



वर्गीय अपेक्षाओं के लिए मानक

टीईसी ५२०१०:२०२६

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STANDARD FOR GENERIC REQUIREMENTS

TEC 52010:2026

(Supersedes No. TEC 52010:2005)

स्ट्रक्चर्ड लैन केबलिंग

Structured LAN Cabling



ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र

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FOREWORD

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

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

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

ABSTRACT

This Standard for Generic Requirements for a Product/Equipment pertains to Structured LAN Cabling.

CONTENTS

<i>Clause*</i>	<i>Particulars</i>	<i>Page No.</i>
History Sheet		5
References		6
	<i>Chapter 1</i>	9
1.0	Scope	9
1.1	Conformity to standard	9
1.2	Structured Cabling	10
1.3	The UTP/STP copper cable	24
1.4	Optical fibre requirements	25
1.5	Equipment room system/Entrance facility	27
1.6	Channel Performance	27
	<i>Chapter 2</i>	29
2.1	Scope	29
2.2	General requirements	29
3.0	Purchaser Requirements	36
	Abbreviations	37
	Annex 1	38
	Annex 2	39
	Annex 3	40
	Annex 4	41
	Annex 5	41
	Annex 6	42
	Annex 7	42
	Annex 8	43

HISTORY SHEET

<i>S. No.</i>	<i>Standard / document No.</i>	<i>Title</i>	<i>Remarks</i>
1.	No. GR/SLC-01/01.FEB 2001		Generic Requirement for Structured LAN Cabling
2.	GR/SLC-01/02 SEP 2005 <i>(Updated No : TEC 52010:2005)</i>		Review of Generic Requirement for Structured LAN Cabling. Incorporation of Modified EMC Requirements and addition of standards for CAT 6 cable
3.	TEC 52010:2026		Revision of GR by including cat 6A & onwards category LAN Cables

REFERENCES

S.No.	Document No.	Title/Document Name
[1]	TEC 11016:2016	Electromagnetic Compatibility Standard for telecommunication Equipment
[2]	TEC 14016:2010	Standard for Environmental testing of Telecommunication equipment
[3]	CISPR32	Electromagnetic compatibility of multimedia equipment - Emission requirements
[4]	QM-118	Quality reliability in product design.
[5]	QM-205	Guidelines for standard of workmanship for printed boards.
[6]	QM-206	Guidelines for standard of workmanship for printed boards assemblies.
[7]	QM-210	Guidelines for standard of workmanship for surface Mounting Devices.
[8]	QM-301	Transmission Equipment General Documentation
[9]	QM-324	Approval procedures for components used in telecom products.
[10]	IEC61000-4-2, IEC61000-4-3, IEC61000-4-4, IEC61000-4-5, IEC61000-4-6	Electromagnetic compatibility: Testing and measurement techniques
[11]	ANSI/TIA TSB 184A	Guidelines for supporting Power over Ethernet (PoE) delivery over balanced twisted-pair cabling
[12]	ANSI/TIA-569-B	Commercial Building Standard for Telecommunications Pathways and Spaces.
[13]	ANSI/TIA-606-A	Administration Standard for Commercial Telecommunications Infrastructure
[14]	ANSI/TIA-606-B	Guidelines for the administration of telecommunications infrastructure in all premises

[15]	ANSI/TIA-607-B	Telecommunications Grounding (Earthing) and Bonding for Customer Premises
[16]	TSB-190:	Guidelines on Shared Pathways and Shared Sheaths.
[17]	TSB-155-A:	Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T
[18]	ANSI/TIA T568 A & ANSI/TIA T568 B	The wiring standards that define the pinout (connection order) for terminating twisted-pair network cable in eight-pin modular connector
[19]	ISO 11801	International standard structured cabling is suitable for a wide range of applications (analog & ISDN telephony, various data communication standards etc.)
[20]	ANSI/TIA-568-2-E	Minimum requirements for balanced twisted-pair telecommunications cabling (channels and permanent links) and components (cable, connectors, connecting hardware, cords, and jumpers) that are used within buildings and between buildings in a campus environment.
[21]	IEC-61156-5	Standard specifying requirements for multicore, screened, or unscreened symmetrical pair/quad cables designed for horizontal floor wiring
[22]	IEC-60332-1	Test method for assessing the vertical flame propagation of a single insulated conductor or cable, whether electrical or optical, under defined fire conditions.
[23]	IEC-60332-3	Test methods for testing the vertical flame spread of vertically-mounted bunched cables or wires, whether electrical or optical, under defined fire conditions
[24]	ISO 9001:2015	Quality Management Systems Requirements.

Note: Unless otherwise explicitly stated, the latest approved issue of the standard/GR/IR, with all amendments in force, listed in references, on the issuance date of this GR/IR are applicable.

TEC 52010:2026

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Chapter 1

Requirements of Structured LAN Cabling

1.0 SCOPE: This chapter defines the different structured LAN cabling methods that shall be deployed in the LAN cabling for different applications of Indian Telecom network. The structured LAN cabling is one of the important requirements to allow the usage of multi-media and to support high-speed application, 10/100/1000Mbps & 10Gbps over up-to 100meters and 25GBase-T/40GBase-T over up-to 30meter of structured cabling according to IEEE 802.3 international standards. The structured cabling consists of elements like cables, faceplates, patch panels, outlets and frames, etc. which shall conform to the standards mentioned in this document so that they can be used for above specified transmission speed.

1.1 Conformity to Standard: The Structured Cabling System shall meet the following standards:

- a) ISO/IEC 11081: International standard for generic cabling for customer premises
 - i. ANSI/TIA TSB 184A : Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
 - ii. ANSI/TIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
 - iii. ANSI/TIA-606-B (administration)
 - iv. ANSI/TIA-607-B: Telecommunications Grounding (Earthing) and Bonding for Customer Premises
 - v. TSB-190: Guidelines on Shared Pathways and Shared Sheaths.
 - vi. TSB-155-A: Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T
 - vii. ANSI/TIA-1179: Healthcare Facility Telecommunications Infrastructure Standard

- viii. ANSI/TIA-4966: Telecommunications Infrastructure for Educational Buildings and Spaces
 - ix. TSB-162-A: Telecommunications Cabling Guidelines for Wireless Access Points.
 - x. TSB-184: Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
- b) ANSI/TIA 568-B Commercial Building Telecommunications cabling Standard (Category 5e cabling) – for characteristics specified up to 100MHz and supports full duplex 1000 Base-T, 100 Base-TX, 10 Base-T.
 - c) ANSI/TIA-568.2-E Telecommunication standard up-to Cat6A & onward Cabling- for characteristics specified up-to 500MHz and supports full 10GBase-T, 1000Base-T, 100Base-TX, 10Base-T.
 - d) The latest ISO/IEC-11801 and IEC 61156 -5 standard for Cat7/7A Cabling- for Characteristics specified up-to 600MHz for Cat7 and 1000MHz for Cat7A and supports full 10GBase-T, 1000Base-T, 100Base-TX, 10Base-T over 100meter and 25GBase-T with less than 30meter in Channel.

1.2 Structured Cabling: The cabling design to the department LAN cabling shall be as per the ANSI/TIA-568.2-E standards for Cat 5e/ Cat 6/ Cat6A & onwards & ISO/IEC-11801, IEC 61156-5 standard for Cat7/7A.

The structured cabling system design considerations is concerned with the following seven sub-systems:

(a) Building Entrance: Building entrance shall be the place where-in the interface equipment to the public network is positioned. The example for this is interface to the WAN through Routers/Leased lines etc.

(b) Equipment Room: The equipment room shall house the Active components for data

i.e. the Server and in case of voice the EPABX. The equipment room shall also house the Main Building Cross Connect connecting various floors of the building.

(c) Backbone Cabling: The backbone cabling shall consist of cables connecting the various floors of the building. The type of cable used shall be either Multi pair Category -5e or 4pair Cat6/Cat6a UTP/STP Cable or preferably be of Fiber optic cable.

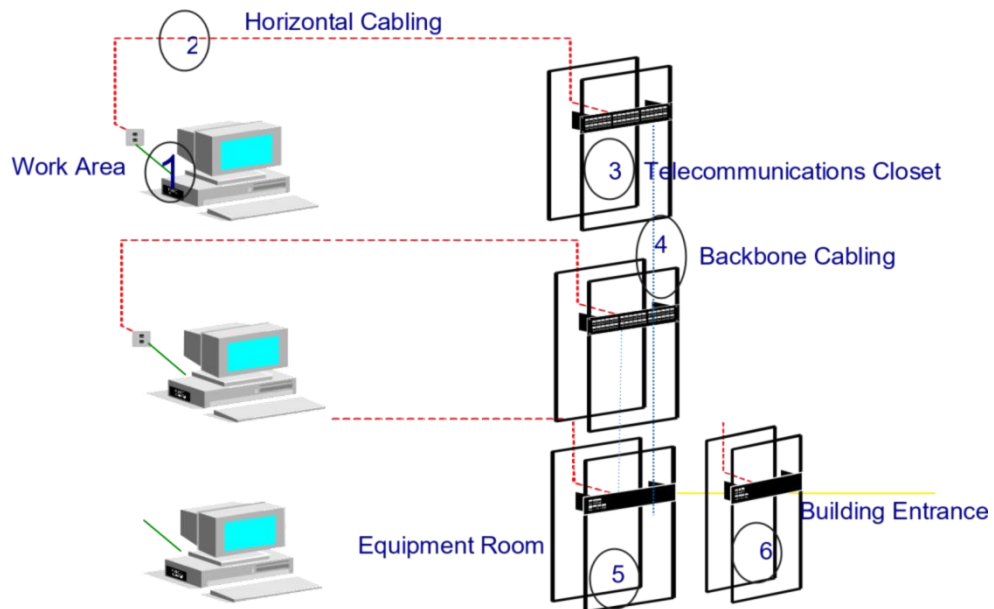
(d) Telecommunications Closet: The telecommunications Closet shall be placed in each floor which is a consolidation point for the Horizontal Cabling termination that interfaces with the Backbone cabling. The telecommunication closet shall also house the active equipment such as the Hubs/Switches catering to that particular floor.

(e) Horizontal Cabling: The horizontal Cabling shall consist of cables connecting the Telecommunications Closet to the Work Area Telecommunication Outlet/Information Out let. The cable type used shall be Category 6 or onwards 4 pair UTP/STP cable or 50/125 μ m multi-mode fiber optic cable.

(f) Work Area: The work area shall consist of the Telecommunications Outlet/Information Outlet wherein the horizontal cabling is terminated. The patch cord connecting the Telecommunication outlet/Information outlet to the node shall also form the part of the Work Area.

(g). Administration Sub System: ANSI/TIA-606-D is a standard that establishes the guidelines for the administration of telecommunications infrastructure in commercial buildings. Its primary goal is to ensure that all components of a structured cabling system are properly identified and documented to simplify maintenance, troubleshooting, and future upgrades.

Refer figure given below.



1.2.1 Category 6, 6A, 7, 7A, 8 Cables: The Transmission performance of Cat 6 is better than Cat 5e Cable.

- a) The characteristics for Cat 6 Channel are specified (requires a positive PSACR) up to 200 MHz and tested to 250 MHz (ref: Annex 1). Characteristics for Cat 6 Cable are specified (requires a positive PSACR) up to 250 MHz (ref: Annex 2)
- b) The Cat 6 link and channel requirements are backward compatible to Cat 5e.
- c) The Category 6 standard has specifications for patch cords and connectors that are intended to assure interoperable Cat 6 performance. (ref: Annex 3)
- d) Category 6 cables are covered under TIA/EIA-T568-B standards.
- e) Category 6A cables shall comply to the electrical and mechanical requirements of the latest standard ANSI/TIA-568.2-E (ref: Annex-1, Annex-2, Annex-3)
- f) Category 7/7A Cables support higher bandwidth applications, shall comply to the requirements of latest ISO/IEC-11801 standard (ref: Annex-4, Annex-5).
- g) Category 8 Cables, shall comply to the requirements of ANSI/TIA-568.2-E. _Cat8 channel length is restricted to **30 meters** (24 meters of horizontal cabling and up to 6 meters of patch cords). Cat8 requires shielding (typically S/FTP-Shielded/Foiled Twisted Pair) to mitigate Alien Crosstalk (AXT) and Electromagnetic Interference (EMI) at high frequencies. It is primarily used for Switch-to-Server connections in data centers (Top-of-Rack or End-of-Row configurations) where the 30-meter limit is sufficient.

1.2.2 Backbone Cabling: The backbone cabling for the Cat 6 & Cat 6A as per latest standard ANSI/TIA-568.2-E provide interconnection between telecommunications closets, equipment rooms, and entrance facilities. It consists of the backbone cable, intermediate and main cross-connects, mechanical terminations and patch cords or jumpers for backbone-to-backbone cross connection. The types and distances are referred in the following table:

Cabling Types	Backbone distance maximum
---------------	---------------------------

100 ohm UTP/STP 22 AWG to 24 AWG	800 meters for Voice
----------------------------------	----------------------

(American Wire Gauge), 100 Ohm	90 meters for Data
--------------------------------	--------------------

Multi-mode 50 /125µm Optical fiber	2,000 meters
------------------------------------	--------------

Single-mode Optical Fiber	3,000 meters
---------------------------	--------------

It is recommended to use 23AWG conductor for better PoE performance.

1.2.3 Horizontal Cabling: The Horizontal Cabling system for the as per the latest standard ANSI/TIA-568.2-E Cat 5e, Cat 6 & onwards & latest ISO/IEC-11801 and IEC 61156-5 for Cat7/7A extends from the telecommunications outlet in the work area (or workstation) to the horizontal cross-connect in the telecommunications closet. The following media types shall be used as options for horizontal cabling, each extending a maximum distance of 90 meters:

- a) 4-pair 100 Ohm UTP/STP cable (24 AWG or 23 AWG solid conductors).
- b) 2 fiber 50 / 125µ meter Optical fiber cable.

1.2.3.1 The horizontal cable shall meet the following requirements:

- (a) Horizontal cables shall be NEXT compliant - 4 pair UTP/STP cable (unshielded Twisted Pair-UTP/STP) of Category 5e or category 6 standard, to connect each telecommunication outlet (TO) or consolidation point (CP) to the backbone sub-system on the same floor.
- (b) The UTP/STP cable shall be of 24 AWG minimum for cat 5e and 23 AWG minimum for cat 6 cable bare solid copper conductors insulated with Polymer jacketed with Fire retardant PVC/LSZH & UV PE. The insulated conductors shall be twisted into pairs, with pairs balanced for attenuation.

It is recommended to include a new jacket material type along with Fire Retardant PVC/LSZH (In conformance to IEC 60332-1-2) & for Indoor-application like Healthcare, Offices, Malls, indoor

stadium or other facilities with dense human occupancy fire rating should comply to IEC 60332-3.

- (c) The UTP/STP cable shall be run using a star topology format from the cross connect at the floor distributor (FD)/ Telecommunication Closet (TC) administration subsystem on each floor to every individual telecommunication outlet. A 4 pair UTP/STP cable shall be run from the cross connect at the floor distributor (FD) administration subsystem on each floor to a consolidation point (CP) on the same floor.
- (d) The 4-pair Cat6A & onward (as per latest standard ANSI/TIA-568.2-E) & Cat7/7A cabling (as per latest standard ISO/IEC 11801 and IEC 61156-5) UTP/STP cable shall be able to meet 100mt Horizontal Cable Alien Crosstalk performance and all application support as per the Annexure 6 from the Floor Distributor (FD) wiring closet to the telecommunications outlet at the work area.
- (e) Each run of cable from the cross connect at the floor distributor (FD) and the telecommunication outlet shall be continuous without any joints or splices except for the open office design, when a consolidation point (CP), is proposed.
- (f) The length of each individual run of fixed horizontal cable from the administration subsystem (FD) on each floor to the telecommunication outlet shall not exceed 90 meters (at 20 degrees Celsius, if the temperature is 40 degrees the length shall not cross 84 meters & If the temperature is 60degree Celsius the cable length shall not exceed 75 meter for UTP type and 84 meter for Shielded Type).
- (g) The Cable design should be such that they are installation stress proof.
- (h) The 4 pair UTP/STP cable shall meet or exceed the following specifications
 - i. ANSI/EIA 568-A/B Commercial Building

Telecommunications Cabling Standard

- ii. Latest standard ANSI/TIA 568-2-E standard Cat 6 & onwards, latest standard ISO/IEC 11801 and IEC 61156-5 for Cat 7/Cat 7A Cable Specifications mentioned in Annex 2,4,5
- iii. All applications as per Annex 6
- iv. Conductor DC Resistance (Max): $9.38 \Omega/100 \text{ meter @}20\text{C}$
- v. DC Resistance unbalanced (Max): 5%
- vi. Insulation Resistance (Min): $5000\text{M}\Omega/1\text{kft@}20\text{C}$
- vii. Mutual Capacitance (Typical): $5.6 \text{ nF/ } 100 \text{ meter ;}$
- viii. Characteristics impedance: $100\pm 5\% \Omega @ 100 \text{ MHz}$
- ix. Typical Cable Skew: $45 \text{ nS /} 100 \text{ Meters.}$
- x. Flame Retardant: as per IEC 60332- 1-2 or IEC 60332-2 or IEC 60332-3
(As per purchaser requirement based on field application).

1.2.4. Telecommunication closet: Each piece of UTP/STP cabling connecting a device to a hub/switch shall be no longer than 90 meters for the reasons given below:

- a) Attenuation
- b) Interference
- c) Noise
- d) Propagation Delay

1.2.4.1 The UTP/STP connecting hardware used in the patch cords per 100 meters (Channel includes cable with connectors plus patch cord) @ 20°C shall meet the attenuation and NEXT (Near End Cross Talk) specifications defined in the TIA recommendations.

- (i) All Indoor Category/LAN cables used in projects should be compliant to latest ANSI/TIA-568-2.E and ISO/IEC-11801 and IEC 61156-5

Permanent link Performance 90 meter.

- (ii) For outdoor Category/LAN cables used in projects should be compliant to latest ANSI/TIA-568-2.E and ISO/IEC-11801 and IEC 61156-5 permanent link length from 50 to 70 meter permanent Link performance.

Purchaser may specify the exact cable requirement for the outdoor category based on the application, as per the options mentioned in the Clause 2.2.9(b) under purchaser requirement

1.2.4.2 The termination method for UTP/STP connecting hardware shall utilize the Insulation Displacement Contact (IDC) method.

1.2.4.3 Outlets shall be securely mounted. Outlet boxes with un-terminated cables must be covered and marked. Performance markings shall be provided to show the applicable transmission category and shall be visible during installation (to Cat 6/ Cat 6A on-wards) in addition to safety markings. Installed connectors shall be protected from physical damage and moisture by dust cover.

1.2.5 Work Area System: Work Area system shall consist of wiring or interconnect that connects active terminal devices to telecommunication outlets such as face plates, connectors, patch cards and terminal leads needed to make connections.

1.2.5.1 Faceplate: Faceplate shall meet the following requirements:

- a) Shall have the ability to fit a dust cap or shutter to prevent dust and dirt getting into the outlet for single, dual, Quad or Hexa outlets.
- b) Shall have clear label for application identification
- c) Shall be able to have 1,2,3,4,6 or 12 outlets
- d) Shall have options for vertical style or horizontal style.
- e) The faceplate housing the UTP/STP connector modules shall have no visible mounting screws.

- f) The faceplate housing the UTP/STP connector modules shall have aperture plugs to cover any unused openings in the faceplate.
- g) The faceplate housing the UTP/STP connector modules shall provide flexibility in configuring multimedia workstation outlets that respond to present of future network needs such as audio, video, coaxial and optical fiber applications.

1.2.5.2 Telecommunication Outlets- The telecommunication outlets shall meet the following requirements:

- a) All telecommunication outlets shall be universal RJ-45 type
- b) The outlet shall be NEXT compliant (as per Annex 3) ISDN 8-position/ 8-conductor standard type and shall be capable of receiving conventional 4,6 and 8 pin jack/plug of 22/23/24 AWG solid wire.
- c) Shall have Surface or flush mounted single or dual/Quad sockets
- d) Shall be able to support all application as per Annex 6.
- e) Shall be made from high-impact, flame-retardant, UL-rated 94 V-0 thermoplastic
- f) Shall meet or exceed latest ANSI/TIA-568-2.E and ISO/IEC 11801 and IEC 61156-5 Cat.6/ Cat 6A on-wards components Specifications
- g) The telecommunication outlet shall be of the insulation displacement connector (IDC) wiring termination. IDC termination shall have as Straight configuration when connecting with the cable conductor to improve termination hold
- h) The Outlet should have a built in mechanism to prevent pair un-twist of more than ¼ inch as specified by TIA.
- i) The IDC contact element shall be spring special brass with 5· m Nickel plating to reduce Oxidation of IDC & contact and sharper termination of copper cable, angularity arranged across the axis of conducting wire to maximize the gas tight connection. The contact range shall be 5 µm Nickel- plated to ensure minimum oxidization impact.

- j) The insulation displacement connectors of the outlets shall accept two insulated solid conductors of 22 to 24 AWG of the same size.
- k) The RJ45 jack offered shall confirm to EIA-T568A or EIA-T568B wiring schemes.
- l) The RJ45 jack technology should be Lead-frame type to have high reliability and better frequency compensation.
- m) The telecommunication outlet shall meet the following electrical performances: -
 - i. RJ Interface resistance: 20 m Ω
 - ii. Insulation resistance 100 M Ω at 500 VDC
 - iii. Contact resistance of 20 m Ω maximum (1 m Ω typical)
 - iv. Current rating of 2A at 20 deg.C per IEC Publication 512-3. Test 5b.
- n) The telecommunication outlet shall meet the following mechanical performance:
 - i. Insertion life of Level B reliability to IEC 603-7
 - ii. Plug/Jack contact force: 100g minimum per contact using FCC- approved plug.
 - iii. Plug retention force: 30 lb (133 N) minimum.
 - iv. Temperature range: -20 to 70 deg.C.

1.2.6 Modular Jack connector: ANSI/TIA T568-A/B defines four basic modular jack styles. The 8-position and 8-position keyed modular jacks are commonly referred as RJ-45 (Registered Jack) connector and keyed RJ45. The 6-position modular jack is commonly refereed as RJ11. RJ45 is the standard connector for unshielded twisted pair cabling. RJ 45 is a plastic connector with eight pins. It allows insertion in only one way. The jack wiring specification is as per the Universal Service Ordering Codes (USOC).

1.2.7 Patch Cord: The Patch cord shall meet the following requirements:

- (a) Shall consist of 8 Solid/Stranded copper conductors terminated with RJ 45 plugs at both ends.

- (b) Shall meet transmission performance and comply to latest ANSI/TIA 5682-E and ISO/IEC 11801- CAT 6 minimum standard for patch cord testing (as per Annex 3)
- (c) Factory terminated with options for 1.2 meter, up to 12.8 meters with a long flexible boot and in different colors. The boot material should be injected into the plug to retain the position of the conductors. The boot should be with inbuilt bend radius property.
- (d) Shall have Characteristics impedance of $100\Omega \pm 15\%$ @ 100 MHz.
- (e) The Patch cord shall have a inbuilt design properties to reduce central cross talk and improve strength.
- (f) Flame Retardant: as per IEC 60332-1 (Purchaser may specify better flame retardant compliance to higher IEC 60332-2 or IEC 60332-3, if required)

1.2.8 Patch Panel: Rack mounted patch panels shall be used for termination of copper cables or rack mount fiber termination unit shall be used for termination of optical fiber cable.

1.2.8.1 Patch cords shall be provided for cross-connections to facilitate Moves, Adds and Changes (MACs). They shall be able to support up to Category 6 & Cat 6A on-wards applications and shall be NEXT compliant.

1.2.8.2 The cross connect module shall be

- (a) Fire -retardant, molded plastic modules UL 94 VO rate, consisting of horizontal index strips for termination of Cat5 25 pair module to ensure ease of re-termination in case of wrong pair termination or
- (b) NEXT compliant RJ 45 Modular jack panel.
- (c) 10/25 pair disconnection module for incoming voice or 8/10/25 pair disconnection module for all data services.

1.2.9 Termination Module: The termination module shall be able to accommodate over 200 repeated insertions without incurring permanent

deformation and it shall pass the reliability test of no more than one contact failure in 1000 connections.

1.2.9.1 The termination module shall be of the disconnection type to minimize wiring termination and allow test cords to isolate the cabling system for testing purposes.

1.2.9.2 The wiring module shall be able to accommodate 22-26 AWG cable conductors. The termination module shall be accessible from front without any contact element exposed.

1.2.9.3 The components of the wire termination module shall meet the Category 5e/6 onwards standards.

1.2.9.4 The termination module shall be 25 pair module with IDC contact element and fully compliant to latest ANSI/TIA 568-2-E /IEC 61156-5 for Category 6 onwards requirement.

1.2.9.5 The IDC contact element shall be spring special brass with 0.5-micron Nickel plating.

1.2.9.6 The Termination module should have the option of mounting on wall or a 19' rack.

1.2.9.7 The Termination module should be able to accept Category 6 & onwards Jumper wire solution for Cross connect or Modular patch cords.

1.2.10 Modular Jack Panel: Modular Jack panel shall meet the following requirements:

- a) Should be Fully flexible and able to accept Category 6, Category

5e/6/6A on-wards RJ-45 jacks, Multi media Outlets, and Fiber modules.

- b) Should have a mechanism to hold the cable at the back, like a metal bar or plate.
- c) The panel should come empty and can be loaded as per the requirement.
- d) The Panel should be able to accept up to 24 RJ45 jacks in a 1U space.
- e) It should be mountable on a 19" rack
- f) The Panel shall have a large front labeling space to facilitate port identification.
- g) The Panel shall have a 16-gauge sheet metal construction and the module holder shall be of UL 94V-0, black, fire-retardant plastic construction.

1.2.11 Rack Mount Fiber Termination Unit: The 19" rack mount fiber termination unit shall provide cross-connect, interconnect or splicing capabilities.

1.2.11.1 The 19" rack mount fiber termination unit shall consist of a frame mountable housing for terminating and / or splicing fiber optic cables and allow for organization of the fiber optic interconnects. The assembly shall have rear slots for cable entry, with grommets fiber retainers for holding buffered fiber in place and fiber storage guide for maintaining bend radius.

1.2.11.2 The 19" rack mounting unit shall be either 12 or 24 ports for one rack unit (1RU) and come with a removable lid for access and can be either a fixed position unit or have a Swingable tray to improve access.

1.2.11.3 The adapter plates are pre-loaded for ST (Straight Tip), SC (Subscriber Connector) Simplex, SC duplex and LC Simplex or Duplex couplings, and the adapter plates should be installed to angled through adapters to the left or to the right of the panel, this improves the patch cord

management and provides safety from possible damage to the eye from active fibers.

1.2.12 Patch Cords: patch cords shall be used for cross-connection and interconnection of termination modules, patch panels and fiber termination unit.

- a) The patch cord shall be available in 1, 2 and 4 pair versions with lengths of 1.2 through 12.8 meters.
- b) The type of patch cord shall depend on the termination module used, i.e. 8-pair termination module, patch panel or a rack mount fiber termination unit.
- c) The patch cord shall have built in exclusion features to prevent accidental polarity reversals and split pairs. It shall have a latching mechanism to prevent accidental dislodging of the plug for the termination module or modular jack panel (e.g. RJ45)
- d) The patch cord shall provide air-tight connection for cross-connection and shall comply with proposed Cat.5E and/or Cat 6 & onwards requirement and Power SUM NEXT requirement. (ref.: Annex 1 to 5)
- e) Patch Cords for Patch panel shall be used for the Moves, Adds and Changes and only hard wire jumper shall be needed for the permanent wiring of the modules, thereby providing better cable management.

1.2.13 Fiber Patch Cord: Fiber Patch Cord shall meet the following requirements:

- a) Shall consists of one or two single, tight buffered, single-mode /multi-mode graded index fibers. For single mode, it shall be ITU-T G.657.A1 or A2 or B3 and for multi mode fibre (refer to section I TEC GR 89010:2021), it shall be OM2 or OM3
- b) The fiber patch shall be used for optical fiber cross connects and interconnects.
- c) The fiber unit shall be covered by aramid yarn and jacket of flame

retardant PVC/LSZH.

- d) The fiber patch cord shall be factory terminated with ST (Straight Tip), SC (Subscriber Connector), LC or hybrid ceramic connectors at each end.
- e) The fiber patch cord shall meet the following specifications:
 - i. Minimum bend radius 90° at min 25.4 mm.
 - ii. Operating temperature: -42 to +75°C.
 - iii. Loss: 0.75 db / mated connectors.
 - iv. Return loss maximum -45 db.
 - v. Cable Outer diameter: 3mm maximum.
 - vi. Tip material: Ceramic.

1.3 The UTP/STP copper cables: The UTP/STP copper cables meet the following requirements:

- (a) Shall be CM or CMR or, CM-ST1 or CMP, or CPR rated depending on purchaser requirements. Shall be compliant to Minimum IEC60332-1 or higher fire standard depending on purchaser requirements
- (b) Shall consists of 22 to 24 AWG, twisted pair copper conductor.
- (c) Fire retardant PVC Sheath shall have improved frictional properties, allowing it to be pulled through conduit without the use of lubricants.
- (d) The insulation should be made from Polyolefin for ruggedness
- (e) Available in the form of 2Pair- 25 pairs for Cat 5e UTP/STP cable and 4pair for cat6/cat6a/cat7/cat7a &cat8.
- (f) The UTP/STP multi pair cable shall meet the following electrical specifications: -
 - i. ANSI/TIA-568.2-E commercial wiring standard.
 - ii. All applications as per annex 6
 - iii. The mutual capacitance of a category 5e, 6 or 6A horizontal cable pair at 1 kHz, measured at or corrected to a temperature of 20 °C, shall not exceed 5.6 nF per 100 m (328 ft).
 - iv. DC resistance: 9.3 Ω per 100 m measured at or corrected to a temperature of 20 °C.

v. Characteristics Impedance: 100 ohms +/- 15 % @ 100MHz
(Optional for 4 Pairs)

vi. Electrical specification as per Annex 2,4,5.

1.4 Optical fiber requirements:

1.4.1 Cable must be Armored/ Unarmoured Single Mode (ITU-T G.657) Multimode (OM2 or OM3) color coded fibers, jelly filled/ Jelly free color coded loose tubes, around the dielectric central strength member, jelly filled, plastic tape, dielectric strength member and outer FRPE/LSZH jacket for Indoor-outdoor use and shall be tight buffered with color-coded PVC/LSZH/ any suitable Polymer material for identification for multi-core fiber optic cable for Indoor use.

1.4.2 Fiber Specification OM2 (50/125 Multimode)

ITEMS	UNITS	SPECIFICATION 50/125 Multi-Mode
Attenuation	dB/km	≤ 2.5 at 850nm ≤ 0.8 at 1300nm
Bandwidth	MHz.km	≥ 500 at 850nm ≥ 500 at 1300nm
Numerical Aperture	-	0.200 ± 0.015
Core Diameter	μm	50 ± 2.5
Core Non-circularity	%	≤ 6.0
Cladding Diameter	μm	125 ± 1
Cladding Non-circularity	%	≤ 2
Core/Cladding Concentricity Error	μm	≤ 3.0
Coating Diameter (uncolored)	μm	245 ± 10
Proof Test	Kpsi	≥ 100

1.4.3 Fiber Specification OM3 (50/125 Multimode)

ITEMS	UNITS	SPECIFICATION OM3 Multi Mode
Typical Attenuation	dB/km	≤ 2.5 at 850nm ≤ 0.8 at 1300nm
Bandwidth	MHz.km	≥ 2000 at 850nm ≥ 500 at 1300nm
10 Gigabit Ethernet Link length.	meters	300
Operating Temperature	°C	-40 to +70.
Core/Cladding Concentricity Error	μm	≤ 2
Coating Diameter	μm	245 ± 10
Proof Test	Kpsi	≥ 100

1.4.4 Fiber Specification Single mode (ITU-T G.657 A1, A2 or B3) as per
Section-I (Type IV & Type V) of TEC GR 89010: 2021 on Raw Materials used
in Manufacturing of Optical Fibre Cable

1.4.5 CABLE CONSTRUCTION – Outdoor Armored Type

The construction of the cable shall be in accordance with Table below. For detailed mechanical and environmental properties, annexure – 8 shall be referred.

ITEMS	DESCRIPTION
Number of Fibers	4/6/12/24
Type of Fiber	Multimode OM2, OM3 or Single Mode G.657.A1/A2/B3 or G.657D
No. of Fibers per Tube	Max. 12
Loose Buffer tube material	PBT (Polybutylene Terephthalate)/Any Suitable Thermoplastic material
Loose Buffer Tube Diameter	Nom. 2.4 mm
Filling Compound in Loose Buffer Tube	Thixotropic Jelly Compound
Water Blocking Material	Water Blocking Tape / Thixotropic Jelly Compound
Central Strength Member	FRP (Fiber Reinforced Plastic)

Core Wrapping Tape	Plastic Tape (To provide heat barrier and good forming of core)
Dielectric Strength Member	Glass yarn
Armor	Steel Tape Armoring
Outer Jacket material	Black FRPE/LSZH
Thickness	Min.1.25 mm, Nom. 1.8mm

1.4.6 FIBER AND LOOSE BUFFER TUBE IDENTIFICATION

The color code of the loose buffer tubes and the individual fibers within each loose buffer tube shall be in accordance with Table below.

The Color Code of the Individual Fibers and Loose Tubes

No. of Fibers/ Loose Buffer Tubes	Color	No. of Fibers/ Loose Buffer Tubes	Color
1	Blue	7	Red
2	Orange	8	Black
3	Green	9	Yellow
4	Brown	10	Violet
5	Gray	11	Pink
6	White	12	Aqua

1.5 Equipment Room System/ Entrance Facility: 25 pair IDC type terminal module to terminate incoming trunk cables, outgoing trunk cables to PABX and PABX Extension lines / cables shall be provided. Each of them shall have lightning over-voltage protection with arrestors, which shall be in 1 pair or 25 pair form. The gas tube protector units shall meet the following standards:

- DC breakdown voltage (at 100V/sec): $230\text{ V} \pm 20\%$
- Surge Breakdown Voltage (at 100V/micro sec): 500 Volts
- Insulation Resistance: Min 10,000 M Ω
- DC Holdover Voltage: Max 135 Volts
- Capacitance (1 MHz): Max 3.0 pF

1 . 6 Channel performance: Channels based on ISO 11801 Class D and E and Proposed ANSI/ TIA 568-B.2 Cat 6 channel specifications. (ref.: Annex 1)

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Chapter 2

Engineering, Operational and Qualitative Requirements

2. SCOPE:

2.1 This document specifies the generic requirements for the structured cabling components which are to be used for LAN wiring for different applications usage in the Indian Telecom network.

2.2 General Requirements

2.2.1 **Engineering Requirements:** The system shall meet the following engineering requirements:

- a) The equipment shall be fully solid state and adopt state of the art technology
- b) The equipment shall be compact, composite construction and lightweight. The actual dimensions and weight of the equipment shall be furnished by the manufacturers.
- c) All connectors shall be reliable, low loss and standard type so as to ensure failure free operations over long operations. The warranty shall be provided by the OEM vendor to customer and shall be administered in India. The duration of the warranty shall be for a minimum of 15- 25 years and shall cover the cabling system performance, application assurance as per the TIA and ISO installation best practices recommendations.
- d) All cables shall be of Gigabit Ethernet ready standards (ANSI/TIA-568.2-E – Cat 5e/Cat 6 on-wards standards).
- e) Each terminal block and individual tags shall be numbered suitably with clear identification code and shall correspond to the associated wiring drawings.

2.2.2 **Operational Requirement (OR):** The system shall meet the following

maintenance & operational requirements:

- a) The equipment shall be designed for continuous operation.
- b) The equipment shall be able to perform satisfactorily without any degradation at an altitude up to 3000 meters above mean sea level.
- c) The design of the equipment shall not allow plugging of a module in the wrong slot or upside down.
- d) Special tools required for wiring shall be provided along with the equipment.
- e) The Hardware and software components shall not pose any problems in the normal functioning of all network elements wherever interfacing with Indian Telecom network for voice, data and transmission systems, as the case may be.
- f) **Field Implementations best practices**
 - i. Untwisting dramatically affects NEXT and RL – the less untwist the better – right up to the termination point.
 - ii. Cable should not be pulled through a length of conduit exceeding 30m (100 ft) Limit 90° bends in conduit to 2
 - iii. Avoid laying cable near noise sources, such as; electrical wiring, electric motors, fluorescent lighting, copiers and other EMI/RFI (Radio frequency Interference) devices
 - iv. Avoid laying cable in areas with excessive moisture such as damp basements and areas where steam will form condensation on the cable

2.2.3 QUALITATIVE REQUIREMENTS (QR): The system shall meet the following qualitative requirements:

- a) The supplier / manufacturer shall manufacture with international quality standards ISO 9001 for which the manufacturer shall be duly accredited. The quality plan describing the quality assurance system followed by the manufacturer shall conform to the guidelines given by CGM QA from time to time and shall be submitted.

- b) The equipment locally manufactured in India shall be as per guidelines issued by Chief General Manager, Quality Assurance Wing of the BSNL vide Documents No. QM 118, QM 205, QM 206, QM 210 and QM 301.
- c) The equipment shall meet the environmental requirements as per category A of Standard for Environmental testing of Telecommunication equipment TEC 14016:2010
- d) All components used shall be as per approval procedures prescribed by BSNL in document QM – 324.
- e) Marking and identification of the equipment, sub-assemblies, PCBs etc. shall be as per guidelines given in para 5.1.7 Quality Assurance Telecom Document QM 351/Issue 2 /Jan.'95.
- f) The MTBF (Mean Time Between Failure) and MTTR (Mean Time To Restore) predicted and observed values shall be furnished along with calculations by the manufacturer.

2.2.4 Other Requirements:

- a) Wherever, the standardized documents like ITU-T, IETF, QA and TEC documents are referred, the latest issue and number with the amendments shall be applicable.

2.2.5 Electromagnetic Compatibility (EMC) Requirements: Kindly refer to the clause 3(f) under purchaser requirements

2.2.6 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

2.2.7 DOCUMENTATION:

All technical documents shall be provided in English language in hard copy. A soft copy or QR code shall also be provided both in Hindi and English.

2.2.7.1 The documents shall comprise of:

1. System description documents
2. Installation, Operation and Maintenance documents
3. Training documents
4. Repair manual

2.2.7.2. System description documents: The following system

description documents shall be supplied along with the system.

- a) Cabling and wiring diagrams.
- b) Adjustment procedures, if there are any field adjustable units.
- c) Spare parts catalogue - including information on individual component values, tolerances, etc. enabling procurement from alternative sources.

2.2.7.3 Operational documents: The following operational documents shall be made available.

- a) Installation manuals and testing procedures.
- b) Precautions for installation, operations and maintenance
- c) Safety measures to be observed in handling the equipment
- d) Fault location and troubleshooting instructions including fault dictionary.
- e) Test jigs and fixtures required and procedures for routine maintenance, preventive maintenance and unit / card / sub-assembly replacement.
- f) Emergency action procedures.

2.2.7.4 Repair Manual:

- a) List of replaceable parts used
- b) Detailed ordering information for all the replaceable parts
- c) Procedure for trouble shooting and sub-assembly replacement
- d) Test fixtures and accessories for repair
- e) Systematic trouble shooting charts (fault tree) for all the probable faults with their remedial actions.

2.2.8 INSTALLATION:

- 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.
- 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.
- c) All installation materials, consumables and spare parts to be supplied.

- d) All literature and instructions required for installation of the equipment, testing and bringing it to service shall be made available in English language.
- g) All cable labels shall be machine typed labeled at each end 100 mm from the termination point. (Refer: *Administration Standard for Commercial Telecommunications Infrastructure* (ANSI/TIA-606-A))
- h) The cabling system shall be planned and the routing shall be selected to ensure system integrity and performance, and it shall not present problems to maintenance access.
- i) All cable trays, catenaries and ductworks required to complete the installation shall be supplied.
- j) All necessary penetrations and access between floors and sealing of the same after installation shall be carried out by the supplier. Support of all cabling within the false space or under raised flooring by steel cable tray, trucking and /or duct, catenary wires, fixed by approved hanger and methods shall be done.
- k) Cables shall be neatly bundled into a neat group (50 cables per bundle).
- l) Maintain at all times a minimum of 150mm spacing from parallel runs of electrical cabling and 300 mm from fluorescent lights. All telecommunication cables shall cross electrical cables at right angles.
- m) Shall support adequately all the cabling that is vertically installed.
- n) Shall provide and use screwed moulded plastic bushes to protect cable, with the use of locknuts inside the trunking or tray work to ensure bush remaining securely in place.
- o) Shall ensure that the tray shall be thoroughly cleaned of any extraneous material, such as cable scraps, dust, dirt and construction debris after the installation is completed.
- p) Shall provide proper protective earthing for all the cable trays and catenary wires.

- q) Shall ensure that the cables are secured with plastic or Velcro cable ties on cable trays and / or catenaries.
- r) Shall not have free protrusion of sharp edges where cabling is done in free spaces.
- s) Shall have cables installed using a bending radius not less than eight (8) times the overall diameter of the cable. The hauling tension shall not exceed 11.3 Kg.
- t) Any Single pull shall be restricted to not more than two (2) 90 degrees' bends, in conduit and ducts.

3. Purchaser Requirements:

- a) Purchaser may decide the appropriate flame retardant capability of horizontal Cabling as per IEC 60332- 1-2 or IEC 60332-2 or IEC 60332-3, As mentioned in clause 1.2.3.1
- b) Purchaser may specify the exact cable requirement for the outdoor category based on the application, mentioned under clause 1.2.4.1
- c) Purchaser may decide the appropriate flame retardant capability of Patch Cord as mentioned in clause 1.2.7 (f)
- d) Purchaser may decide the appropriate type of UTP/STP copper cables as mentioned in clause 1.3 (a)
- e) For standalone Structured LAN cables, no EMI/EMC tests are applicable. However, if the purchaser requires EMI/ EMC compliance, the same shall be tested & demonstrated at the equipment level like LAN Switch, Router, CCTV Camera etc, with structured LAN cables connected as per the Standard No. TEC 11016:2016 from any TEC accredited LAB & reports of compliance shall be submitted in such cases.

Abbreviations

AWG	America Wire Gauge
ATM	Asynchronous Transfer mode
BSNL	Bharat Sanchar Nigam Limited
CAT	Category
CMR	Certification Maintenance report
CMP	Communications plenum cable
CGM	Chief General Manager
EMC	Electromagnetic Compatibility
EIA	Electronic Industries Alliance
EPABX	Electronic Private Automatic Branch Exchange
FRNC	Flame Retardant Non-Corrosive (cable)
FD	Fade Depth
ISO	International Organization for Standardization
IEC	International Electro technical Commission
ICEA	Insulated Cable Engineers Association
IDC	Insulation Displacement Contact
ITU	International Telecommunication Union
IETF	Internet Engineering Task Force
LAN	Local Area Network
LSZH	Low Smoke Zero Halogen
MAC	Media Access Control
MPR	Manufacturer Production Run
NEXT	Near End Cross Talk
PSACR	Power Sum Attenuation to Crosstalk Ratio
PVC	Polyvinyl Chloride
PCB	Printed Circuit Board
TIA	Technology Industries Association
UTP/STP	Unshielded Twisted Pair/ Shielded Twisted Pair
WGNA	Wide Band Gigabit Networking Alliance

Annexure 1:

Cat 6 Channel (Addendum to TIA/EIA-568B)										
Frequency (MHz)	Insertion loss	NEXT pp	ACR pp	NEXT ps	ACR ps	ELFEXT pp	ELFEXT ps	Return Loss		
1	3.0	65.0	62.0	62.0	59.0	63.3	60.3	19.0		dB
4	4.0	63.0	59.0	60.5	56.5	51.2	48.2	19.0		dB
8	5.7	58.2	52.5	55.6	49.9	45.2	42.2	19.0		dB
10	6.3	56.6	50.2	54.0	47.7	43.3	40.3	19.0		dB
16	8.0	53.2	45.2	50.6	42.5	39.2	36.2	18.0		dB
20	9.0	51.6	42.6	49.0	39.9	37.2	34.2	17.5		dB
25	10.1	50.0	39.9	47.3	37.2	35.3	32.3	17.0		dB
31.25	11.4	48.4	37.0	45.7	34.3	33.4	30.4	16.5		dB
62.5	16.5	43.4	26.9	40.6	24.1	27.3	24.3	14.0		dB
100	21.3	39.9	18.6	37.1	15.8	23.3	20.3	12.0		dB
125	24.1	38.3	14.2	35.4	11.3	21.3	18.3	11.0		dB
200	31.5	34.8	3.2	31.9	0.3	17.2	14.2	9.0		dB
250	36.0	33.1	-2.8	30.2	-5.8	15.3	12.3	8.0		dB

Cat6A Channel (ANSI/TIA-568-2.E)

Frequency (MHz)	Min. RL (dB)	Max. IL (dB)	Min. NEXT (dB)	Min. PSNEXT (dB)	Min. PSACRF (dB)	Min. ACRF (dB)
1	19.0	2.3	65.0	62.0	60.3	63.3
4	19.0	4.2	63.0	60.5	48.2	51.2
8	19.0	5.8	58.2	55.6	42.2	45.2
10	19.0	6.5	56.6	54.0	40.3	43.3
16	18.0	8.2	53.2	50.6	36.2	39.2
20	17.5	9.2	51.6	49.0	34.2	37.2
25	17.0	10.2	50.0	47.3	32.3	35.3
31.25	16.5	11.5	48.4	45.7	30.4	33.4
62.5	14.0	16.4	43.4	40.6	24.3	27.3
100	12.0	20.9	39.9	37.1	20.3	23.3
200	9.0	30.1	34.8	31.9	14.2	17.2
250	8.0	33.9	33.1	30.2	12.3	15.3
300	7.2	37.4	31.7	28.8	10.7	13.7
400	6.0	43.7	28.7	25.8	8.2	11.2
500	6.0	49.3	26.1	23.2	6.3	9.3

Annexure 2:

Cat 6 Cable latest standard for Permanent link (ANSI/TIA-568-2.E)

Cat 6 Cable (Addendum to TIA/EIA-568B)										
Frequency (MHz)	Insertion loss	NEXT pp	ACR pp	NEXT ps	ACR ps	ELFEXT pp	ELFEXT ps	Return Loss (solid)	Return Loss str.)	
1	2.0	74.3	72.3	72.3	70.3	67.8	64.8	20.0	20.0	dB
4	3.8	65.3	61.5	63.3	59.5	55.8	52.8	23.0	23.0	dB
8	5.3	60.8	55.4	58.8	53.4	49.7	46.7	24.5	24.5	dB
10	6.0	59.3	53.3	57.3	51.3	47.8	44.8	25.0	25.0	dB
16	7.6	56.2	48.7	54.2	46.7	43.7	40.7	25.0	25.0	dB
20	8.5	54.8	46.3	52.8	44.3	41.8	38.8	25.0	25.0	dB
25	9.5	53.3	43.8	51.3	41.8	39.8	36.8	24.3	24.2	dB
31.25	10.7	51.9	41.2	49.9	39.2	37.9	34.9	23.6	23.3	dB
62.5	15.4	47.4	32.0	45.4	30.0	31.9	28.9	21.5	20.7	dB
100	19.8	44.3	24.5	42.3	22.5	27.8	24.8	20.1	19.0	dB
125	22.4	42.8	20.5	40.8	18.5	25.9	22.9	19.4	18.2	dB
200	29.0	39.8	10.8	37.8	8.8	21.8	18.8	18.0	16.4	dB
250	32.8	38.3	5.5	36.3	3.5	19.8	16.8	17.3	15.6	dB

Cat6A for Horizontal Cable (ANSI/TIA-568-2.E)

TRANSMISSION CHARACTERISTICS – 100 M

Frequency (MHz)	Max attenuation(dB/100M)	RL (dB)	NEXT (dB)	PSNEXT (dB)	ACRF	PSACRF
1	2.1	20.0	74.3	72.3	67.8	64.8
4	3.8	23.0	65.3	63.3	55.8	52.8
10	5.9	25.0	59.3	57.3	47.8	44.8
16	7.5	25.0	56.2	54.2	43.7	40.7
20	8.4	25.0	54.8	52.8	41.8	38.8
31.25	10.5	23.6	51.9	49.9	37.9	34.9
62.5	15	21.5	47.4	45.4	31.9	28.9
100	19.1	20.1	44.3	42.3	27.8	24.8
200	27.6	18.0	39.8	37.8	21.8	18.8
250	31.1	17.3	38.3	36.3	19.8	16.8
300	34.3	16.8	38.1	35.1	18.3	15.3
500	45.3	15.2	34.8	31.8	13.8	10.8

Annexure 3:

Cat 6 Connecting Hardware (Addendum to TIA/EIA-568B)										
Frequency (MHz)	Insertion loss	NEXT pp	ACR pp	NEXT ps	ACR ps	ELFEXT pp	ELFEXT ps	Return Loss		
1	0.02	94.0		90.0		83.1	80.1	30.0		dB
4	0.04	82.0		78.0		71.1	68.1	30.0		dB
8	0.06	75.9		71.9		65.0	62.0	30.0		dB
10	0.06	74.0		70.0		63.1	60.1	30.0		dB
16	0.08	69.9		65.9		59.0	56.0	30.0		dB
20	0.09	68.0		64.0		57.1	54.1	30.0		dB
25	0.10	66.0		62.0		55.1	52.1	30.0		dB
31.25	0.11	64.1		60.1		53.2	50.2	30.0		dB
62.5	0.16	58.1		54.1		47.2	44.2	28.1		dB
100	0.20	54.0		50.0		43.1	40.1	24.0		dB
125	0.22	52.1		48.1		41.2	38.2	22.1		dB
200	0.28	48.0		44.0		37.1	34.1	18.0		dB
250	0.32	46.0		42.0		35.1	32.1	16.0		dB

Freq. (MHz)	TIA/EIA category 5e (dB)					TIA/EIA category 6 (dB)				
	NEXT				RL	NEXT				RL
	1 m	2 m	5 m	10 m		1 m	2 m	5 m	10 m	
1	65.0	65.0	65.0	65.0	19.8	65.0	65.0	65.0	65.0	19.8
4	62.6	62.3	61.5	60.4	21.6	65.0	65.0	65.0	65.0	21.6
8	56.7	56.4	55.6	54.6	22.5	65.0	65.0	65.0	64.8	22.5
10	54.8	54.5	53.7	52.8	22.8	65.0	65.0	64.5	62.9	22.8
16	50.7	50.4	49.7	48.9	23.4	62.6	62.0	60.5	59.0	23.4
20	48.8	48.5	47.9	47.1	23.7	60.7	60.1	58.6	57.2	23.7
25	46.9	46.7	46.0	45.3	24.0	58.8	58.1	56.8	55.4	24.0
31.25	45.0	44.8	44.2	43.5	23.0	56.9	56.2	54.9	53.6	23.0
62.5	39.1	38.9	38.5	38.1	20.0	51.0	50.4	49.2	48.1	20.0
100	35.2	35.1	34.8	34.6	18.0	47.0	46.4	45.3	44.4	18.0
125						45.1	44.5	43.5	42.7	17.0
200						41.1	40.6	39.8	39.3	15.0
250						39.2	38.8	38.1	37.6	14.0

Annexure 4:

Cat 7 Channel(ISO/IEC-11801)

Frequency (MHz)	RL (dB)	IL (dB)	NEXT (dB)	PSNEXT (dB)	ACR-F (dB)	PS ACR-F (dB)
1.00	19.0	4.0	65.0	62.0	65.0	62.0
16.00	18.0	8.1	65.0	62.0	57.5	54.5
100.00	12.0	20.8	62.9	59.9	44.4	41.4
250.00	8.0	33.8	56.9	53.9	37.8	34.8
500.00	8.0	49.3	52.4	49.4	32.6	29.6
600.00	8.0	54.6	51.2	48.2	31.3	28.3

Annex 5.

Cat7A Channel (ISO/IEC-11801)

Frequency (MHz)	RL (dB)	IL (dB)	NEXT (dB)	PSNEXT (dB)	ACR-F (dB)	PS ACR-F (dB)
1.00	19.0	4.0	65.0	62.0	65.0	62.0
16.00	18.0	8.0	65.0	62.0	63.3	60.3
100.00	12.0	20.3	65.0	62.0	47.4	44.4
250.00	8.0	32.5	59.1	56.1	39.4	36.4
500.00	8.0	46.7	53.6	50.6	33.4	30.4
600.00	8.0	51.4	52.1	49.1	31.8	28.8
1000.00	6.0	67.6	47.9	44.9	27.4	24.4

Annexure-6

The UTP/STP-based and shielded cabling system shall be capable of supporting the following applications:

- 10 Gigabit Ethernet (10GBASE-T)/10Base-T/100Base-T4/1000Base-T/2.5GBase-T/5GBase-T
- Digital and Analogue voice and video (RGB) signals
- ATM-25/ATM-51/ATM-155
- 100VG-AnyLan
- TR-4/TR-16 Active/ TR-16 Passive
- Future applications using 1000 MHz of bandwidth*

*Note: When using the same transmission technique as Gigabit Ethernet.

Annexure -7

- Delivery of the Power & data over same single Ethernet cable is the concept of PoE.
- With the newly ratified IEEE 802.3 bt Standard there is significant increase in the amount of power that can deliver through Ethernet cable.

Refer to the below table for bundle Size & temperature rating:

Table 725.144, Ampacities of each conductor (in Amperes) in a 4-pair Class 2 or Class 3 data cable, based on copper conductors at ambient temperature of 30°C (86°F) with all conductors in all cables carrying current, 60°C (140°F) and 90°C (194°F) rated cables																					
AWG	Number of 4-pair cables in a bundle																				
	1			4-7			8-19			20-37			38-61			62-91			92-192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	N/A	N/A	N/A
24	2.0	2.0	2.0	1.0	1.4	1.6	0.8	1.0	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3.0	3.0	3.0	1.4	1.8	2.1	1.0	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note: The conductor sizes in data cables in widespread use are typically 22-26 AWG.

Annexure – 8

Mechanical & Environmental properties of Optical Fibre Cable

S.No	Parameter Name	Standard	Value
1	Cabled Attenuation at 1310nm	ITU-T G.65x, G.650.1 and IEC 60793-2-50, 60793-1-40,	≤ 0.40 dB/Km
2	Cabled Attenuation at 1383nm		≤ 0.40 dB/Km
3	Cabled Attenuation at 1490 nm		≤ 0.40 dB/Km
4	Cabled Attenuation at 1550nm		≤ 0.30 dB/Km
5	Cabled Attenuation at 1625nm		≤ 0.30 dB/Km
6	PMD Cabled Loose Fibre		≤ 0.3 ps/ $\sqrt{\text{km}}$
9	Tensile Strength	IEC 60794-1-21, 60794-3, 60794-3-10, 60794-3-11,	1W or 50N @ 0.6% fibre strain whichever is higher. Change in attenuation at 1550 nm: ≤ 0.05 dB.
10	Crush Resistance	IEC 60794-1-21, 60794-3, 60794-3-10, 60794-3-11,	Change in attenuation at 1310 & 1550nm shall be ≤ 0.05 dB subjected to a compressive load of 500 N:
11	Impact	IEC 60794-1-21, 60794-3, 60794-3-10, 60794-3-11,	Impact : 1J, Change in attenuation: ≤ 0.1 dB at 1550nm.
12	Kink Test	IEC 60794-1-21, 60794-3, 60794-3-10, 60794-3-11,	Kink Radius: 10D, there shall be no damage to the sheath or to the cable elements under visual examination without magnification. Optical Continuity shall be checked.

13	Bend Test	IEC 60794-1-21, 60794-3, 60794-3-10, 60794-3-11,	Bending Radius: 20D, No of cycles: 3 No of turns: 4, Change in attenuation $\leq 0.1\text{dB}$ at 1550nm.
14	Repeated Bend Test	IEC 60794-1-21, 60794-3, 60794-3-10, 60794-3-11,	Bending radius: 20D, No of cycles: 25 Load: Adequate to assure uniform contact with the mandrel; Cable shall be free from any optical & visual physical damage.
16	Cable Drip Test	IEC 60794-1-21, 60794-3, 60794-3-10, 60794-3-11,	Sample is kept vertically with open end downwards in the oven for 24 hours at 70° C and examine the paper placed below the cable for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.
18	Temperature Cycling	IEC 60794-1-22, 60794-3, 60794-3-10, 60794-3-11	As per IEC & Indian Scenario: TA2: - 20°C, TA1: - 10°C. TB1: + 60°C, TB2: + 70°C. Change in attenuation $\leq 0.15\text{dB}$ at 1550nm.
19	Cable Aging test	IEC 60794-1-22, 60794-3, 60794-3-10, 60794-3-11	Exposure Time: 168 hr - Max. Change in attenuation at 1550 nm: 0,25 dB/km, Avg.: 0.10 dB/km, Any elements of the cable which are colour coded (fibres, buffer tubes, sheath) shall be discernible.
20	Water Blocking Test	IEC 60794-1-22,	Test Duration: 24 hr

		60794-3, 60794-3-10, 60794-3-11	Sample length: 3 m Water Head Height: 1m No water shall be detected at the unsealed end of the sample. If a fluorescent dye is used, an ultraviolet light may be used for the examination.
21	UV Radiation Test	ASTM G-154-12a, IEC 60794-1-22 Method F14	Type of lamp: 40watt UV-B lamp with peak emission at 313nm. Duration: 2000 hours. There should not be any fading or change in colour of the sheath.
23	Cable Material Compatibility	Telecordia GR 20, IEC60794	Optical fibre, buffers/core tubes, and other core components shall meet the requirements of the compatibility with buffer/core tube filling material(s) and/or water-blocking materials that are in direct contact with identified components within the cable structure
24	Flame Spread-Single cable	IEC/EN 60332-1-2	Char less than 0.54 m at completion of test
26	Smoke Test	IEC/EN 61034-2	Minimum transmittance 60%
27	Acid gas (Toxicity) (Test on toxic gases evolved during combustion of materials from cables)	IEC/EN 60754-2	pH not less than 4.3 Conductivity not more than 10 μS/mm

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