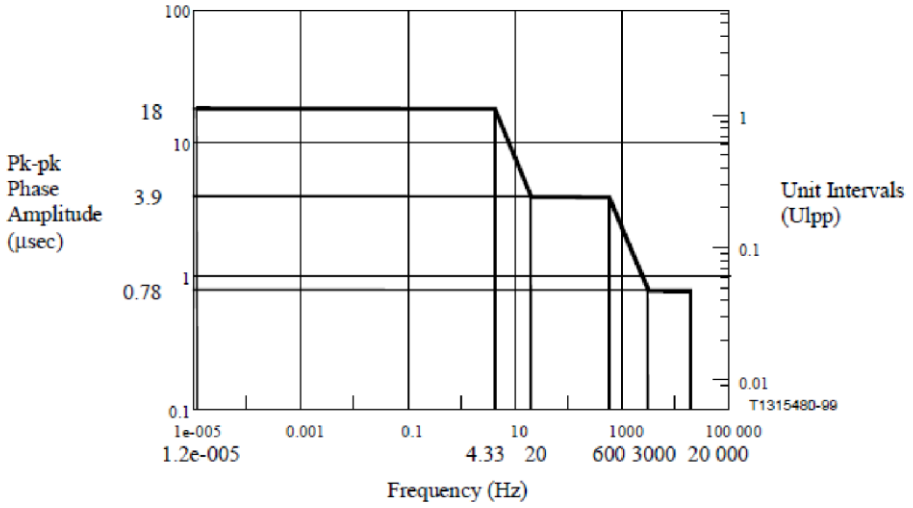
NOTE 3 – The effect of dispersion and non-linearities on the eye opening and on the choice of this value is for further study.

NOTE 4 – STM-1 1 UI = 6.43 ns
STM-4 1 UI = 1.61 ns
STM-16 1 UI = 0.402 ns
STM-64 1 UI = 0.100 ns

Test Procedure	1. Connect the setup as shown in the figure. 2. Measure the output jitter on the connected PDH/SDH interface 3. Verify whether the output jitter is within the tolerance limits as specified in the relevant ITU specifications as indicated above. 4. Enclose the test results
Expected Results	Enclose the Test Results

Test No.	6
Test Details	Test for Input Jitter Tolerance
Test Instruments Required	1. PDH/SDH Performance analyser with POS capability for SDH and Packet Payload Capability for PDH
Test Setup	
Test Limits	

64 Kbps co-directional interface input jitter and wander tolerance limit	Refer Figure 12/G.823
2048 Kbps input jitter and wander tolerance limit	Refer Figure 13/G.823
34.368 Mbps input jitter and wander tolerance limit	Refer Figure 15/G.823
44.736 Mbps input jitter and wander tolerance limit	Refer Figure 9/G.824
STM-1e Jitter Tolerance Requirement for 2048Kbps Networks	Refer Figure 2/G.825
STM-4 Jitter Tolerance Requirement	Refer Figure 3/G.825
STM-16 Jitter Tolerance Requirement	Refer Figure 4/G.825
STM-64 Jitter Tolerance Requirement	Refer Figure 5/G.825

Standards reference	**Figure 12/G.823**
	
	Figure 12/G.823 – 64 kbit/s input jitter and wander tolerance limit
	Figure 13/G.823

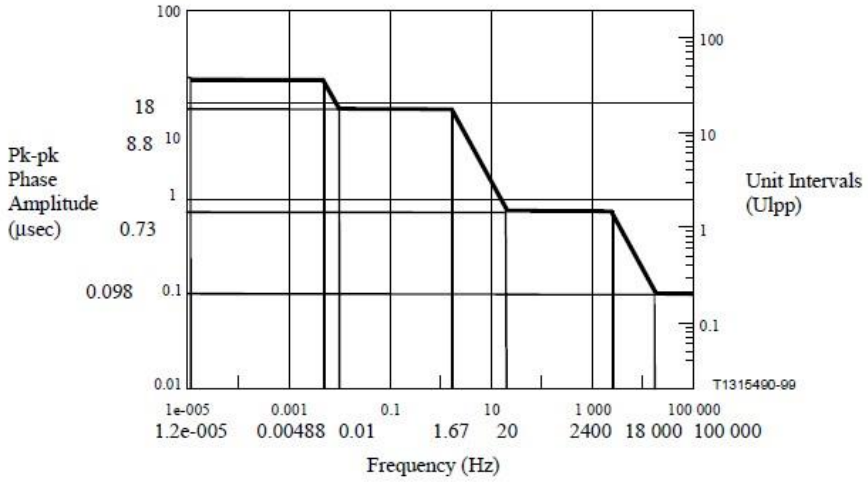


Figure 13/G.823 – 2048 kbit/s input jitter and wander tolerance limit

Figure 15/G.823

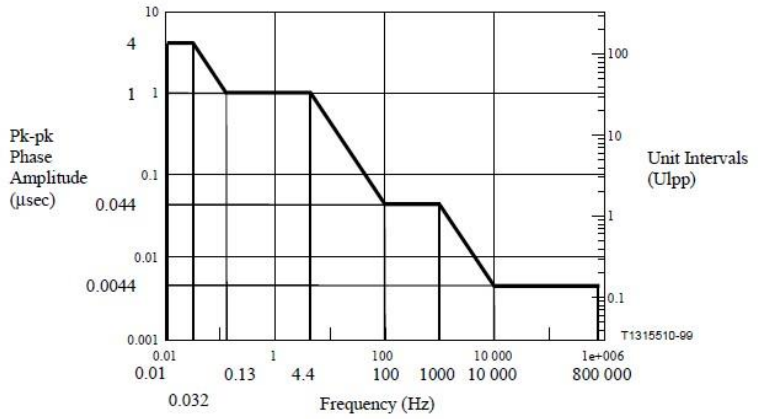


Figure 15/G.823 – 34 368 kbit/s input jitter and wander tolerance limit

Figure 9/G.824

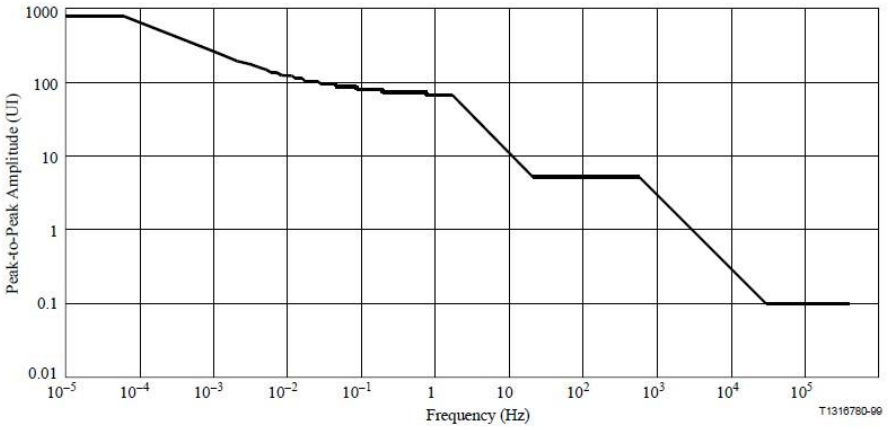


Figure 9/G.824 – Jitter and wander tolerance of 44 736 kbit/s input ports

Figure 2/G.825

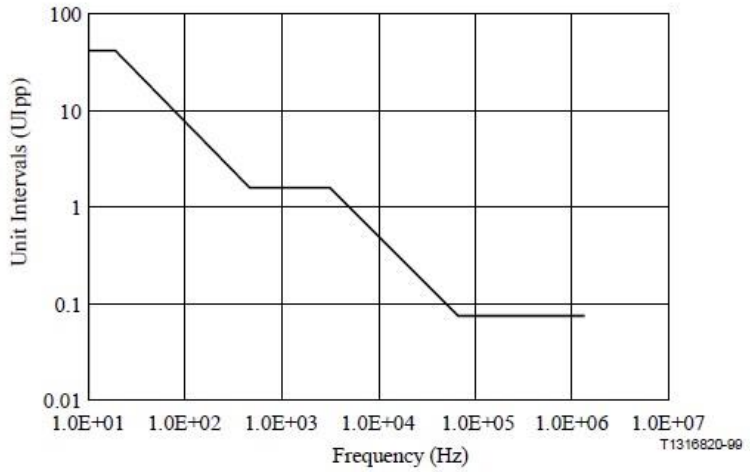
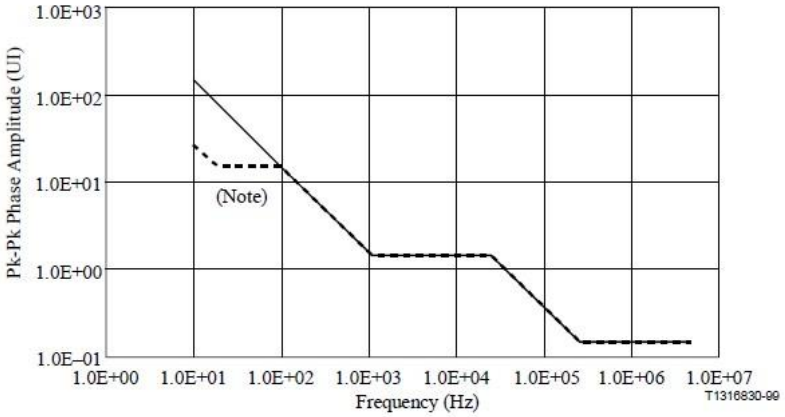


Figure 2/G.825 – STM-1e jitter tolerance requirement (applies to 2048 kbit/s networks only)

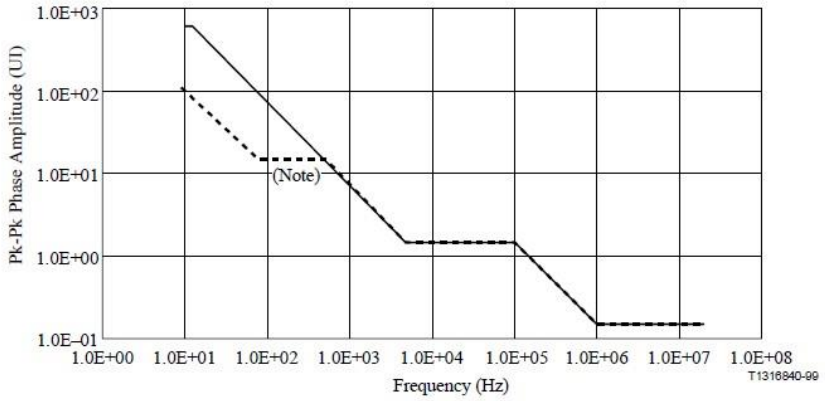
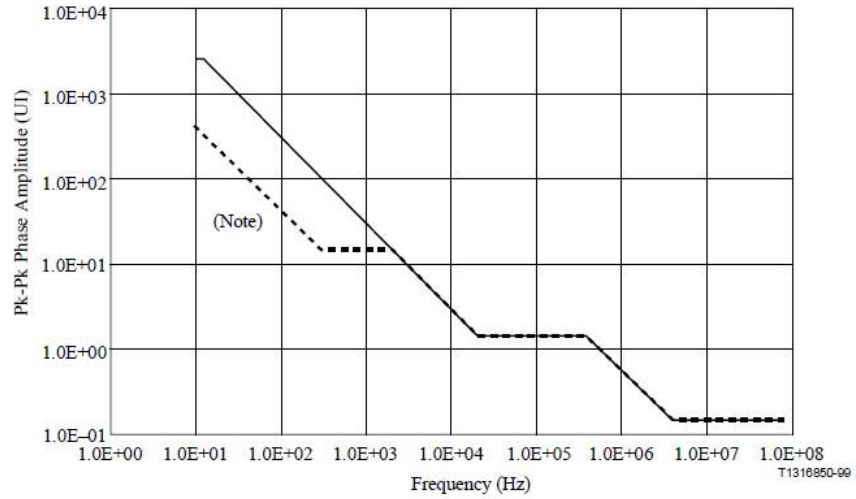
Figure 3/G.825

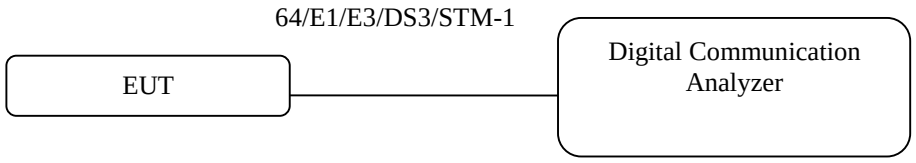


NOTE – The dashed curve is the requirement for 1544 kbit/s networks for frequencies less than 100 Hz.

Figure 3/G.825 – STM-4 jitter tolerance

Figure 4/G.825

	 NOTE – The dashed curve is the requirement for 1544 kbit/s networks for frequencies less than 500 Hz. **Figure 4/G.825 – STM-16 jitter tolerance**
	Figure 5/G.825
	 NOTE – The dashed curve is the requirement for 1544 kbit/s networks for frequencies less than 2 kHz. **Figure 5/G.825 – STM-64 jitter tolerance**
Test Procedure	1. Connect the setup as shown in the figure. 2. Configure the Router with Port-1 as IP-1 and Port-2 as IP-2 3. Configure the POS in the SDH analyser with Source Address as IP-1 and destination address as IP-2 4. Configure Router-A for Static routing the packets 5. SDH Analyser shall introduce Jitter over the generated packets with PRBS pattern as per G.825 6. Measure the Jitter tolerance as per the Mask and Range of frequencies 7. Take a plot of the Jitter tolerance along with the Mask
Expected Results	Enclose the Test Results

Test No.	7
Test Details	Test for Output Pulse Mask for PDH/SDH interfaces
Test Instruments Required	1. Digital Communication Analyser OR Digital Storage Oscilloscope
Test Setup	

Test Limits

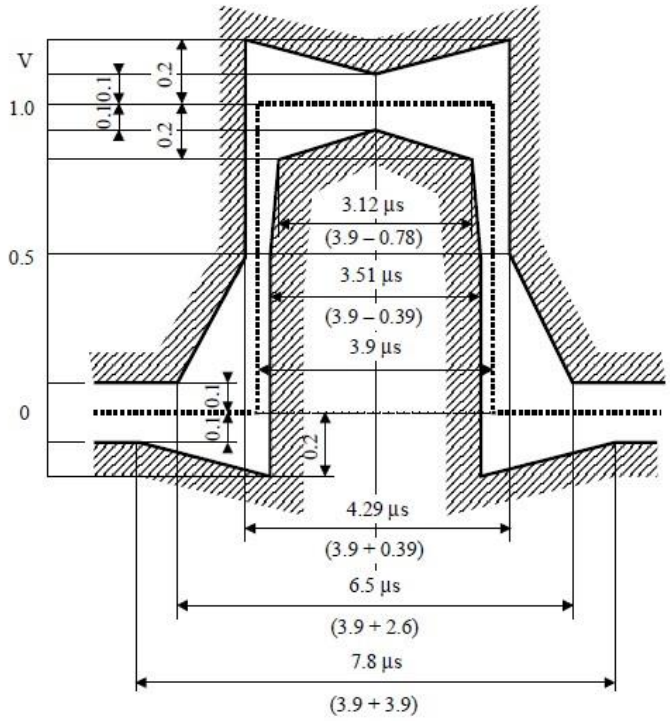
Limits for Pulse shape & characteristics for 64Kbps co-directional interface	Refer Table-1 and Figure-5 G.703
Limits for Pulse shape & characteristics for 2048kbps (E1) interface	Refer Table-7 and Figure-15 G.703
Limits for Pulse shape & characteristics for 34Mbps interface	Refer Table-9 and Figure-17 G.703
Limits for Pulse shape & characteristics for 44.736Mbps (DS3) Interface	Refer Table-6 and Figure-14 G.703
STM-1	Refer Table-12 and Figure-22,23 G.703

Standards reference

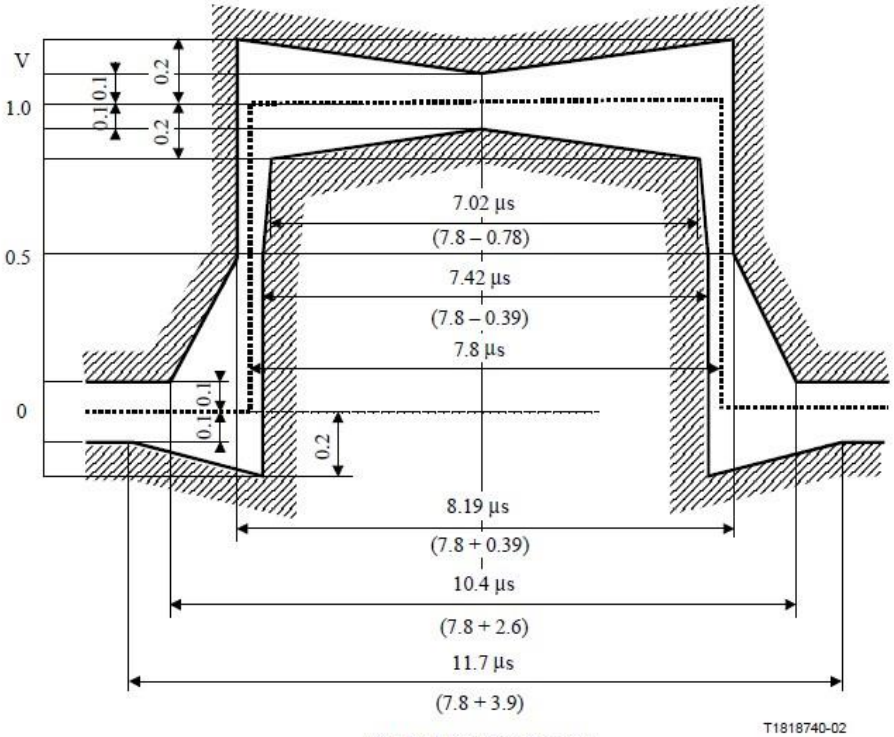
Table-1 and Figure-5 G.703

Table 1/G.703 – Digital 64 kbit/s codirectional interface

Symbol rate	256 kBauds
Pulse shape (nominally rectangular)	All pulses of a valid signal must conform to the masks in Figure 5, irrespective of the polarity
Pair for each direction	One symmetric pair
Test load impedance	120 ohms resistive
Nominal peak voltage of a "mark" (pulse)	1.0 V
Peak voltage of a "space" (no pulse)	0 V ± 0.10 V
Nominal pulse width	3.9 µs
Ratio of the amplitudes of positive and negative pulses at the centre of the pulses interval	0.95 to 1.05
Ratio of the widths of positive and negative pulses at the nominal half amplitude	0.95 to 1.05
Maximum peak-to-peak jitter at the output port (Note)	Refer to 5.1/G.823
NOTE – For the time being these values are valid only for equipments of the 2 Mbit/s hierarchy.	



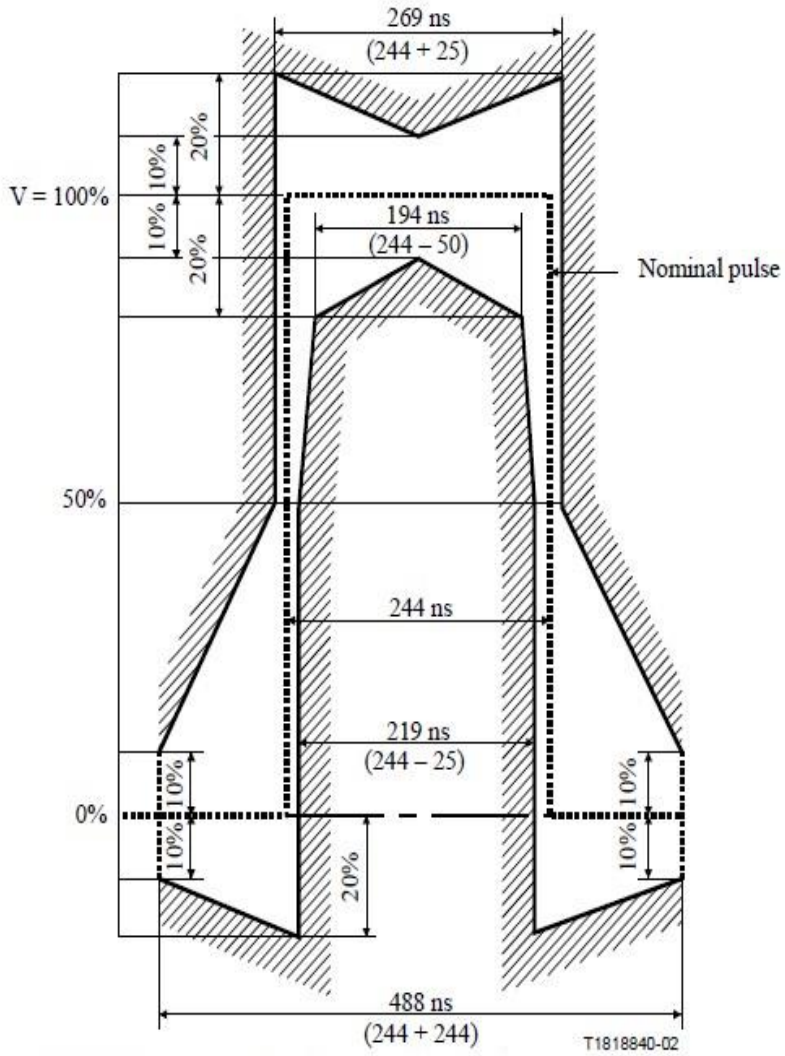
a) Mask for single pulse



b) Mask for double pulse

NOTE – The limits apply to pulses of either polarity.

	Table-7 and Figure-15 G.703



NOTE – V corresponds to the nominal peak value.

Figure 15/G.703 – Mask of the pulse at the 2048 kbit/s interface

Table 7/G.703 – Digital interface at 2048 kbit/s

Pulse shape (nominally rectangular)	All marks of a valid signal must conform with the mask (see Figure 15) irrespective of the sign. The value V corresponds to the nominal peak value.	
Pair(s) in each direction	One coaxial pair (see 9.4)	One symmetrical pair (see 9.4)
Test load impedance	75 ohms resistive	120 ohms resistive
Nominal peak voltage of a mark (pulse)	2.37 V	3 V
Peak voltage of a space (no pulse)	0 ± 0.237 V	0 ± 0.3 V
Nominal pulse width	244 ns	
Ratio of the amplitudes of positive and negative pulses at the centre of the pulse interval	0.95 to 1.05	
Ratio of the widths of positive and negative pulses at the nominal half amplitude	0.95 to 1.05	
Maximum peak-to-peak jitter at an output port	Refer to 5.1/G.823	

Table-9 and Figure-17 G.703

Table 9/G.703 – Digital interface at 34 368 kbit/s

Pulse shape (nominally rectangular)	All marks of a valid signal must conform with the mask (see Figure 17), irrespective of the sign.
Pair(s) in each direction	One coaxial pair (see 11.4)
Test load impedance	75 ohms resistive
Nominal peak voltage of a mark (pulse)	1.0 V
Peak voltage of a space (no pulse)	0 V ± 0.1 V
Nominal pulse width	14.55 ns
Ratio of the amplitudes of positive and negative pulses at the center of a pulse interval	0.95 to 1.05
Ratio of the widths of positive and negative pulses at the nominal half amplitude	0.95 to 1.05
Maximum peak-to-peak jitter at an output port	Refer to 5.1/G.823

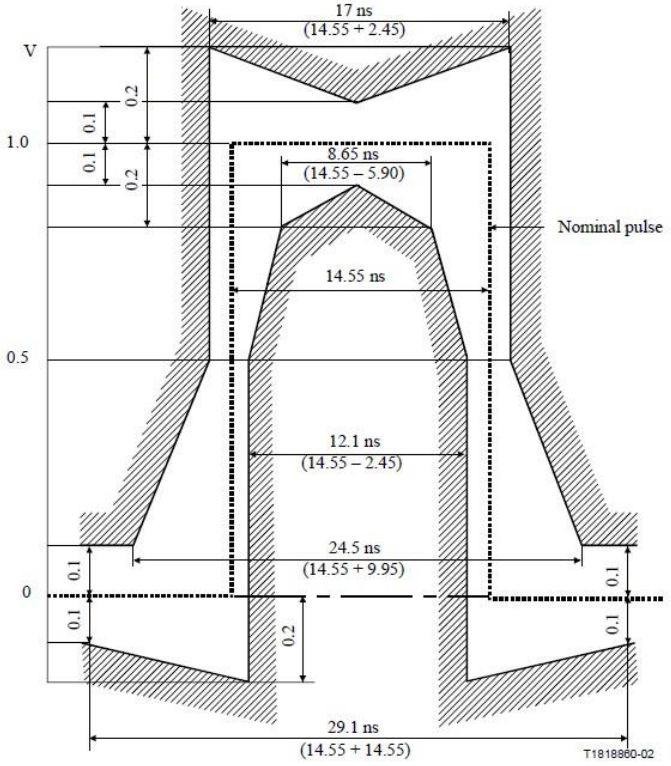


Figure 17/G.703 – Pulse mask at the 34 368 kbit/s interface

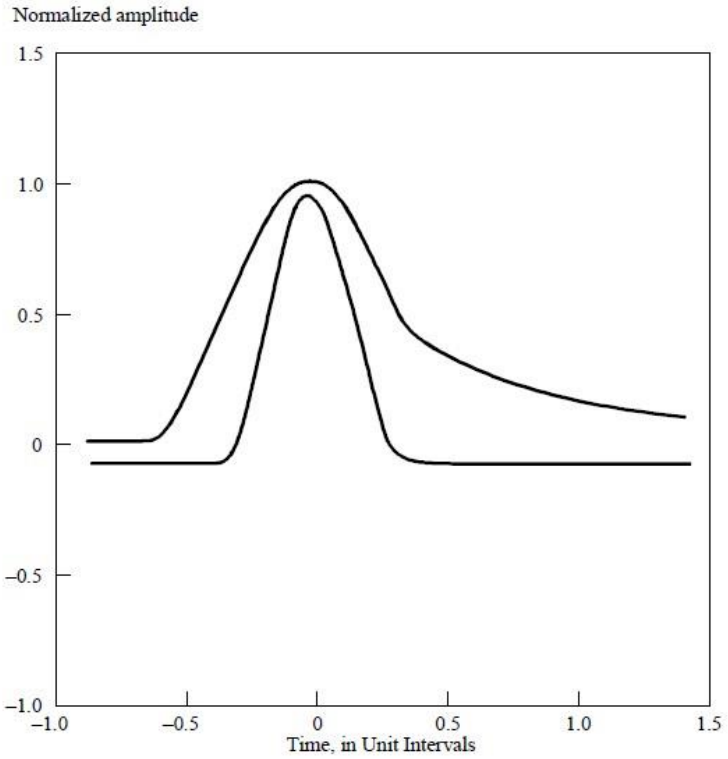
S

Table-6 and Figure-14 G.703

Table 6/G.703 – Digital interface at 44 736 kbit/s

Parameter	Specification
Nominal bit rate	44 736 kbit/s
Bit rate accuracy	In a self-timed, free-running mode, the bit rate accuracy shall be ±895 bits/s (±20 ppm) or better.
Line code	B3ZS (bipolar with three-zero substitutions)
Frame structure	The signal shall have the frame structure defined in ITU-T Rec. G.752 to ensure transmission through all types of 44 736 kbit/s transport equipment. The frame structure is not required for multiplexing to higher level DSN signals.
Medium	One unbalanced coaxial line shall be used for each direction of transmission.
Test load impedance	A resistive test load of 75 ohms ± 5% shall be used at the interface for the evaluation of pulse shape and the electrical parameters specified below.
Pulse amplitude	The amplitude (Note 1) of an isolated pulse shall be between 0.36 V and 0.85 V peak.
Pulse shape	The shape of every pulse that approximates an isolated pulse (is preceded by two zeros and followed by one or more zeros) shall conform to the mask in Figure 14. See 5.2 for allowable procedures to be followed in checking conformance. This mask includes an allowance of ±3% of the peak pulse amplitude at any point on the mask relative to the pulse mask in the earlier version. Equations defining the various line segments making up the mask are listed below the figure.
Power level	A wideband power measurement of an AIS signal (as defined in ITU-T Rec. G.704) using a power level sensor with a working frequency range of 200 MHz shall be between –4.7 dBm and +3.6 dBm, including the effects of a range of connecting cable lengths between 68.6 meters (225 feet) and 137.2 meters (450 feet). A low-pass filter having a flat passband and cutoff frequency of 200 MHz shall be used. The rolloff characteristics of this filter are not important; or an alternate power level specification of the power of an all-ones signal (Note 2) is useful for some equipment qualifications. It requires that the power in a 3 kHz ± 1 kHz band centered at 22 368 kHz be between –1.8 dBm and +5.7 dBm. It further requires that the power in a 3 kHz ± 1 kHz band centered at 44 736 kHz be at least 20 dB below that at 22 368 kHz.
Pulse imbalance	1) The ratio of amplitudes of positive and negative isolated pulses shall be between 0.90 and 1.10. 2) Positive and negative isolated pulses shall both conform to the mask of Figure 14.
DC power	There shall be no DC power applied at the interface.
Verification access	Access to the signal at the interface shall be provided for verification of these signal specifications.

Parameter	Specification
NOTE 1 – While both voltage and power requirements are given to assist in qualification of signals at the interface, the values are not equivalent. Voltage specifications are given for isolated pulses, while power levels are specified for an AIS signal, or alternatively an all-ones signal. NOTE 2 – The all-ones signal is not realizable within the frame structure specified in Recommendation G.752, and is not encountered in North American telecommunication networks.	



Time axis range (Unit Intervals)	Normalized amplitude equation
Upper curve	
$-0.85 \le T \le -0.68$	0.03
$-0.68 \le T \le 0.36$	$0.5\left\{1+\sin\left[\frac{\pi}{2}\left(1+\frac{T}{0.34}\right)\right]\right\}+0.03$
$0.36 \le T \le 1.4$	$0.08+0.407e^{-1.84(T-0.36)}$
Lower curve	
$-0.85 \le T \le -0.36$	–0.03
$-0.36 \le T \le 0.36$	$0.5\left\{1+\sin\left[\frac{\pi}{2}\left(1+\frac{T}{0.18}\right)\right]\right\}-0.03$
$0.36 \le T \le 1.4$	–0.03

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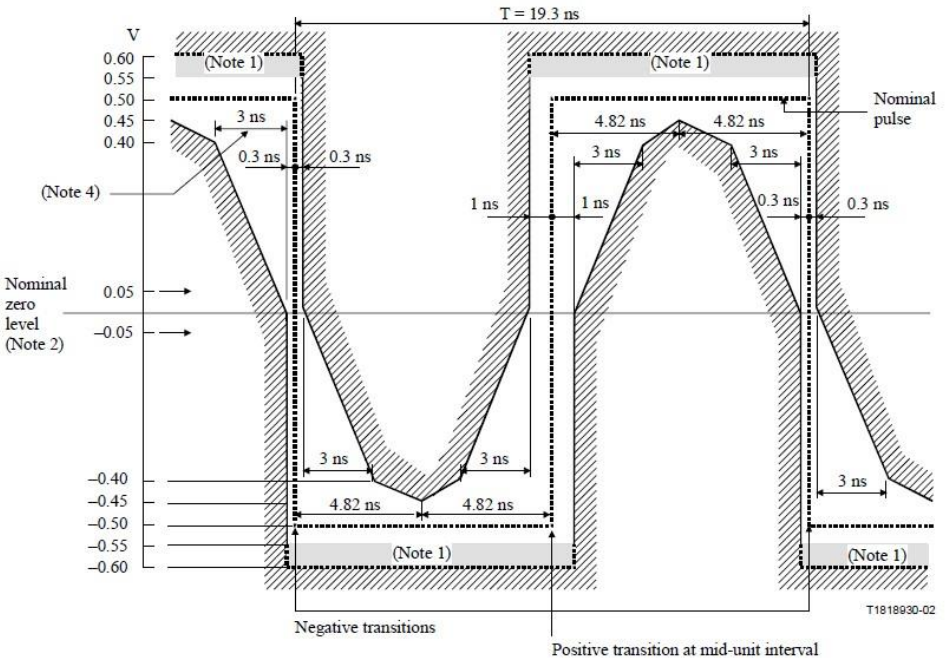
Figure 14/G.703 – 44 736 kbit/s interface isolated pulse mask and equations

Table-12 and Figure-22,23 G.703

Table 12/G.703 – Digital interface at 155 520 kbit/s

Pulse shape	Nominally rectangular and conforming to the masks shown in Figures 22 and 23
Pair(s) in each direction	One coaxial pair
Test load impedance	75 ohms resistive
Peak-to-peak voltage	1 ± 0.1 V
Rise time between 10% and 90% amplitudes of the measured steady state amplitude	≤2 ns
Transition timing tolerance referred to the mean value of the 50% amplitude points of negative transitions	Negative transitions: ±0.1 ns Positive transitions at unit interval boundaries: ±0.5 ns Positive transitions at mid-unit intervals: ±0.35 ns
Return loss	≥15 dB over frequency range 8 MHz to 240 MHz
Maximum peak-to-peak jitter at an output port	Refer to 5.1/G.825



NOTE 1 – The maximum "steady state" amplitude should not exceed the 0.55 Vlimit. Overshoots and other transients are permitted to fall into the dotted area, bounded by the amplitude levels 0.55 V and 0.6 V, provided that they do not exceed the steady state level by more than 0.05 V. The possibility of relaxing the amount by which the overshoot may exceed the steady state level is under study.

NOTE 2 – For all measurements using these masks, the signal should be AC coupled, using a capacitor of not less than 0.01 µF, to the input of the oscilloscope used for measurements.

The nominal zero level for both masks should be aligned with the oscilloscope trace with no input signal. With the signal then applied, the vertical position of the trace can be adjusted with the objective of meeting the limits of the masks. Any such adjustment should be the same for both masks and should not exceed ±0.05 V. This may be checked by removing the input signal again and verifying that the trace lies within ±0.05 V of the nominal zero level of the masks.

NOTE 3 – Each pulse in a coded pulse sequence should meet the limits of the relevant mask, irrespective of the state of the preceding or succeeding pulses, with both pulse masks fixed in the same relation to a common timing reference, i.e. with their nominal start and finish edges coincident.

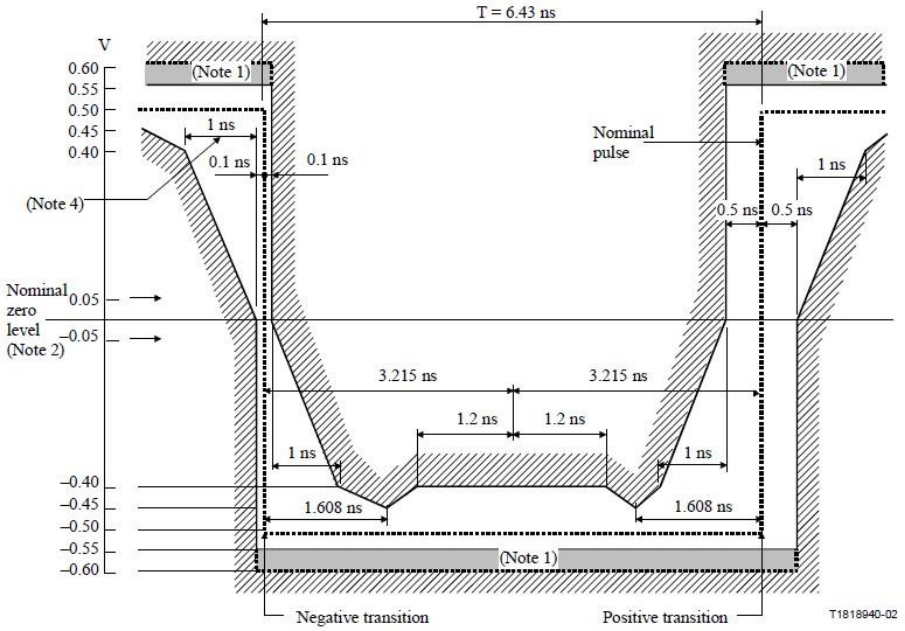
The masks allow for HF jitter caused by intersymbol interference in the output stage, but not for jitter present in the timing signal associated with the source of the interface signal.

When using an oscilloscope technique to determine pulse compliance with the mask, it is important that successive traces of the pulses overlay in order to suppress the effects of low frequency jitter. This can be accomplished by several techniques [e.g. a) triggering the oscilloscope on the measured waveform or b) providing both the oscilloscope and the pulse output circuits with the same clock signal].

These techniques require further study.

NOTE 4 – For the purpose of these masks, the rise time and decay time should be measured between –0.4 V and 0.4 V, and should not exceed 2 ns.

Figure 22/G.703 – Mask of a pulse corresponding to a binary 0 (at the 155 520 kbit/s interface)



NOTE 1 – The maximum "steady state" amplitude should not exceed the 0.55 V limit. Overshoots and other transients are permitted to fall into the dotted area, bounded by the amplitude levels 0.55 V and 0.6 V, provided that they do not exceed the steady state level by more than 0.05 V. The possibility of relaxing the amount by which the overshoot may exceed the steady state level is under study.

NOTE 2 – For all measurements using these masks, the signal should be AC coupled, using a capacitor of not less than 0.01 µF, to the input of the oscilloscope used for measurements.

The nominal zero level for both masks should be aligned with the oscilloscope trace with no input signal. With the signal then applied, the vertical position of the trace can be adjusted with the objective of meeting the limits of the masks. Any such adjustment should be the same for both masks and should not exceed ±0.05 V. This may be checked by removing the input signal again and verifying that the trace lies within ±0.05 V of the nominal zero level of the masks.

NOTE 3 – Each pulse in a coded sequence should meet the limits of the relevant mask, irrespective of the state of the preceding or succeeding pulses, with both pulse masks fixed in the same relation to a common timing reference, i.e. with their nominal start and finish edges coincident.

The masks allow for HF jitter caused by intersymbol interference in the output stage, but not for jitter present in the timing signal associated with the source of the interface signal.

When using an oscilloscope technique to determine pulse compliance with the mask, it is important that successive traces of thepulses overlay in order to suppress the effects of low frequency jitter. This can be accomplished by several techniques [e.g. a) triggering the oscilloscope on the measured waveform or b) providing both the oscilloscope and the pulse output circuits with the same clock signal].

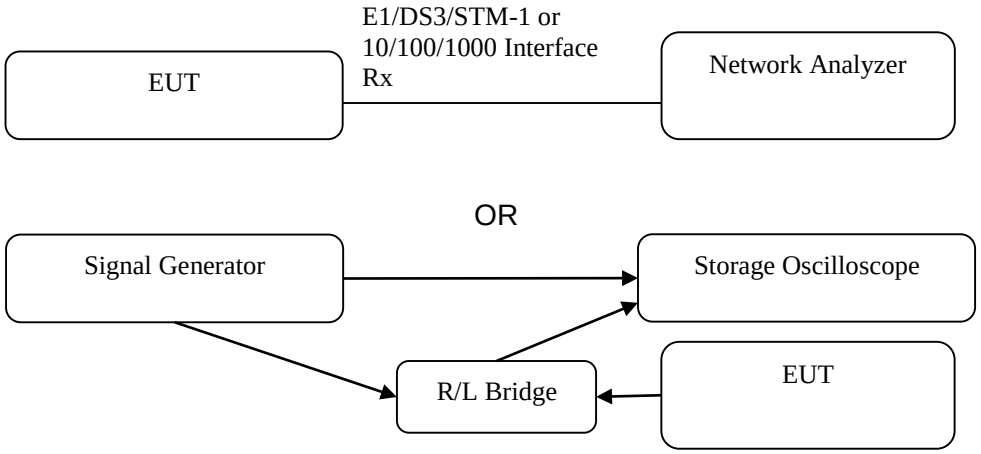
These techniques require further study.

NOTE 4 – For the purpose of these masks, the rise time and decay time should be measured between –0.4 V and 0.4 V, and should not exceed 2 ns.

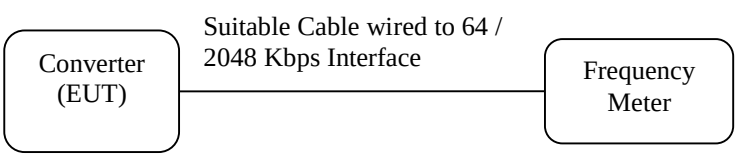
NOTE 5 – The inverse pulse will have the same characteristics, noting that the timing tolerance at the level of the negative and positive transitions are ±0.1 ns and ±0.5 ns respectively.

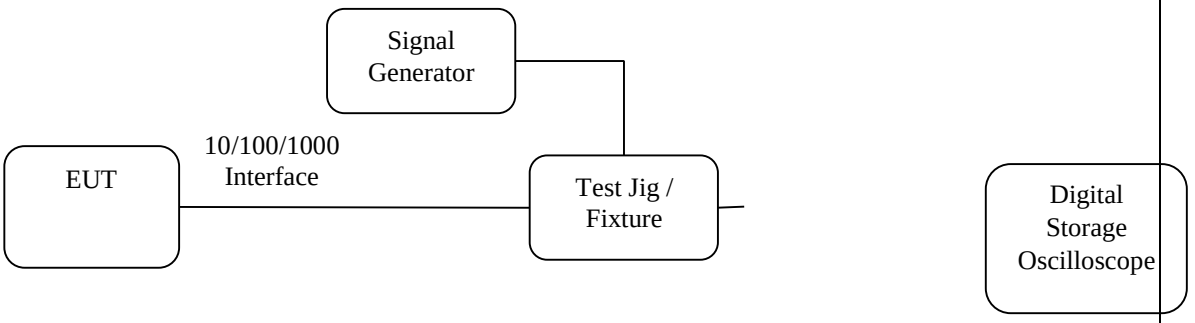
Figure 23/G.703 – Mask of a pulse corresponding to a binary 1 (at the 155 520 kbit/s interface)

Test Procedure	1. Connect the EUT as shown in the figure. 2. Enable the Port if required. 3. See whether the output pulse is within the mask/limits as indicated above.
Expected Results	Enclose the Test Results with the Pulse shape & the Pulse Mask

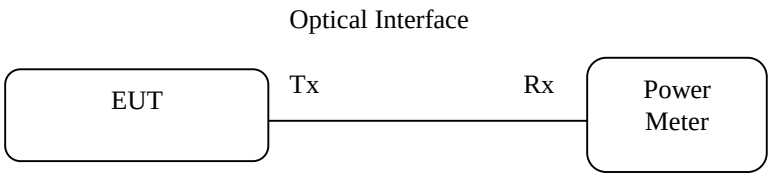
<table>
<tr><td>Test No.</td><td>8</td></tr>
<tr><td>Test Details</td><td>Test for Return Loss (This test is applicable to 64Kbps / 2048Kbps / 34Mbps/45Mbps/STM-1 interfaces)</td></tr>
<tr><td>Test Instruments Required</td><td>1. Network Analyser for PDH/SDH Interfaces
2. Vector Network Analyser with Balun to convert to differential voltage OR Signal Generator, Storage Oscilloscope & Return Loss Bridge</td></tr>
<tr><td>Test Setup</td><td> 
</td></tr>
<tr><td>Test Limits</td><td>
<table>
<tr><td>Minimum Return loss limits at input port for 64Kbps co-directional interface</td><td>Refer clause 4.2.1.3 of G.703</td></tr>
<tr><td>Minimum Return loss limits at output port for 64Kbps co-directional interface</td><td>Refer clause 4.2.1.2 of G.703</td></tr>
<tr><td>Minimum Return loss limits at input port for 2048 kbps (E1) interface</td><td>Refer clause 9.3 of G.703</td></tr>
<tr><td>Minimum Return loss limits at output port for 2048 kbps (E1) interface</td><td>Refer clause 9.2 of G.703</td></tr>
<tr><td>Minimum Return loss limits at input port for 34Mbps interface</td><td>Refer clause 11.3 of G.703</td></tr>
<tr><td>Minimum Return loss limits at output port for 34Mbps interface</td><td>Refer clause 11.2 of G.703</td></tr>
<tr><td>Minimum Return loss limits at input port for STM-1 interface</td><td>≥15 dB over frequency range 8 MHz to 240 MHz</td></tr>
<tr><td>Minimum Return loss limits at output port for STM-1 interface</td><td>≥15 dB over frequency range 8 MHz to 240 MHz</td></tr>
</table>
</td></tr>
<tr><td>Standards Reference</td><td>clause 4.2.1.3 of G.703
<table>
<tr><th>Frequency range (kHz)</th><th>Return loss (dB)</th></tr>
<tr><td>4 to 13
13 to 256
256 to 384</td><td>12
18
14</td></tr>
</table>
clause 4.2.1.2 of G.703</td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><th>Frequency range (kHz)</th><th>Return loss (dB)</th></tr>
<tr><td>6.4 to 13
13 to 384</td><td>6
8</td></tr>
</table>
clause 9.3 of G.703
<table>
<tr><th>Frequency range (kHz)</th><th>Return loss (dB)</th></tr>
<tr><td>51 to 102
102 to 2048
2048 to 3072</td><td>12
18
14</td></tr>
</table>
clause 9.2 of G.703
<table>
<tr><th>Frequency range (kHz)</th><th>Return loss (dB)</th></tr>
<tr><td>51 to 102
102 to 3072</td><td>6
8</td></tr>
</table>
clause 11.3 of G.703
<table>
<tr><th>Frequency range (kHz)</th><th>Return loss (dB)</th></tr>
<tr><td>860 to 1720
1720 to 34 368
34 368 to 51 550</td><td>12
18
14</td></tr>
</table>
clause 11.2 of G.703
<table>
<tr><th>Frequency range (kHz)</th><th>Return loss (dB)</th></tr>
<tr><td>860 to 1720
1720 to 51 550</td><td>6
8</td></tr>
</table>
</td></tr>
<tr><td>Test Procedure</td><td>1. Connect the Setup as shown in the figure.
2. Measure the input port return loss using the Network Analyser
3. Check whether the Return Loss is within the specified limits</td></tr>
<tr><td>Expected Results</td><td>Enclose the Test Results</td></tr>
</table>

<table>
<tr><td>Test No.</td><td colspan="2">9</td></tr>
<tr><td>Test Details</td><td colspan="2">Test for Output Frequency</td></tr>
<tr><td>Test Instruments Required</td><td colspan="2">1. Frequency Meter</td></tr>
<tr><td>Test Setup</td><td colspan="2"> 
</td></tr>
<tr><td>Test Limits</td><td>64Kbps</td><td>±100 ppm</td></tr>
<tr><td></td><td>2048Kbps</td><td>±50 ppm</td></tr>
<tr><td>Test Procedure</td><td colspan="2">1. Connect the test setup as shown in figure using a suitable cable wired to the 64/2048Kbps interface
2. Measure the Output Frequency using the Frequency Meter</td></tr>
<tr><td>Expected Results</td><td colspan="2">Enclose the Test Results</td></tr>
</table>

<table>
<tr><td>Test No.</td><td>10</td></tr>
<tr><td>Test Details</td><td>Test for Ethernet Interface
1. Differential output voltage
2. AC Differential input impedance
3. Output Jitter</td></tr>
<tr><td>Test Instruments Required</td><td>1. Digital Storage Oscilloscope
2. Ethernet parameters measurement test Jig/Fixture
3. Signal generator</td></tr>
<tr><td>Test Setup</td><td> 
</td></tr>
<tr><td>Test Limits</td><td>
<table>
<tr><td>Differential output voltage, loaded 10Base-T</td><td>Refer 14.3.1.2.1of IEEE802.3 Section1 Differential output voltage</td></tr>
<tr><td>Differential output voltage, 100Base-T</td><td>Refer 23.5.1.2.1 of IEEE802.3 Section2 Peak differential output voltage</td></tr>
<tr><td>Differential output voltage, loaded 1000Base-T</td><td>Refer 40.6.1.2.1 of IEEE802.3 Section3 Peak differential output voltage</td></tr>
<tr><td>Differential input impedance - 10BaseT</td><td>Refer 14.3.1.3.4 of IEEE802.3 Section-
1AC differential input impedance</td></tr>
<tr><td>Receiver differential input impedance - 100Base-T</td><td>Refer 23.5.1.3.3 of IEEE802.3 Section-
2 Receiver differential input impedance</td></tr>
<tr><td>10Base-T Output timing Jitter</td><td>Refer 14.3.1.2.3of IEEE802.3 Section 3 Output timing jitter</td></tr>
<tr><td>100base-T Output timing Jitter</td><td>Refer 23.5.1.2.5 of IEEE802.3 Section 3 Output timing jitter</td></tr>
<tr><td>1000Base-T Transmitter output Jitter</td><td>Refer 40.6.1.2.6 of IEEE802.3 Section 3 Transmitter Timing Jitter</td></tr>
</table>
</td></tr>
<tr><td>Test Procedure</td><td>1. Connect the test setup as shown in figure to the 10/100/1000Base-T interface
2. The test Jig / Fixture is an electronics hardware attached to the oscilloscope / Network analyser for the measurement of Ethernet parameters
3. Measure the Ethernet parameters</td></tr>
<tr><td>Expected Results</td><td>Enclose the Test Results</td></tr>
</table>

Note:	1. Tests can be conducted under one of the following options a. Test facility in TEC if available. b. Any Test Location in India including the premises of the trader/manufacturer of the product approved by RTEC where the Test facility is available for testing by RTEC.
	2. In case it is not possible to carry out the tests as above, the test results from any one of the following options can be accepted. RTEC shall verify whether the test results are within the prescribed limits. a. Results from any Indian/Foreign lab accredited as per ISO 17025 and having Ethernet Physical interface testing included in the scope of accreditation b. In house test results of the Equipment Under Test (EUT) in case of Foreign OEM c. In house test results of the Ethernet chipsets used in the EUT, from the OEM of the Ethernet chipset. The physical availability of the Ethernet Chipset in the EUT shall be verified by the RTEC. The following remark shall be indicated in the TAC. "The chipset number/code of the Ethernet chipset used in the equipment offered for testing: ……..."

<table>
<tr><td>Test No.</td><td>11</td></tr>
<tr><td>Test Details</td><td>Test for output Power [Mean Launch Power]</td></tr>
<tr><td>Test Instruments Required</td><td>1. Optical Power Meter</td></tr>
<tr><td>Test Setup</td><td> 
</td></tr>
<tr><td>Test Limits</td><td>
<table>
<tr><td>STM-1 Short Haul / Long Haul</td><td>Refer Table-2/G.957</td></tr>
<tr><td>STM-4 Short Haul / Long Haul</td><td>Refer Table-3/G.957</td></tr>
<tr><td>STM-16 Short Haul / Long Haul</td><td>Refer Table-4/G.957</td></tr>
<tr><td>FE Short Haul/Long Haul (100BASE-FX/SX/LX)</td><td>Refer IEEE 802.3u</td></tr>
<tr><td>GE Short Haul (1000BASE-SX)</td><td>Refer clause 38.3.1 Transmitter optical specifications of IEEE 802.3 2008 Section-3</td></tr>
<tr><td>GE Long Haul (1000BASE-LX)</td><td>Refer clause 38.4.1 Transmitter optical specifications of IEEE 802.3 2008 Section-3</td></tr>
<tr><td>10 GE Short Haul/Long Haul (10G-SR/LR/ER)</td><td>Refer table 52-7 for SR, 52-12 for LR and 52-16 for ER of IEEE 802.3ae specifications</td></tr>
<tr><td>40 GE (SR4/LR4)</td><td>Refer Table 86-6 for SR4 and 87-7 for LR4 of IEEE 802.3ba specifications</td></tr>
<tr><td>100 GE (SR10/LR4/ER4)</td><td>Refer Table 86-6 for SR10, 88-7 for LR4/ER4 of IEEE 802.3ba specifications</td></tr>
<tr><td>25 GE (SR/LR/ER)</td><td>Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures</td></tr>
<tr><td>50 GE (SR/LR/ER/FR)</td><td>Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures</td></tr>
<tr><td>200 GE (SR4/LR4/DR4/FR4)</td><td>Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures</td></tr>
<tr><td>400 GE (SR8/LR8/DR4/FR8)</td><td>Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures</td></tr>
</table>
</td></tr>
</table>

Standards	**Table-2/G.957**

Reference

Table 2/G.957 – Parameters specified for STM-1 optical interfaces

	Unit	Values								
Digital signal Nominal bit rate	kbit/s	STM-1 according to ITU-T Rec. G.707/Y.1322 155 520								
Application code (Table 1)		I-1	S-1.1	S-1.2		L-1.1		L-1.2	L-1.3	
Operating wavelength range	nm	1260[b]-1360	1261[a],[b]-1360	1430-1576	1430-1580	1263[a]-1360		1480-1580	1534-1566/ 1523-1577	1480-1580
Transmitter at reference point S Source type		MLM	LED	MLM	MLM	SLM	MLM	SLM	SLM	MLM	SLM
Spectral characteristics: – maximum RMS width (σ) – maximum –20 dB width – minimum side mode suppression ratio	 nm nm dB	 40 – –	 80 – –	 7.7 – –	 2.5 – –	 – 1 30	 3 – –	 – 1 30	 – 1 30	 3/2.5 – –	 – 1 30
Mean launched power: – maximum – minimum	 dBm dBm	 –8 –15		 –8 –15			 0 –5		 0 –5		
Minimum extinction ratio	dB	8.2		8.2			10		10		
Optical path between S and R Attenuation range[b]	dB	0-7		0-12			10-28		10-28		
Maximum dispersion	ps/nm	18	25	96	296	NA	246	NA	NA	246/296	NA
Minimum optical return loss of cable plant at S, including any connectors	dB	NA		NA			NA		20	NA	
Maximum discrete reflectance between S and R	dB	NA		NA			NA		–25	NA	
Receiver at reference point R Minimum sensitivity[b]	dBm	–23		–28			–34		–34		
Minimum overload	dBm	–8		–8			–10		–10		
Maximum optical path penalty	dB	1		1			1		1		
Maximum reflectance of receiver, measured at R	dB	NA		NA			NA		–25	NA	

[a] Some Administrations may require a limit of 1270 nm.
[b] See clause 6.

Table-3/G.957

Table 3/G.957 – Parameters specified for STM-4 optical interfaces

	Unit	Values							
Digital signal Nominal bit rate	kbit/s	STM-4 according to ITU-T Rec. G.707/Y.1322 622 080							
Application code (Table 1)		I-4		S-4.1	S-4.2	L-4.1		L-4.2	L-4.3
Operating wavelength range	nm	1261[a],[b]-1360		1293-1334/ 1274-1356	1430-1580	1300-1325/ 1296-1330	1280-1335	1480-1580	1480-1580
Transmitter at reference point S Source type		MLM	LED	MLM	SLM	MLM	SLM	SLM	SLM
Spectral characteristics: – maximum RMS width (σ) – maximum –20 dB width – minimum side mode suppression ratio	 nm nm dB	 14.5 – –	 35 – –	 4/2.5 – –	 – 1 30	 2.0/1.7 – –	 – 1 30	 – < 1[b] 30	 – 1 30
Mean launched power: – maximum – minimum	 dBm dBm	 –8 –15		 –8 –15	 –8 –15	 +2 –3		 +2 –3	 +2 –3
Minimum extinction ratio	dB	8.2		8.2	8.2	10		10	10
Optical path between S and R Attenuation range[b]	dB	0-7		0-12	0-12	10-24		10-24	10-24
Maximum dispersion	ps/nm	13	14	46/74	NA	92/109	NA	1600	NA
Minimum optical return loss of cable plant at S, including any connectors	dB	NA		NA	24	20		24	20
Maximum discrete reflectance between S and R	dB	NA		NA	–27	–25		–27	–25
Receiver at reference point R Minimum sensitivity[b]	dBm	–23		–28	–28	–28		–28	–28
Minimum overload	dBm	–8		–8	–8	–8		–8	–8
Maximum optical path penalty	dB	1		1	1	1		1	1
Maximum reflectance of receiver, measured at R	dB	NA		NA	–27	–14		–27	–14

[a] Some Administrations may require a limit of 1270 nm.
[b] See clause 6.

Table-4/G.957

Table 4/G.957 – Parameters specified for STM-16 optical interfaces

	Unit	Values					
Digital signal Nominal bit rate	kbit/s	STM-16 according to ITU-T Rec. G.707/Y.1322 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	1260[a]-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	< 1[b]	1	< 1[b]	< 1[b]
– 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							
Attenuation range[b]	dB	0-7	0-12	0-12	12-24[d]	12-24[d]	12-24[d]
Maximum dispersion at upper wavelength limit	ps/nm	12[c]	NA	800[c]	NA	1600[c]	450[c]
Maximum dispersion at lower wavelength limit	ps/nm	12[c]	NA	420[c]	NA	1200[c]	450[c]
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 sensitivity[b]	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

[a] Some Administrations may require a limit of 1270 nm.

[b] See clause 6.

[c] For wavelengths between the upper and lower wavelength limits, the maximum dispersion is linearly interpolated between the values given for the wavelength extremes. Where the maximum dispersion values are the same, this value is required to be met across the entire wavelength range.

[d] Some Administrations may require 10 dB minimum attenuation instead of 12 dB, to do this, it is required to decrease the maximum output power of the transmitter or to increase the minimum overload of the receiver (or a combination of both).

Clause 38.3.1 Transmitter optical specifications of IEEE 802.3 2008 Section-3

Table 38–3—1000BASE-SX transmit characteristics

Description	62.5 μm MMF	50 μm MMF	Unit
Transmitter type	Shortwave Laser		
Signaling speed (range)	1.25 ± 100 ppm		GBd
Wavelength (λ, range)	770 to 860		nm
T_{rise}/T_{fall} (max; 20%-80%; λ > 830 nm)	0.26		ns
T_{rise}/T_{fall} (max; 20%-80%; λ ≤ 830 nm)	0.21		ns
RMS spectral width (max)	0.85		nm
Average launch power (max)	See footnote [a]		dBm
Average launch power (min)	–9.5		dBm
Average launch power of OFF transmitter (max)[b]	–30		dBm
Extinction ratio (min)	9		dB
RIN (max)	–117		dB/Hz
Coupled Power Ratio (CPR) (min)[c]	9 < CPR		dB

[a]The 1000BASE-SX launch power shall be the lesser of the class 1 safety limit as defined by 38.7.2 or the average receive power (max) defined by Table 38–4.

[b]Examples of an OFF transmitter are: no power supplied to the PMD, laser shutdown for safety conditions, activation of a "transmit disable" or other optional module laser shut down conditions. During all conditions when the PMA is powered, the ac signal (data) into the transmit port will be valid encoded 8B/10B patterns (this is a requirement of the PCS layers) except for short durations during system power-on-reset or diagnostics when the PMA is placed in a loopback mode.

[c]Radial overfilled launches as described in 38A.2, while they may meet CPR ranges, should be avoided.

Clause 38.4.1 Transmitter optical specifications of IEEE 802.3 2008 Section-3

Table 38–7—1000BASE-LX transmit characteristics

Description	62.5 μm MMF	50 μm MMF	10 μm SMF	Unit
Transmitter type	Longwave Laser			
Signaling speed (range)	1.25 ± 100 ppm			GBd
Wavelength (range)	1270 to 1355			nm
T_{rise}/T_{fall} (max, 20-80% response time)	0.26			ns
RMS spectral width (max)	4			nm
Average launch power (max)	–3			dBm
Average launch power (min)	–11.5	–11.5	–11.0	dBm
Average launch power of OFF transmitter (max)	–30			dBm
Extinction ratio (min)	9			dB
RIN (max)	–120			dB/Hz
Coupled Power Ratio (CPR)[a]	28 < CPR< 40	12 < CPR < 20	N/A	dB

[a]Due to the dual media (single-mode and multimode) support of the LX transmitter, fulfillment of this specification requires a single-mode fiber offset-launch mode-conditioning patch cord described in 38.11.4 for MMF operation. This patch cord is not used for single-mode operation.

Table 52-7 for SRof IEEE 802.3ae specifications

Table 52–7—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 footnote[b]		
Average launch power (max)	See footnote[c]		
Average launch power[d] (min)	–7.3		dBm
Launch power (min) in OMA	See footnote[b]		
Average launch power of OFF transmitter[e] (max)	–30		dBm
Extinction ratio (min)	3		dB
$RIN_{12}OMA$ (max)	–128		dB/Hz
Optical Return Loss Tolerance (max)	12		dB
Encircled flux	See footnote[f]		
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.40, 0.45, 0.25, 0.28, 0.40}		
Transmitter and dispersion penalty[g] (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 a 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 equal to 30% when measured into Type A1a (50/125 μm multimode) fiber per ANSI/TIA/EIA-455-203-2001.
[g]TDP(max) and OMA(min) are at the respective wavelength and spectral width as specified in Table 52–8.

Table 52-12 for LR of IEEE 802.3ae specifications

Table 52–12—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
$RIN_{12}OMA$ (max)	–128		dB/Hz
Optical Return Loss Tolerance (max)	12		dB
Transmitter Reflectance[e] (max)	–12		dB
Transmitter eye mask definition {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 52-16 for ER of IEEE 802.3ae specifications

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 launch power (max)	4.0		dBm
Average launch 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 (max)	21		dB
Transmitter eye mask definition {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]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 86-6 for SR4/SR10 of IEEE 802.3ba specifications

Table 86–6—40GBASE–SR4 or 100GBASE–SR10 optical transmit characteristics

Description	Type	Value	Unit
Center wavelength	Range	840 to 860	nm
RMS spectral width[a]	Max	0.65	nm
Average launch power, each lane	Max	2.4	dBm
Average launch power, each lane	Min	–7.6	dBm
Optical Modulation Amplitude (OMA), each lane	Max	3	dBm
Optical Modulation Amplitude (OMA), each lane	Min	–5.6[b]	dBm
Difference in launch power between any two lanes (OMA)	Max	4	dB
Peak power, each lane	Max	4	dBm
Launch power in OMA minus TDP, each lane	Min	–6.5	dBm
Transmitter and dispersion penalty (TDP), each lane	Max	3.5	dB
Extinction ratio	Min	3	dB
Optical return loss tolerance	Max	12	dB
Encircled flux[c]		≥ 86% at 19 µm, ≤ 30% at 4.5 µm	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} Hit ratio 5×10^{-5} hits per sample	Spec values	0.23, 0.34, 0.43, 0.27, 0.35, 0.4	
Average launch power of OFF transmitter, each lane	Max	–30	dBm

[a] RMS spectral width is the standard deviation of the spectrum.
[b] Even if the TDP < 0.9 dB, the OMA (min) must exceed this value.
[c] If measured into type A1a.2 50 µm fiber in accordance with IEC 61280-1-4.

Table 87-7 for LR4 of IEEE 802.3ba specifications

Table 87–7—40GBASE-LR4 transmit characteristics

Description	Value	Unit
Signaling rate, each lane (range)	10.3125 ± 100 ppm	GBd
Lane wavelengths (range)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	nm
Side-mode suppression ratio (SMSR), (min)	30	dB
Total average launch power (max)	8.3	dBm
Average launch power, each lane (max)	2.3	dBm
Average launch power, each lane[a] (min)	–7	dBm
Optical Modulation Amplitude (OMA), each lane (max)	3.5	dBm
Optical Modulation Amplitude (OMA), each lane (min)[b]	–4	dBm
Difference in launch power between any two lanes (OMA) (max)	6.5	dB
Launch power in OMA minus TDP, each lane (min)	–4.8	dBm
Transmitter and dispersion penalty (TDP), each lane (max)	2.6	dB
Average launch power of OFF transmitter, each lane (max)	–30	dBm
Extinction ratio (min)	3.5	dB
$RIN_{20}OMA$ (max)	–128	dB/Hz
Optical return loss tolerance (max)	20	dB
Transmitter reflectance[c] (max)	–12	dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}	

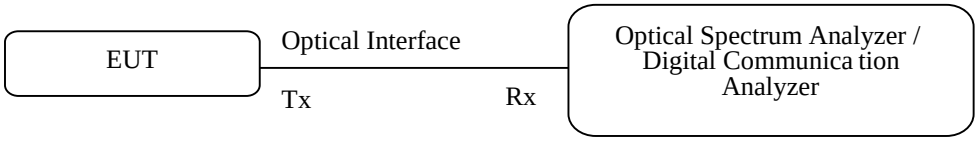
[a]Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.
[b]Even if the TDP < 0.8dB, the OMA (min) must exceed this value.
[c]Transmitter reflectance is defined looking into the transmitter.

	Table 88-7 for LR4/ER4 of IEEE 802.3ba specifications
	Table 88–7—100GBASE-LR4 and 100GBASE-ER4 transmit characteristics

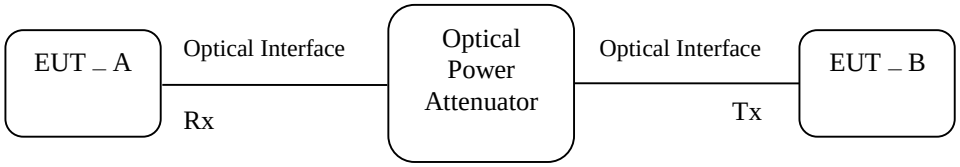
Description	100GBASE–LR4	100GBASE–ER4	Unit
Signaling rate, each lane (range)	25.78125 ± 100 ppm		GBd
Lane wavelengths (range)	1294.53 to 1296.59 1299.02 to 1301.09 1303.54 to 1305.63 1308.09 to 1310.19		nm
Side-mode suppression ratio (SMSR), (min)	30		dB
Total average launch power (max)	10.5	8.9	dBm
Average launch power, each lane (max)	4.5	2.9	dBm
Average launch power, each lane[a] (min)	–4.3	–2.9	dBm
Optical Modulation Amplitude (OMA), each lane (max)	4.5		dBm
Optical Modulation Amplitude (OMA), each lane (min)	–1.3[b]	0.1	dBm
Difference in launch power between any two lanes (OMA) (max)	5	—	dB
Difference in launch power between any two lanes (Average and OMA) (max)	—	3.6	
Launch power in OMA minus TDP, each lane (min)	–2.3	—	dBm
Transmitter and dispersion penalty (TDP), each lane (max)	2.2	2.5	dB
Average launch power of OFF transmitter, each lane (max)	–30		dBm
Extinction ratio (min)	4	8	dB
$RIN_{20}OMA$ (max)	–130		dB/Hz
Optical return loss tolerance (max)	20		dB
Transmitter reflectance[c] (max)	–12		dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}		

[a]Average launch power, each lane (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]Even if the TDP < 1 dB, the OMA (min) must exceed this value.
[c]Transmitter reflectance is defined looking into the transmitter.

Test Procedure	1. Connect the Setup as shown in the figure. 2. Enable the output Optical Port 3. Measure the optical output power 4. Check whether the output power is within the specification limits
Expected Results	Enclose the Test Results

<table>
<tr><td>Test No.</td><td>12</td></tr>
<tr><td>Test Details</td><td>Wavelength/Spectrum / Extinction Ratio</td></tr>
<tr><td>Test Instruments Required</td><td>1. Optical Spectrum Analyser or Digital Communication Analyser</td></tr>
<tr><td>Test Setup</td><td> 
</td></tr>
<tr><td>Test Limits</td><td>
<table>
<tr><td>STM-1 Short Haul / Long Haul</td><td>Refer Table-2/G.957</td></tr>
<tr><td>STM-4 Short Haul / Long Haul</td><td>Refer Table-3/G.957</td></tr>
<tr><td>STM-16 Short Haul / Long Haul</td><td>Refer Table-4/G.957</td></tr>
<tr><td>FE Short Haul/Long Haul (100BASE-FX/SX/LX)</td><td>Refer IEEE 802.3u</td></tr>
<tr><td>GE Short Haul (1000BASE-SX)</td><td>Refer clause 38.3.1 Transmitter optical specifications of IEEE 802.3 2008 Section-3</td></tr>
<tr><td>GE Long Haul (1000BASE-LX)</td><td>Refer clause 38.4.1 Transmitter optical specifications of IEEE 802.3 2008 Section-3</td></tr>
<tr><td>10 GE Short Haul/Long Haul (10G-SR/LR/ER)</td><td>Refer table 52-7 for SR, 52-12 for LR and 52-16 for ER of IEEE 802.3ae specifications</td></tr>
<tr><td>40 GE (SR4/LR4)</td><td>Refer Table 86-6 for SR4 and 87-7 for LR of IEEE 802.3ba specifications</td></tr>
<tr><td>100 GE (SR10/LR4/ER4)</td><td>Refer Table 86-6 for SR10, 88-7 for LR4/ER4 of IEEE 802.3ba specifications</td></tr>
<tr><td>25 GE (SR/LR/ER)</td><td>Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures</td></tr>
<tr><td>50 GE (SR/LR/ER/FR)</td><td>Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures</td></tr>
<tr><td>200 GE (SR4/LR4/DR4/FR4)</td><td>Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures</td></tr>
<tr><td>400 GE (SR8/LR8/DR4/FR8)</td><td>Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures</td></tr>
</table>
</td></tr>
<tr><td>Standards Reference</td><td>Refer the Standards Reference in Test 11</td></tr>
<tr><td>Test Procedure</td><td>1. Connect the Setup as shown in the figure.
2. Enable the output Optical Port
3. Measure the Wavelength/Spectrum / Extinction Ratio
4. Check whether the Wavelength/Spectrum / Extinction Ratio is within the specification limits</td></tr>
</table>

Expected Results	Enclose the Test Results

Test No.	13	
Test Details	Test for Receiver Sensitivity	
Test Instruments Required	1. Optical Attenuator	
Test Setup		
Test Limits	STM-1 Short Haul / Long Haul	Refer Table-2/G.957 (Given under Test-11)
	STM-4 Short Haul / Long Haul	Refer Table-3/G.957 (Given under Test-11)
	STM-16 Short Haul / Long Haul	Refer Table-4/G.957 (Given under Test-11)
	FE Short Haul/Long Haul (100BASE-FX/SX/LX)	Refer IEEE 802.3u
	GE Short Haul (1000BASE-SX)	Refer clause 38.3.2 Receiver optical specifications of IEEE 802.3 2008 Section-3
	GE Long Haul (1000BASE-LX)	Refer clause 38.4.2 Receiver optical specifications of IEEE 802.3 2008 Section-3
	10 GE Short Haul/Long Haul (10G-SR/LR/ER)	Refer table 52-9 for SR, 52-13 for LR and 52-17 for ER of IEEE 802.3ae specifications
	40 GE (SR4/LR4)	Refer Table 86-8 for SR4 and 87-8 for LR4 of IEEE 802.3ba specifications
	100 GE (SR100/LR4/ER4)	Refer Table 86-8 for SR100, 88-8 for LR4/ER4 of IEEE 802.3ba specifications
	25 GE (SR/LR/ER)	Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures
	50 GE (SR/LR/ER/FR)	Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures
	200 GE (SR4/LR4/DR4/FR4)	Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures
	400 GE (SR8/LR8/DR4/FR8)	Refer Annexure H in Annexure to ER document available in https://www.mtcte.tec.gov.in/annexures

Standards Reference	**Clause 38.3.2 Receiver optical specifications of IEEE 802.3 2008 Section-3**

Table 38–4—1000BASE-SX receive characteristics

Description	62.5 μm MMF	50 μm MMF	Unit
Signaling Speed (range)	1.25 ± 100 ppm		GBd
Wavelength (range)	770 to 860		nm
Average receive power (max)	0		dBm
Receive sensitivity	–17		dBm
Return loss (min)	12		dB
Stressed receive sensitivity[a, b]	–12.5	–13.5	dBm
Vertical eye-closure penalty[c]	2.60	2.20	dB
Receive electrical 3 dB upper cutoff frequency (max)	1500		MHz

[a]Measured with conformance test signal at TP3 (see 38.6.11) for BER = 10^{-12} at the eye center.
[b]Measured with a transmit signal having a 9 dB extinction ratio. If another extinction ratio is used, the stressed receive sensitivity should be corrected for the extinction ratio penalty.
[c]Vertical eye-closure penalty is a test condition for measuring stressed receive sensitivity. It is not a required characteristic of the receiver.

Section-3

Table 38–8—1000BASE-LX receive characteristics

Description	Value	Unit
Signaling speed (range)	1.25 ± 100 ppm	GBd
Wavelength (range)	1270 to 1355	nm
Average receive power (max)	–3	dBm
Receive sensitivity	–19	dBm
Return loss (min)	12	dB
Stressed receive sensitivity[a, b]	–14.4	dBm
Vertical eye-closure penalty[c]	2.60	dB
Receive electrical 3 dB upper cutoff frequency (max)	1500	MHz

[a]Measured with conformance test signal at TP3 (see 38.6.11) for BER = 10^{-12} at the eye center.
[b]Measured with a transmit signal having a 9 dB extinction ratio. If another extinction ratio is used, the stressed receive sensitivity should be corrected for the extinction ratio penalty.
[c]Vertical eye-closure penalty is a test condition for measuring stressed receive sensitivity. It is not a required characteristic of the receiver.

Table 52-9 for SR of IEEE 802.3ae specifications

Table 52–9—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 52-13 for LR of IEEE 802.3ae specifications

Table 52–13—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 52-17 for ER of IEEE 802.3ae specifications

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 (max)	12.3	GHz

[a]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.
[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 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 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 86-8 for SR4/SR100 of IEEE 802.3ba specifications

Table 86–8—40GBASE–SR4 or 100GBASE–SR10 optical receiver characteristics

Description	Type	Value	Unit
Center wavelength, each lane	Range	840 to 860	nm
Damage threshold[a]	Min	+3.4	dBm
Average power at receiver input, each lane	Max	+2.4	dBm
	Min	–9.5	dBm
Receiver reflectance	Max	–12	dB
Optical Modulation Amplitude (OMA), each lane	Max	3	dBm
Stressed receiver sensitivity in OMA, each lane[b]	Max	–5.4	dBm
Peak power, each lane	Max	4	dBm
Conditions of stressed receiver sensitivity test:			
Vertical eye closure penalty (VECP)[c], each lane	—	1.9	dB
Stressed eye J2 Jitter[c], each lane	—	0.3	UI
Stressed eye J9 Jitter[c], each lane	—	0.47	UI
OMA of each aggressor lane	—	–0.4	dBm
Receiver jitter tolerance in OMA, each lane[d]	Max	–5.4	dBm
Conditions of receiver jitter tolerance test:			
Jitter frequency and peak-to-peak amplitude	—	(75, 5)	(kHz, UI)
Jitter frequency and peak-to-peak amplitude	—	(375, 1)	(kHz, UI)
OMA of each aggressor lane	—	–0.4	dBm

[a] The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane. The receiver does not have to operate correctly at this input power.
[b] Measured with conformance test signal at TP3 (see 86.8.4.7).
[c] Vertical eye closure penalty and stressed eye jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver. The apparent discrepancy between VECP and TDP is because VECP is defined at eye center while TDP is defined with ±0.15 UI offsets of the sampling instant.
[d] This is a test of the optical receiver's ability to track low-frequency jitter and is inappropriate for any subsystem that does not include a CRU.

Table 87-8 for LR4 of IEEE 802.3ba specifications

Table 87–8—40GBASE–LR4 receive characteristics

Description	Value	Unit
Signaling rate, each lane (range)	10.3125 ± 100 ppm	GBd
Lane wavelengths (range)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	nm
Damage threshold[a] (min)	3.3	dBm
Average receive power, each lane (max)	2.3	dBm
Average receive power, each lane[b] (min)	–13.7	dBm
Receive power, each lane (OMA) (max)	3.5	dBm
Difference in receive power between any two lanes (OMA) (max)	7.5	dB
Receiver reflectance (max)	–26	dB
Receiver sensitivity (OMA), each lane[c] (max)	–11.5	dBm
Receiver 3 dB electrical upper cutoff frequency, each lane (max)	12.3	GHz
Stressed receiver sensitivity (OMA), each lane[d] (max)	–9.6	dBm
Conditions of stressed receiver sensitivity test:		
Vertical eye closure penalty,[e] each lane	1.9	dB
Stressed eye J2 Jitter,[e] each lane	0.3	UI
Stressed eye J9 Jitter,[e] each lane	0.47	UI

[a]The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level

[b]Average receive power, each lane (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 (OMA), each lane (max) is informative.

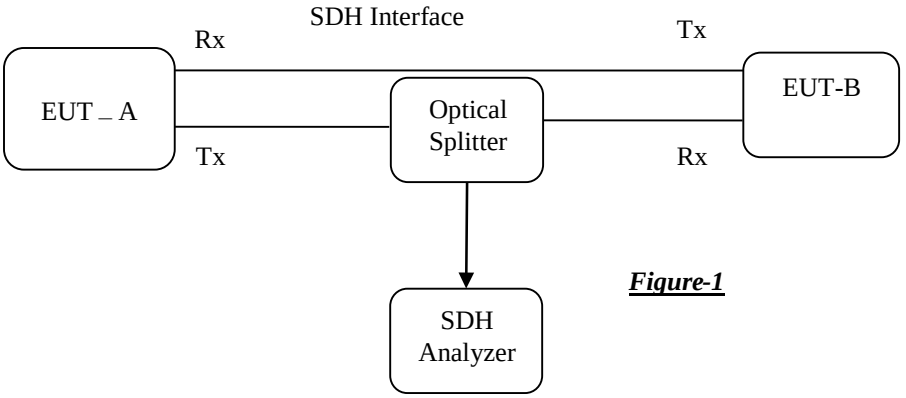
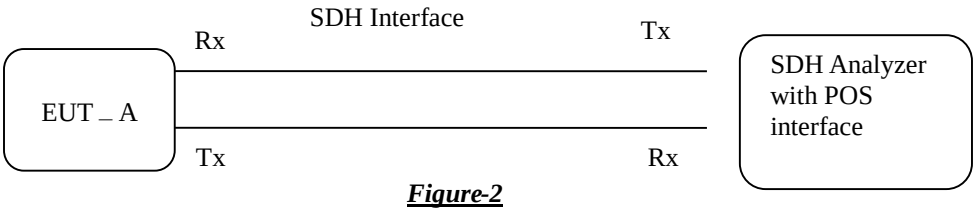
[d]Measured with conformance test signal at TP3 (see 87.8.11) for BER = 10^{-12}.

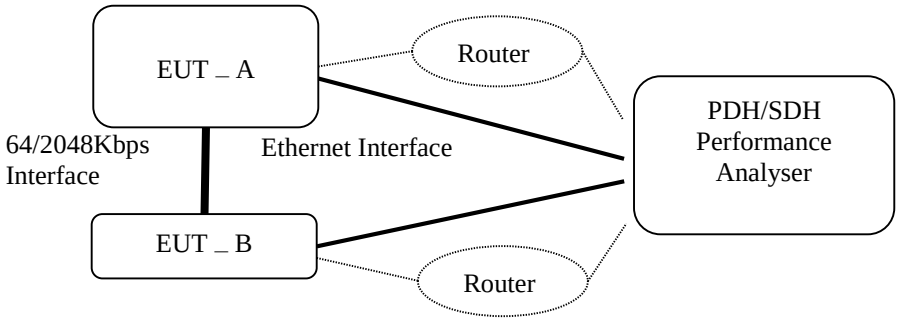
[e]Vertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

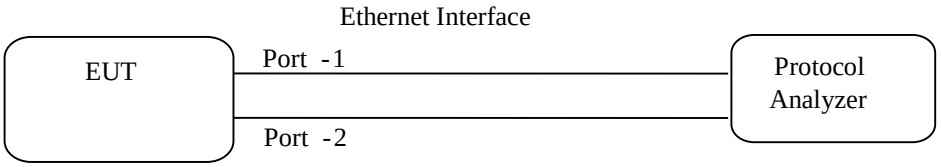
<table>
<tr><td></td><td>Table 88-8 for LR4/ER4 of IEEE 802.3ba specifications

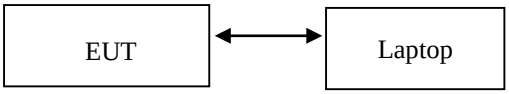
Table 88–8—100GBASE–LR4 and 100GBASE–ER4 receive characteristics

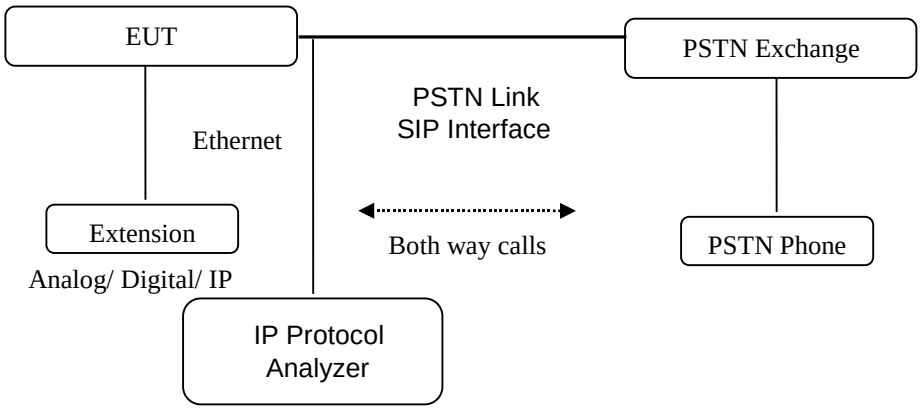
<table>
<tr><th>Description</th><th>100GBASE–LR4</th><th>100GBASE–ER4</th><th>Unit</th></tr>
<tr><td>Signaling rate, each lane (range)</td><td colspan="2">25.78125 ± 100 ppm</td><td>GBd</td></tr>
<tr><td>Lane wavelengths (range)</td><td colspan="2">1294.53 to 1296.59
1299.02 to 1301.09
1303.54 to 1305.63
1308.09 to 1310.19</td><td>nm</td></tr>
<tr><td>Damage threshold[a]</td><td colspan="2">5.5</td><td>dBm</td></tr>
<tr><td>Average receive power, each lane (max)</td><td colspan="2">4.5[b]</td><td>dBm</td></tr>
<tr><td>Average receive power, each lane[c] (min)</td><td>–10.6</td><td>–20.9</td><td>dBm</td></tr>
<tr><td>Receive power, each lane (OMA) (max)</td><td colspan="2">4.5</td><td>dBm</td></tr>
<tr><td>Difference in receive power between any two lanes (OMA) (max)</td><td>5.5</td><td>—</td><td>dB</td></tr>
<tr><td>Difference in receive power between any two lanes (Average and OMA) (max)</td><td>—</td><td>4.5</td><td></td></tr>
<tr><td>Receiver reflectance (max)</td><td colspan="2">–26</td><td>dB</td></tr>
<tr><td>Receiver sensitivity (OMA), each lane[d] (max)</td><td>–8.6</td><td>–21.4</td><td>dBm</td></tr>
<tr><td>Receiver 3 dB electrical upper cutoff frequency, each lane (max)</td><td colspan="2">31</td><td>GHz</td></tr>
<tr><td>Stressed receiver sensitivity (OMA), each lane[e] (max)</td><td>–6.8</td><td>–17.9</td><td>dBm</td></tr>
<tr><td>Conditions of stressed receiver sensitivity test</td><td></td><td></td><td></td></tr>
<tr><td>Vertical eye closure penalty,[f] each lane</td><td>1.8</td><td>3.5</td><td>dB</td></tr>
<tr><td>Stressed eye J2 Jitter,[f] each lane</td><td colspan="2">0.3</td><td>UI</td></tr>
<tr><td>Stressed eye J9 Jitter,[f] each lane</td><td colspan="2">0.47</td><td>UI</td></tr>
</table>
[a]The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.
[b]The average receive power, each lane (max) for 100GBASE-ER4 is larger than the 100GBASE-ER4 transmitter value to allow compatibility with 100GBASE-LR4 units at short distances.
[c]Average receive power, each lane (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.
[d]Receiver sensitivity (OMA), each lane (max) is informative.
[e]Measured with conformance test signal at TP3 (see 88.8.10) for BER = 10^{-12}.
[f]Vertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.</td></tr>
<tr><td>Test Procedure</td><td>1. Connect the setup as shown in the figure above.
2. Configure EUT B for sending packets to EUT A
3. Enable the output Optical Port of EUT B
4. Adjust the Optical Power Attenuator
5. Measure the Receiver Sensitivity
6. Verify whether the Receiver Sensitivity is within limits.
7. In case of Ethernet Optical Ports verify whether the Output Power / Receiver Sensitivity combination is able to meet the distance criteria requirements</td></tr>
<tr><td>Expected Results</td><td>Enclose the Test Results</td></tr>
</table>

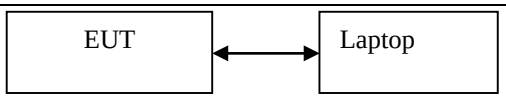
Test No.	14
Test Details	Test for SDH Payload Measurements
Test Instruments Required	1. SDH Network Analyser, Optical Splitter OR 2. SDH Analyser with POS capability
Test Setup	 ***Figure-1*** **OR**  ***Figure-2***
Test Procedure	1. Connect the test setup as shown in figure. 2. The test setup in Figure-2 shall be used in case the SDH analyser has the POS interface. [Packet Over SDH] 3. The EUT-A shall be configured in the loopback mode such that the Packets sent from EUT-B / SDH Analyser is sent back. 4. Verify whether the SDH frame structure sent by the EUT is as per G.707 standards.
Expected Results	Enclose the Test Results

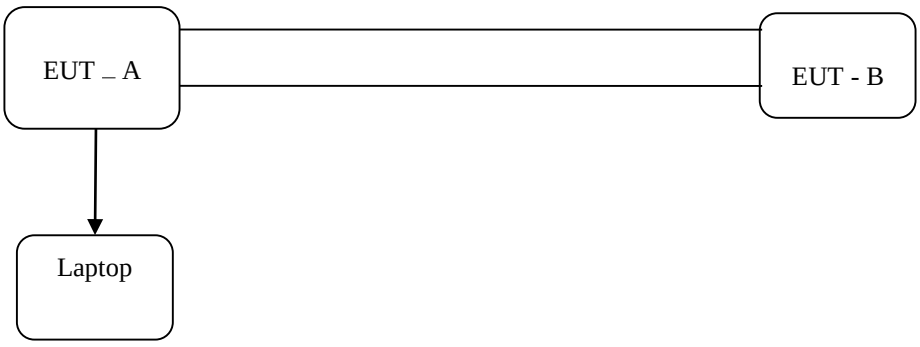
Test No.	15
Test Details	Test for Bit Error Rate [BER]
Test Instruments Required	1. PDH/SDH Performance Analyser
Test Setup	
Test Limits	The EUT shall be able to work with a BER better than $1x10^{-10}$ measured in any 15 minutes interval for all the speed/s of digital interface.
Test Procedure	1. Connect the test setup as shown in figure using a suitable cable wired to the Ethernet interface 2. A Router may be used for interface conversion in case the PDH/SDH Analyser does not have the compatible interface. 3. Perform the BER performance for 15 minutes interval
Expected Results	Enclose the Test Results

Test No.	16
Test Details	Test for Various Protocols
Test Instruments Required	1. IP Protocol Analyser
Test Parameters	As per various protocols being referred in the respective clause of the Test Schedule (TSTP)
Test Setup	
Test Procedure	1. Connect the test setup as shown in figure 2. The EUT shall be configured through the CLI [Command Line Interface] or SNMP interface for the various tests like IPv4, IPv6, TCP, Static Routing, Dynamic Routing, BGP, PPP etc 3. Various test parameters shall be measured using this setup 4. The test results may be recorded.
Expected Results	Enclose the Test Results
	Note: 1. The test procedure for those RFC's which are forming part of the "compendium of test setup and test procedures for testing of RFC's of IETF" shall be performed as per the same. This test setup (at test no 16) is generic in nature and shall apply in case of RFC's which are not covered in the above referred compendium. 2. TEC New Delhi NGN Lab has this test facility 3. Where ever conformance tests are not available, functional tests shall be carried out. Moreover, wherever the specification requirement is to meet a specific functionality of the RFC, the clause of the RFC refereeing to the function shall be tested as per the functional test procedure. The functional test model available in the "compendium of test setup and test procedures for testing of RFC's of IETF" can be followed for those RFC's which are not covered in the compendium and where functional tests are carried out. 4. The protocol analyser shall be able to send various test packets to the EUT, check the response packet and check the conformance/functionality. Software tools like wireshark has got only the capability to analyse the received packets and do not have the capability to send test packets and measure the response. Hence the tools like wireshark cannot be used for this test. 5. In case the product is offered (with the same product version) is 'IPv6 Readylogo Certified', then the tests against RFC 4862, RFC 4443, RFC 4291, RFC 2460, RFC 4861, RFC 1981 and RFC 5095 (where ever referred in the Test Schedule) which are covered as part of the 'IPv6 Readylogo certification' shall not be carried out. I.e. in this case, the product version of the 'IPv6 Readylogo certificate' and the offered product shall be the same. Later versions than the certified versions will not come under the purview of this condition.

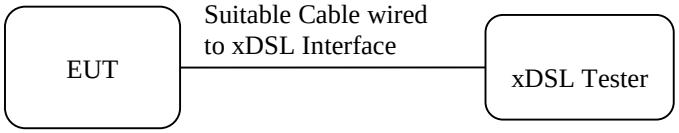
Test No.	17
Test Details	Test for Various Protocols using Wireshark
Test Instruments Required	1. Laptop/PC
Test Parameters	1. TCP as per RFC 793 2. UDP as per RFC 768
Test Setup	
Test Procedure	1. Connect the test setup as shown in figure 2. Load a suitable protocol analysis software such as Wireshark in the Laptop 3. The EUT shall be configured through the CLI [Command Line Interface] or SNMP interface for the TCP & UDP test. 4. The IP Packets may be observed in the Wireshark for TCP/UDP Compliance 5. The test results may be recorded.
Expected Results	Enclose the Test Results

Test No.	18
Test Details	Test for the IP Protocol support for PSTN interface - over IP 1. SIP Protocol 2. IP version 4 3. Audio codecs 4. TCP protocol 5. RTP protocol 6. RTCP protocol
Test Instruments Required	1. IP Protocol Analyzer
Test Setup	
Test Procedure	1. Connect the system, as shown in the above setup and configure the EUT to enable it to send and receive calls to/from PSTN using SIP interface with different audio codecs. 2. Make outgoing and incoming calls from SIP extension to PSTN phone and vice versa. 3. Take message traces from IP Protocol Analyzer for verifying support for a. SIP Protocol b. IP version 4 c. All the Audio codecs (G.711, G.723, G.726, G.729, G.729A, G.729B, G.728AB, G.725A, AMR and T.38) d. TCP protocol e. RTP protocol f. RTCP protocol
Expected Results	Enclose the message traces from IP Protocol Analyzer

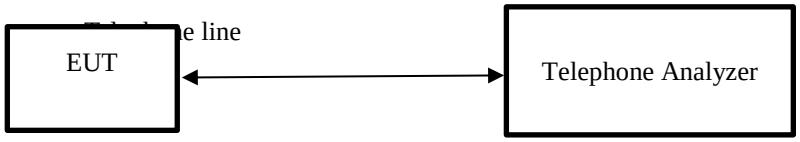
Test No.	19
Test Details	Test for Management Interface
Test Instruments Required	1. Laptop
Test Setup	
Test Procedure	1. Connect the EUT to the Laptop over Ethernet Interface as shown in the setup. 2. Load SNMP management software supplied by the Equipment Manufacturer or any other software [Freely downloadable from the Internet] 3. Configure EUT from the Laptop to act as the SNMP master. 4. Configure the SNMP software for SNMPv2 5. Check for the alarms [Traps] coming from the EUT to the Laptop. 6. Configure some parameters of the EUT from the Laptop through get and set commands.
Expected Results	Enclose the Test Results / Screen Shots

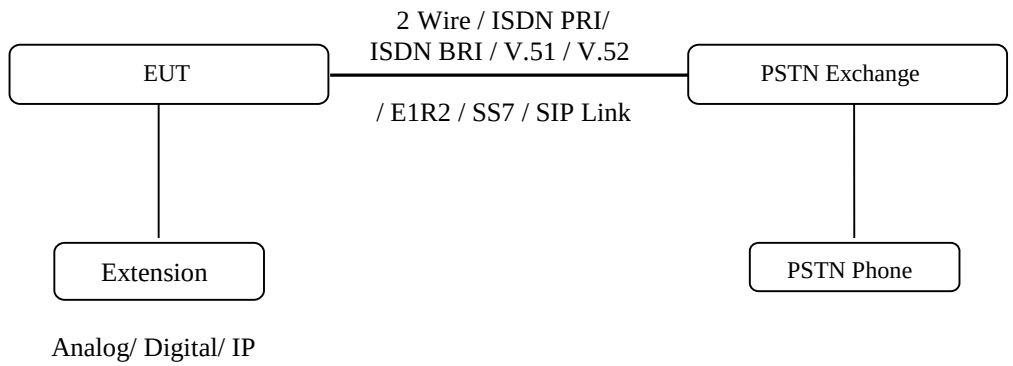
Test No.	20
Test Details	Test for Clock Extraction
Test Instruments Required	1. Laptop
Test Setup	
Test Procedure	1. Connect the test setup as shown in figure 2. Configure EUT-A for using the clock extracted from the interface connected to EUT-B [Slave Mode] 3. Verify the configuration about the usage of the clock 4. Verify whether the EUT-A is able to configure in Master Mode
Expected Results	Enclose the Command Line Interface [CLI] Results / Screenshots

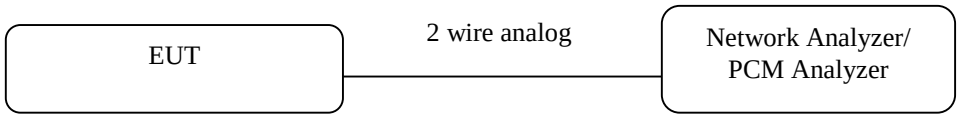
Test No.	21
Test Details	Test for NTP Server Synchronization support
Test Instruments Required	Nil
Test Setup	
Test Procedure	1. Setup the system as shown in the diagram above. 2. Configure the system to synchronize with NTP server, either located locally or on the internet. 3. The system should be able to synchronize with NTP server.
Expected Results	Enclose the Screen Capture Results

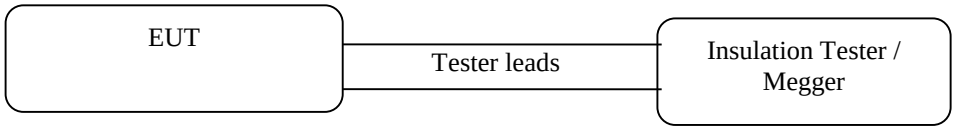
<table>
<tr><td>Test No.</td><td>22</td></tr>
<tr><td>Test Details</td><td>xDSL Line Tests
[The tests shall be limited to the tests specified under the Test Limits below]<table>
<tr><td>ADSL Tests</td><td>Conformity Tests as per G.992.1, G.992.3, G.992.5</td></tr>
<tr><td>VDSL Tests</td><td>Conformity Tests as per G.993.1, G.993.2</td></tr>
<tr><td>SHDSL Tests</td><td>Conformity Tests as per G.991.2 Annex G</td></tr>
<tr><td>Other Tests for all xDSL interfaces</td><td>Support of Protocols - PPPoE as per RFC2516, PVC, VPI/VCI support FTP Speed Test
Metallic Loop Tests (Loop Resistance, Insulation Resistance, Capacitance)
Impulse Noise Protection</td></tr>
</table></td></tr>
<tr><td>Test Instruments Required</td><td>1. xDSL Tester [Capable of testing xDSL CPE’s].
2. In case the tester do not have the capability to measure some of the above tests, separate tester can be used
3. For Impulse Noise Tests test results from the OEM can be obtained.</td></tr>
<tr><td>Test Setup</td><td> 
</td></tr>
<tr><td>Test Limits</td><td><table>
<tr><td>G.992.1</td><td>PSD [Power Spectral Density] as per Annexure-A</td></tr>
<tr><td>G.992.3</td><td>PSD</td></tr>
<tr><td>G.992.5</td><td>PSD</td></tr>
<tr><td>G.993.1</td><td>PSD and Return Loss as per clause 6.2 and 6.5</td></tr>
<tr><td>G.993.2</td><td>Profiles as per Clause 6.3, PSD as per clause 7.2</td></tr>
<tr><td>G.991.2</td><td>Return Loss as per Clause 11.3 and PSD as per Clause 11.5</td></tr>
<tr><td>PPPoE</td><td>Shall support PPPoE configuration as per RFC2516</td></tr>
<tr><td>PVC</td><td>Shall support PVC configuration</td></tr>
<tr><td>VPI/VCI</td><td>Shall support VPI/VCI configuration</td></tr>
<tr><td>FTP Speed Tests</td><td>1. ADSL2+ interface supporting 16Mbps speeds using 0.5mm copper loop distance of 2Km
2. VDSL2 interface supporting 30Mbps speeds using 0.5mm copper loop distance of 500m
3. SHDSL interface supporting 1.5Mbps speeds using 0.5mm copper loop distance of 2Km</td></tr>
<tr><td>Loop Resistance</td><td>As per Telephone line requirements</td></tr>
<tr><td>Insulation Resistance</td><td>As per Telephone line requirements</td></tr>
<tr><td>Capacitance</td><td>As per Telephone line requirements</td></tr>
<tr><td>Impulse Noise Protection[INP]</td><td>INP shall be better than 2</td></tr>
</table></td></tr>
<tr><td>Test Procedure</td><td>1. Connect the test setup as shown in figure
2. Measure the various parameters as per the test details and verify whether they are within the Test Limits.</td></tr>
<tr><td>Expected Results</td><td>Enclose the Test Results / Screen Shots</td></tr>
</table>

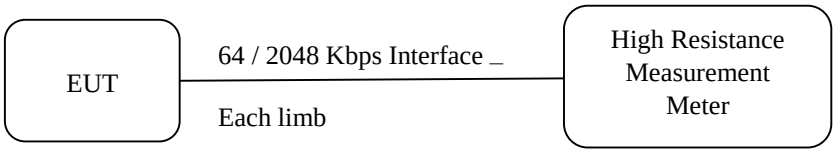
Test No.	23

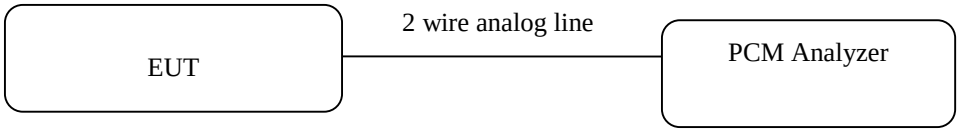
Test Details	Test for Loop Current (for 2 wire analog interface only
Test Instruments	1. Telephone Analyzer Required
Test Setup	
Test Procedure	1. Setup the CTI equipment and Telephone analyser as shown in the test setup above while enabling the 2 wire analog interface on the EUT. 2. Measure the loop current on the telephone analyser .
Expected Results	1. The loop current in idle condition (on-hook) should not be more than 0.5 mA. 2. The loop current in the off-hook condition should not be more than 60 mA. 3. When CTI is connected to PSTN line (i.e. when customer calls IVRS facility) the current drawn from the line shall be less than 40 micro Amps. Enclose the test results

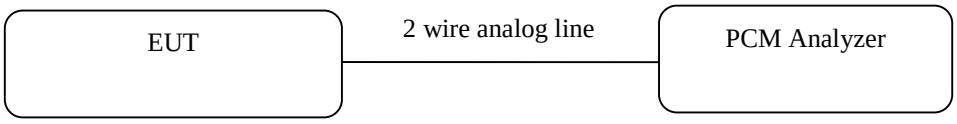
Test No.	24
Test Details	Test for the DTMF support
Test Instruments Required	Nil
Test Setup	
Test Procedure	1. Setup the system as per above diagram and configure the EUT to enable it to send and receive calls to/from PSTN 2. Make an incoming call from PSTN phone to EUT and the Interactive Voice Response System should get activated and should prompt the user to dial a digit soon. 3. Program the IVRS to detect all DTMF tones and respond accordingly. 4. Check that the IVRS system responds properly to all dialled digits. 5. Make an outgoing call from EUT system to PSTN phone and activate the IVRS facility. Prompt the user to dial different digits. The EUTshall respond according to the dialled digits. 6. Make an incoming call from a mobile phone to EUT and check that the call matures.
Expected Results	Enclose the logs from EUT.

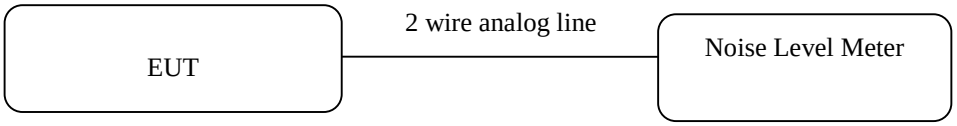
Test No.	25
Test Details	Test for Return Loss (2 wire interface only)
Test Instruments Required	1. Network Analyser or PCM Analyzer
Test Setup	
Test Limits	1. Balance Return Loss > 12 dB in the range 300Hz to 3400Hz 2. Echo Return Loss > 16 dB
Test Procedure	1. Connect the Setup as shown in the figure. 2. Measure the Balance and Echo Return loss using the Test instrument. 3. Check whether the Return Loss is within the specified limits.
Expected Results	Enclose the Test Results

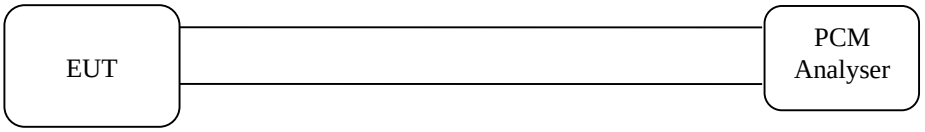
Test No.	26
Test Details	Test for Insulation Resistance (2 wire interface only)
Test Instruments Required	1. Insulation Tester / Megger
Test Setup	
Test Limits	1. Insulation resistance >= 5 Mega ohms
Test Procedure	2. Connect the Setup as shown in the figure. 3. Measure the Insulation resistance (between any two points not electrically connected) using the Test instrument leads. 4. Check whether the Insulation resistance is within the specified limits.
Expected Results	Enclose the Test Results

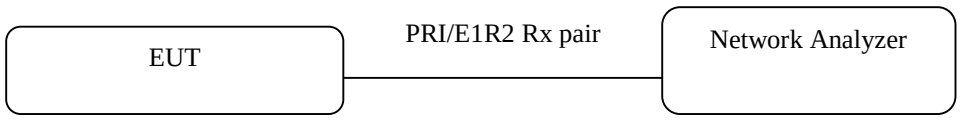
Test No.	27
Test Details	Test for Input Resistance
Test Instruments Required	1. High Resistance measurement Meter
Test Setup	
Test Limits	> 5 Mohm
Test Procedure	1. Connect the test setup as shown in figure for Limb-A 2. Measure the Input resistance 3. Repeat the test for Limb-B
Expected Results	Enclose the Test Results

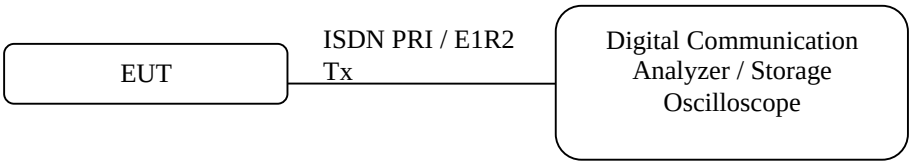
Test No.	28
Test Details	Test for Loudness Rating (SLR and RLR) (2 wire interface only)
Test Instruments Required	1. PCM Analyzer
Test Setup	
Test Limits	1. SLR at zero line +7dB 2. SLR at limiting line +12dB 3. RLR not louder than -6dB 4. RLR not quieter than -1dB
Test Procedure	1. Connect the Setup as shown in the figure. 2. Measure the SLR and RLR values using test equipment. 3. Check whether the values are within the specified limits.
Expected Results	Enclose the Test Results

Test No.	29
Test Details	Test for Side Tone Masking Rate (STMR) (2 wire interface only)
Test Instruments Required	1. PCM Analyzer
Test Setup	
Test Limits	1. STMR > +8 dB
Test Procedure	1. Connect the Setup as shown in the figure. 2. Measure the STMR value using test equipment for different line lengths. 3. Check whether the values are within the specified limits.
Expected Results	Enclose the Test Results

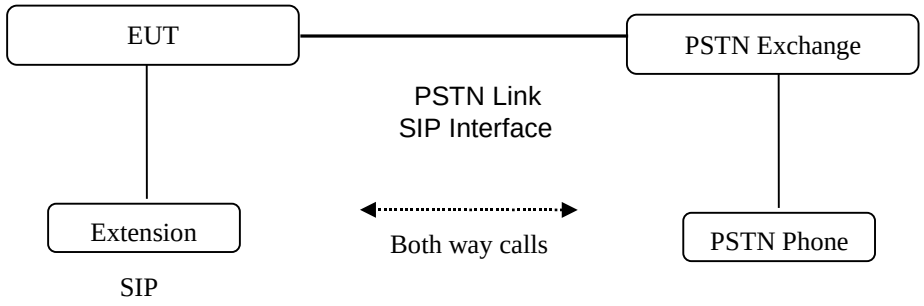
Test No.	30
Test Details	Test for Noise level (2 wire interface only)
Test Instruments Required	1. Noise Level Meter
Test Setup	
Test Limits	1. Noise level less than -65dBm
Test Procedure	1. Connect the Setup as shown in the figure. 2. Measure the Noise level value across 600 ohms termination of EUT using test equipment. 3. Check whether the values are within the specified limits.
Expected Results	Enclose the Test Results

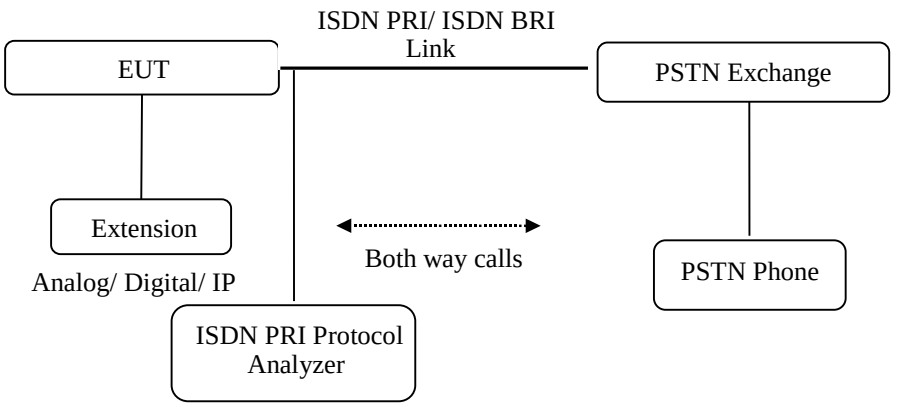
Test No.	31
Test Details	Test for Minimum Longitudinal Loss
Test Instruments Required	1. PCM Analyser
Test Setup	
Test Procedure	1. Connect the test setup as shown in figure 2. Measure the Minimum Longitudinal Loss using the PCM Analyser
Expected Results	Enclose the Results / Screenshots

Test No.	32
Test Details	Test for Return Loss (ISDN PRI/E1R2 interface)
Test Instruments Required	1. Network Analyser
Test Setup	
Test Limits	1. Refer clause 9.3 of ITU-T G.703 [Refer Test-8 for details]
Test Procedure	1. Connect the Setup as shown in the figure. 2. Measure the input port return loss using the Network Analyser 3. Check whether the Return Loss is within the specified limits
Expected Results	Enclose the Test Results

Test No.	33
Test Details	Test for Output Pulse Mask (ISDN PRI/E1R2 interface)
Test Instruments Required	1. Digital Communication Analyser / Storage Oscilloscope
Test Setup	
Test Limits	Refer Figure-15 G.703 [Refer Test-7 for details]
Test Procedure	1. Connect the EUT as shown in the figure. 2. Enable the Port if required. 3. See whether the output pulse is within the mask/limits as indicated above.
Expected Results	Enclose the Test Results with the Pulse shape & the Pulse Mask

Test No.	34
Test Details	Test for support of Traffic report generation

Test Instruments Required	Nil
Test Setup	
Test Procedure	1. Connect the system, as shown in the above setup and configure the EUT to enable it to send and receive calls to/from PSTN using SIP interface. 2. Configure the system to generate traffic reports for IC and OG calls. 3. Make outgoing and incoming calls from SIP extension to PSTN phone and vice versa. 4. Check if the system is able to generate traffic report.
Expected Results	Enclose the traffic report.

Test No.	35
Test Details	Test for the ISDN PRI/BRI Protocols
Test Instruments Required	ISDN Protocol Analyzer
Test Setup	
Test Procedure	1. Connect the system, as shown in the above setup configure the EUT to and enable it to send and receive calls to/from PSTN 2. Make outgoing and incoming calls from EUT extension to PSTN phone and vice versa. 3. Use ISDN PRI protocol Analyzer for verifying support of the following parameters in ISDN PRI / BRI messages - a. Call reference b. Bearer capability c. Called party number d. Calling party number e. Channel identification f. Numbering plan identification
Expected Results	Enclose the results from ISDN PRI / BRI Protocol Analyzer

Test No.	36
Test	Tests with connectivity over E1R2 Signaling
Tests involved	1. Line Signaling 2. Register Signaling 3. Fax Transmission
Test Setup	Typical connectivity of EUT with E1R2 Signaling Interface
	Note: E1R2 signaling to be tested between EUT and two Switches of different switching technologies.

Line Signaling and Register Signaling as per Chapter 2, Section B of GR G/LLT-01/04.DEC98

(Relevant clauses are given.)

2.5.2.1.1 Line signalling - Digital Type 1

Operating condition	Signaling				
	Forward			Backward	
	af	bf	cf	ab	bb
Idle	1	0	0	1	0
Seizure	0	0	0	1	0
Acknowledgement	0	0	0	1	1
Answer	0	0	0	0	1
Metering Pulse (180 - 270 ms)	0	0	0	1	1
Clear back	0	0	0	1	1
Clear forward	1	0	0	0 or 1	1
Release guard	1	0	0	1	0
Trunk Offering and Re-ringing					
a) TKO press key	0	0	1	1	1
b) False answer	0	0	1	0	1
c) Release key	0	0	0	0	1
d) “B” party on hook	0	0	0	1	1
e) Re-verify	0	0	1	1	1
Blocking	1	0	0	1	1

Notes:

1. For all supervisory signals bf = 0; a change to bf = 1 indicates a fault.
2. The trunk offering signal can be used as a control signal for echo suppresser in case of satellite application.

3 df, cb, db are spare bits, df =db = 1, and cb = 0, are assigned according to ITU-T Recommendation G732.

2.5.2.2.1 Line signalling - Digital Type 2

Operating condition	Signaling			
	Forward		Backward	
	af	bf	ab	bb
Idle	1	1	1	0
Seizure	0	1	1	0
Acknowledgement	0	1	1	1
Answer	0	1	0	1
Metering Pulse	0	1	1	1
Clear back	0	1	1	1
Clear forward	1	1	0 or 1	1
Release guard	1	1	1	0
Trunk Offering and Re-ringing				
a) TKO press key	0	0	1	1
b) False answer	0	0	0	1
c) Release key	0	1	0	1
d) “B” party on hook	0	1	1	1
e) Re-verify	0	0	1	1
Blocking	1	1	1	1

Forward	cf = 0
	df = 1
Backward	cb = 0
	db = 1

2.5.2.3.1 Line signalling - Digital Type 3

Operating condition	Signaling			
	Forward		Backward	
	af	bf	ab	bb
Idle	1	1	1	1
Seizure	0	1	1	1
Answer	0	1	0	1
Metering Pulse	0	1	1	1
Clear back	0	1	1	1
Clear forward	1	1	0 or 1	1
Release guard	1	1	1	0
Trunk Offering and Re-ringing				
a) TKO press key	0	0	1	1
b) False answer	0	0	0	1
c) Release key	0	1	0	1
d) "B" party on hook	0	1	1	1
e) Re-verify	0	0	1	1
Blocking	1	1	0	1

2.5.2.4.1 Line Signalling - Digital Type 4 (E&M signalling)

This signalling scheme is used over carrier circuits and is basically the same as that specified for ITU-T signalling system R2, analogue version as per recommendations Q.411, Q.412, Q.414, Q.415 and Q.416. It is of the out of band and low level continuous type (3825 Hz + 4 Hz) with tone-OFF in the answered condition (tone-ON-idle signalling). The system provides for link-by-link transmission of the line signals. The tone OFF condition in the forward (backward), direction is signalled by connecting earth to the send (receive) leg of the signalling channel. The signalling scheme available on the analogue media and corresponding sequence on TS16 of the 2048 kbit/s PCM stream is outlined in the table below :

Signal	Forward	Backward	af	bf	ab	bb
Idle	Tone ON	Tone ON	0	0	0	0
Seizure	Tone OFF	Tone ON	1	0	0	0
Answer	Tone OFF	Tone OFF	1	0	1	0
Metering Over channel	Tone OFF	Tone ON during the meter pulse followed by Tone OFF	1	0	1/0/1	0
Clear forward	Tone ON	Tone ON or OFF	0	0	0 or 1	0
Clear back	Tone OFF	Tone ON	1	0	0	0

Release guard	Tone ON	On recognition of clear forward Tone OFF followed by Tone ON	0	0	1/0	0
Blocking	Tone ON	Tone OFF	0	0	1	0
Echo canceller control						
(On O/G side)	Tone OFF	Tone ON	1	1	0	0
(On I/C side)	Tone OFF	Tone ON	1	0	0	1

Notes:

1. The period of backward tone off for release guard is 450 □ 90 ms, as per ITU-T R2 Recommendation Q.412. However, in existing electromechanical exchanges in the Indian network this may be of the order of 70-100 ms only. E-10B TAXs may provide the timing as per ITU-T R2 Recommendation Q.412.
2. The recognition time for a changed condition is 20 ms.
3. In transit exchanges, the answer signal is immediately repeated to the preceding exchange.
4. The metering signal has a duration of 180 to 270 ms.
5. A signal to switch "in" or "out" echo-suppresser is to be sent, while working over satellite circuits. The echo-suppresser is assumed to be provided along with the transmission equipment outside the exchange. The signal to switch echo-suppresser is carried out on M 2 wire.

2.0 : Register Signalling - Indian R2 Modified MFC Signalling

2.5.1.2.2.1 Indian R2 Modified MFC Signalling

2.5.1.2.2.1(a) The register signalling uses multi-frequency compelled sequence self-checking code. Generally end to end signalling is used except on national and international calls established through a TAX, in which case, the signalling is end-to-end between the originating exchange and the originating TAX and between originating TAX and the last exchange (TAX or local) using MFC.

2.5.1.2.2.1(b) In the existing TAXs, only 5 forward and 5 backward frequencies have been equipped (allowing 10 MF signals in each direction in 2/5 code), though provision exists for introduction of sixth frequency as per R2 scheme. In local MFC type exchanges, only 5 forward and 4 backward frequencies have been equipped.

2.5.1.2.2.1(c) The frequencies used in the backward direction are 660, 780, 900, 1020 and 1140 Hz. Those used in forward direction are 1380, 1500, 1620, 1740, and 1860 Hz. (Provision exists for addition of 1980 Hz in forward and 540 Hz in backward direction).

2.5.1.2.2.1(d) Forward signals

The forward frequencies can be used to send digits (when used as Group-I

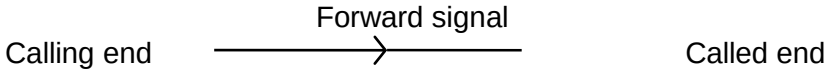
forward signals) or to send the category of calling subscriber (when used as group-II forward signals).

2.5.1.2.2.1(e) Backward signals

The backward frequencies can be used to make further demands (when used as Group-A backward signals), or to report back the called line condition to the calling side (when used as Group-B backward signals). In electronic exchanges all 5 backward frequencies shall be equipped.

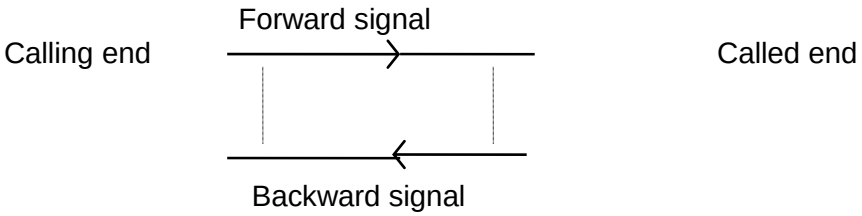
2.5.1.2.2.1(f) Signalling sequence

i)



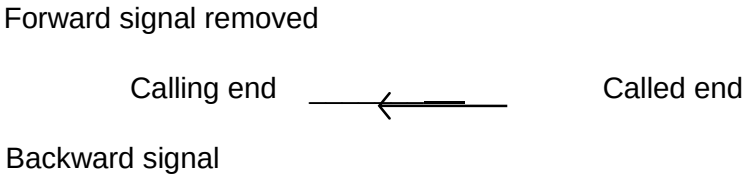
Calling end applies the forward signal as per the demand previously made by the called end (or the first digit start with). At the called end, this signal is examined for relevance and 2/5 validity.

ii)



Called end applies backward signal as per next requirement. The application of backward signal is recognised at calling end as the acknowledgement for reception of forward signal. The 2/5 validity is checked and the demand is decoded.

iii)



Forward signal is removed as an acknowledgement to the receipt of a backward signal.

iv) When the removal of a forward signal is recognised, the backward signal is also removed and this removal is recognised by the calling end, to end the sequence.

2.5.1.2.2.1(g) Significance of the Multi-frequency signals:

The significance of the forward signals and backward signals, as interpreted in the Indian network, are given in tables below :

Group I - Forward Signals

Signals	Indian National MFC scheme
I.1	Digit 1
I.2	Digit 2
I.3	Digit 3
I.4	Digit 4
I.5	Digit 5
I.6	Digit 6
I.7	Digit 7
I.8	Digit 8
I.9	Digit 9
I.10	Digit 0

Group II - Forward Signals

Signals	Indian National MFC scheme
II.1	Ordinary Subscriber
II.2	Priority Subscriber
II.3	Spare at present (proposed for use in future for 'maintenance equipment call')
II.4	Spare at present
II.5	Operator
II.6	STD coin box.
II.7	Spare
II.8	Spare
II.9	Spare
II.10	Spare

Group A - Backward Signals

Signals	Indian National MFC scheme
A.1	Send next digit (n+1)
A.2	Restart
A.3	Change over to reception of B-signals
A.4	Calling line identification-see note
A.5	Send category of the calling subscriber
A.6	Switch-through the speech path
A.7	Send last but two digit (n-2) } Not
A.8	Send last but three digit (n-3) } available in
A.9	Send last but one digit (n-1) } local
A.10	exchange Spare at present (may be used for } at present trunk congestion if network permits) }

Group B - Backward Signals

Signals	Indian National MFC scheme
B.1	Spare
B.2	Changed number
B.3	Called line busy
B.4	Congestion
B.5	Unallotted number
B.6	Normal subscriber, free, with metering
B.7	Spare
B.8	Spare; not available in local exchange
B.9	Spare; not available in local exchange
B.10	Spare; not available in local exchange

Test No.	37
	SIGNALLING TEST FOR CONNECTIVITY BY CCS7
Test Setup	
Tests	1. Protocol Data Check 2. MTP Level 2 Tests 3. MTP Level 3 Tests 4. ISUP Tests 5. Interface Tests
Test arrangement:	At least 2 signaling link sets should be available to check various capabilities of CCS7 signaling. A suitable CCS7 protocol Simulator and Analyser is required to be connected to IP based Integrated Media Gateway for simulating and monitoring the messages. The testing shall be carried out as per the test description given in each Test sheet of the ITU-T document given in the following Test Schedule.

1. Protocol Data check: Check the document or obtain certificate from the vendor in support of the following sub paras:

1.1. Signalling network Management messages:

Check messages implemented in the system with Table 1 of ITU-T recommendation Q.704 (1988).
Following signalling network management messages are optional for interface approval.

CNP, CNS, CSS, DLC, RSR, TFR and UPU.

1.2. ISUP messages: Check Heading Code implemented in the system with Table 3 of ITU-T recommendation Q.763 (1988). Following ISUP messages are optional for interface approval:

CMC, CMRJ, CMR, CQM, CQR, COT, DRS, FAA, FAR, FRJ, FOT, LPA, OLM, PAM, USR and UCIC.

1.3. Timer values: Check the values of Level 2 Timers, Level 3 Timers and Application call processing timers implemented in the system with the following documents:

Timer Document Reference

Level 2 Timers Page 3 MTP para 12.3 of National CCS7 specification for Local/Tandem exchanges No. G/CCS-01/01.JUN93.

Level 3 Timers Para 16.8 of ITU-T recommendation Q.704 (1988). Timers T11, T15, T16 are not applicable. Timers T7, T18, T19, T20, T21 & T24 are optional.

Application call Annex A to ITU-T recommendation Q.764 of call 1988. Timers T3 and T4 timers processing are not used. Timers T28, T31 and T32 are optional.

2. MTP Level 2 tests: The compatibility tests given in ITU-T Q.781 (1988) will be done on the CCS7 links of Integrated Media Gateway with a suitable CCS 7 protocol Simulator and Analyser. The protocol shall conform to the ITU-T test sheets mentioned below.

Tests for MTP2

Clause No.	Description		Test results
2.3 Clause from S/CCS 02/03	The functions and procedures relating to transfer of signaling messages over a data link shall be as per ITUT Rec. Q.703 (1993). This provides the layer 2 functions for the CCS7 protocol Stack.		ITU-T Rec. Q.781 validates the protocol specification in ITU-T Rec Q.703
	ITU-T Rec Q781 Test Cases		
SI No	Test case Description	Limits	Compliance Test Results
MTP2-1	Timer T2 - Q781:1.2	5-150sec	
MTP2-2	Timer T3- Q781:1.3	1-2sec	
MTP2-3	Timer T1 and T4 (Normal) – Q781:1.4	7.5-9.5sec	
MTP2-4	Normal Alignment - correct procedure (FISU) - Q781:1.5		
MTP2-5	Emergeny Alignment – Timer T4 - Q781:1.19	400-600msec	
MTP2-6	AERM: Error rate above normal threshold - Q781:7.3		
MTP2-7	Negative Acknowledgement - Q781:8.2		
MTP2-8	Retransmission Buffer Full - Q781:8.3		
MTP2-9	Excessive delay of acknowledgement - Q781:8.12		
MTP2-10	Restart of Timer T7 - DelayQ781:10.2		
MTP2-11	Timer T6 -Congestion Control Timer Q781:10.3	3-6sec	

3. MTP Level 3 tests: The compatibility tests given in ITU-T Q.782 (1988) will be done on the CCS7 links of Integrated Media Gateway with Suitable CCS7 Simulator and Analyser. The protocol shall conform to the ITU-T test sheets mentioned below.

Tests for MTP3

Clause No.	Description	Test Results
2.4 Clause from S/CCS-02/03	The functions and procedures relating to transfer of signaling messages between the signaling points shall be as per ITU-T Rec. Q.704 (1993). This provides the layer 3 functions for the CCS7 protocol stack	ITU-T Rec. Q.782 validates the protocol specification in ITUT Rec Q.704
	ITU-T Rec Q782 Test Cases	

Sl.No	**Test Cases Description**	
MTP3-1	Signalling linkset deactivation - Q782:1.2	
MTP3-2	Signalling linkset activation- Q782:1.3	
MTP3-3	Message with invalid DPC - Q782.2.2 – use a SLTM message.	
MTP3-4	Message with errorneous SI-Q782.2.3	
MTP3-5	Reception of an additional Changeover Order – Q782.3.6	
MTP3-6	Changeover to several links within a linkset - Q782:3.15	
MTP3-7	Additional CBD – Q782.4.3	
MTP3-8	No Acknowledgement to first CBD – Q782.4.4	
MTP3-9	Inhibition of an available link - Q782:7.1.1	
MTP3-10	Inhibition of an unavailable link – Q782:7.1.2	
MTP3-11	Local reject on available link – Q782:7.2.1	
MTP3-12	Forced unhibition of a link - sending LFU - Q782:7.10.1	
MTP3-13	Forced unhibition of a link - reception of LFU - Q782:7.10.2	
MTP3-14	Management Inhibiting Test: Periodic sending and receiving of LLI and LRI-Q 782: 7.17.1	
MTP3-15	Signalling link test: After activation of a Link-Q782:12.1	
	Miscellaneous MTP Test Cases	
MTPMisc-1	It shall be possible to assign the signaling data link to any timeslot of the PCM except timeslot 0.	

4. ISUP tests:

The compatibility tests given in ITU-T Q.784 (1991) will be done on the CCS7 links of Integrated Media Gateway with A Suitable CCS7 Simulator and Analyser. The protocol shall conform to the ITU-T test sheets mentioned below.

Test Cases for ISUP

Clause No.	Description	**Test Results**
	Clause from S/CCS-02/03	
5.1	ISUP shall be as per the functional description given in ITU-T Rec. Q.761 (09/97).	ITU-T Rec. Q.784 validates the protocol specification in ITU-T Rec Q.761Q.764
5.2	The messages, parameters and the parameter information used by ISUP shall be as per ITU-T Rec.Q.762(09/97)	
5.3	The formats and codes of ISUP messages and the parameters required to support basic bearer services and the supplementary services shall be as per ITU-T Rec. Q763(09/97)	
5.4	The ISUP signaling procedures for setting up and clearing down of national and international ISDN connections shall be as per ITU-T Rec.	

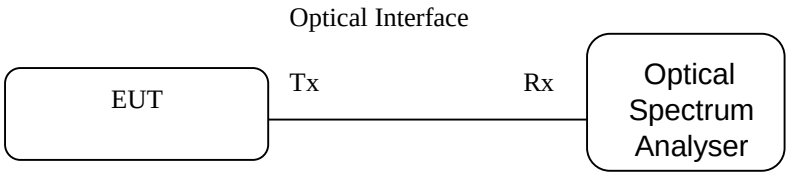
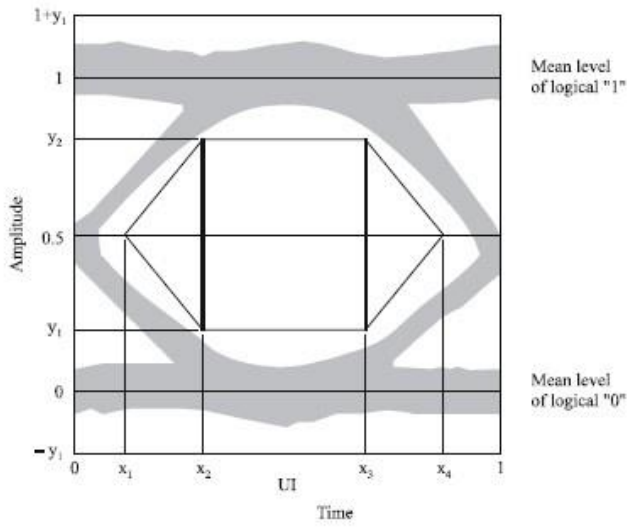
	Q764(09/97)	
	ITU-T Rec.Q784 Test Cases	
SL.No.	Test Cases Description	
ISUP-1	Reset received on an idle circuit – Q784.1.2.1	
ISUP-2	Reset sent on an idle circuit – Q784.1.2.2	
ISUP-3	Circuit group reset received-Q784:1.2.5	
ISUP-4	Circuit group reset sent-Q784.1.2.6	
ISUP-5	CGB and CGU received - Q784:1.3.1.1	
ISUP-6	CGB and CGU sent - Q784:1.3.1.2	
ISUP-7	Circuit Blocking received– Q784.1.3.2.1	
ISUP-8	Circuit blocking sent – Q784.1.3.2.2	
ISUP-9	Continuity Check Test: CCR received: Q784:1.4.1	
ISUP-10	Continuity Check Test: CCR sent: Q784:1.4.2	
ISUP-11	Normal Call setup:Overlap operation(with SAM)-Q784:2.2.2	
ISUP-12	T7: Waiting for ACM - Q784:5.2.1	
ISUP-13	T9:Waiting for an answer message-Q784:5.2.2	
ISUP-14	T16 and T17: failure to receive a RLC – Q784.5.2.8	
ISUP-15	Reset of circuits during a call – outgoing circuit- Q784:5.3.1	
ISUP-16	Reset of circuits during a call – incoming circuit- Q784:5.3.2	
ISUP-17	Automatic repeat attempt - blocking of a circuit - Q784:6.2.2	
ISUP-18	Dual Seizure for controlling SP-Q784:6.3.1	

Test For ISUP Supplementary Services

Clause No.	Description	Test Results
	Clause No. S/CCS-02/03	
Chapter4	The general format for ISDN user part (ISUP) supplementary services shall be as per ITU-T Rec.Q.730(9/97)The implementation of the supplementary services shall be as per IT-T Rec. Q.731 to Q.737.	
Sl.No.	Test Case Description	
SUPP-1	Calling Line Identification Presentation (CLIP)-Q731.3(3/97)	
SUPP-2	Calling Line Identification Restriction(CLIR)-Q.731.4(3/97)	
SUPP-3	Connected Line Identification Presentation(COLP)-Q.731.5(3/97)	
SUPP-4	Connected Line Identification Restriction (COLR)-Q.731.6(3/97)	
SUPP-5	Malicious Call Identification (MCID)-Q.731.7(2/97)	
SUPP-6	Sub addressing (SUB)-Q.731.8(6/97)	

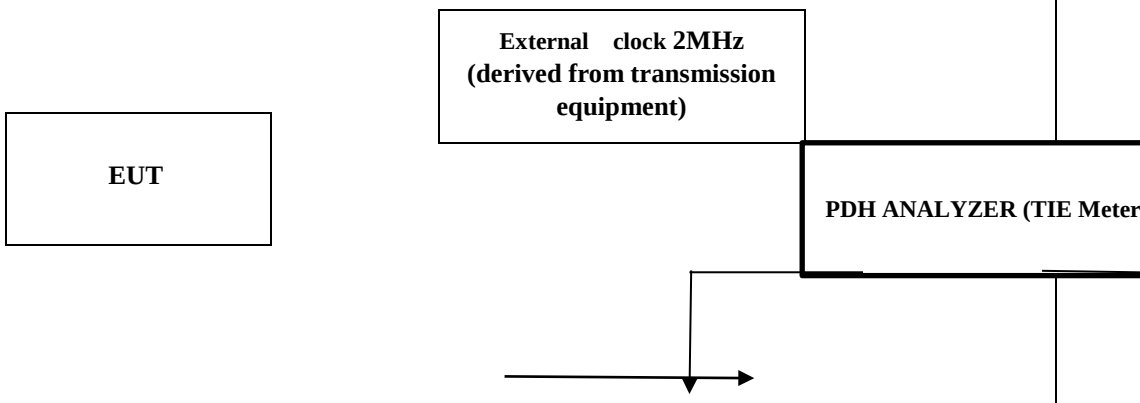
5 : Interface Tests for CCS7 Signaling

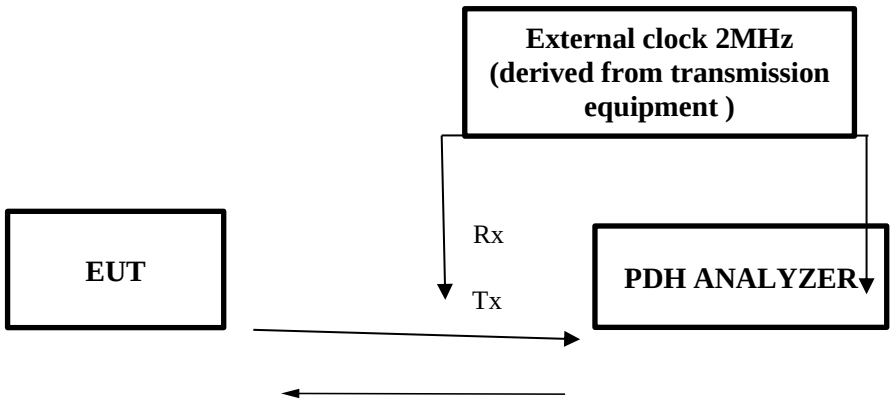
Clause No.	*Description*		Test Results
1	**Completed Call**	Check for ISUP Messages	
2	A-Party Release	Check for ISUP Messages	
3	B-Party Release	Check for ISUP Messages	
4	B-Party Engaged	Check for ISUP Messages	
5	Incomplete Dialling	-	
6	Call with 10 digit CLI	Check for ISUP Messages	
7	B Party No answer	Check for ISUP Messages	
8	Fax	Fax Transmission	
9	Modem connection	Set the codec to G711 & initiate call from Modem A to Modem B through VOIP network. The data transfer should be tested between the two modems.	
10	Modem Connection	Set the codec to G729 & initiate call from Modem A to modem B through VOIP network. The data transfer should be tested between the two modems.	

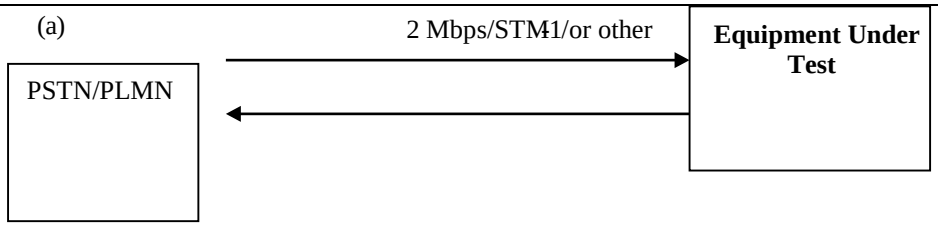
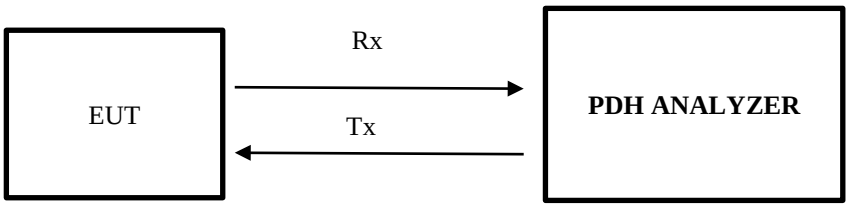
<table>
<tr><td>Test No.</td><td>38</td></tr>
<tr><td>Test Details</td><td>Eye Pattern for Optical Interfaces</td></tr>
<tr><td>Test Instruments Required</td><td>1. Optical Spectrum Analyser</td></tr>
<tr><td>Test Setup</td><td> 
</td></tr>
<tr><td>Test Limits</td><td><table>
<tr><td>STM-1 Short Haul / Long Haul</td><td>Refer Figure-2/G.957</td></tr>
<tr><td>STM-4 Short Haul / Long Haul</td><td>Refer Figure-2/G.957</td></tr>
<tr><td>STM-16 Short Haul / Long Haul</td><td>Refer Figure-2/G.957</td></tr>
</table></td></tr>
<tr><td>Standards Reference</td><td> 

<table>
<tr><td></td><td>STM-1</td><td>STM-4</td></tr>
<tr><td>x1/x4</td><td>0.15/0.85</td><td>0.25/0.75</td></tr>
<tr><td>x2/x3</td><td>0.35/0.65</td><td>0.40/0.60</td></tr>
<tr><td>y1/y2</td><td>0.20/0.80</td><td>0.20/0.80</td></tr>
</table>
<table>
<tr><td></td><td>STM-16</td></tr>
<tr><td>x3–x2</td><td>0.2</td></tr>
<tr><td>y1/y2</td><td>0.25/0.75</td></tr>
</table>
G.957_F02
NOTE – In the case of STM-16, x2 and x3 of the rectangular eye mask need not be equidistant with respect to the vertical axes at 0 UI and 1 UI. The extent of this deviation is for further study. In view of the frequencies involved in STM-16 systems and the consequent difficulty of realizing this filter, the parameter values for STM-16 may need slight revision in light of experience.
Figure 2/G.957 – Mask of the eye diagram for the optical transmit signal</td></tr>
<tr><td>Test Procedure</td><td>1. Connect the Setup as shown in the figure.
2. Enable the output Optical Port
3. Measure the optical spectrum / eye pattern
4. Check whether the spectrum / eye patternis within the specification limits</td></tr>
</table>

Expected Results	Enclose the Test Results

Test No.	39
Test Details	Test for Frequency Stability in Holdover Mode
Test Instruments Required	PDH Analyzer
Test Setup	
Test Procedure	1. Connect the Setup as shown in the figure. Synchronies both the EUT & PDH Analyser (Testing equipment) as per test setup from external timing reference which may be extracted from transmission equipment.) 2. After the EUT is synchronised and stabilised, remove the reference input. 3. It will go to holdover mode. 4. Now run the TIE measurement in holdover mode, which should be started at this point for 24 Hrs. 5. Measure Time Interval Error (TIE) on PDH analyzer 6. Clock stability should be calculated as follows: Clock stability= Time Interval Error (TIE)/Measurement Duration
Test Limits	Frequency Stability in Holdover Mode. Minimum stability of clock in holdover mode shall be 1*10-9 per day. The term 'minimum stability' implies that the stability should be equal to or better than the value specified.

Test No.	40
Test Details	Test for Bit Slip Measurement
Test Instruments Required	PDH Analyzer
Test Setup	
Test Procedure	1. Connect the Setup as shown in the figure. Synchronize both the EUT & PDH Analyser (Testing equipment) as per test setup from external timing reference which may be extracted from transmission equipment.) 2. After the EUT is synchronised and stabilized, run the measurement (PRBS bit pattern) which should be started at this point for 96 Hrs. 3. Measure Slipon PDH analyzer for a period of atleast 96 hours of operation. In synchronised mode of operation, not more than 2 slips per day are permitted.
Test Limits	Under synchronized condition, slips observed at the 2048 Kbits interface of digital exchange/ EUT shall be less than or equal to 2 slips in 24 hours.

Test No.	41
Test Details	Test for junction test
Test Instruments Required	PDH Analyzer
Test Setup	(a)   (b)
Test Procedure	1. *First connect the Setup as shown in the figure (a) as per interface applicable 2Mbps/STM-1/or other. Break the interface continuity either by soft command or physically removing the wire. Verify the status of link in break condition; alarm should appear, when reconnect the alarm should disappear.* 2. *Now connect the Setup as shown in the figure (b) as per interface applicable 2Mbps/STM-1/or other through PDH analyzer. Verify the status of link in healthy condition of interface from PDH analyzer. Now increase the BER gradually through PDH analyzer and observe the alarm condition. Note down the BER threshold level when alarm appear. This value of BER should be within accepting limits.*
Test Limits	Check all alarms and note down the values of thresholds regarding junction testing.