Telecommunication Engineering Centre
K.L. Bhawan, Janpath, New Delhi-110001.

File No: TEC/T/OFC-OFJ/155/2013 Dated: 07.05.13

Errata No. 1

Optical Fibre Jumpers (Type-I to Type-IV) & Adapters (Type-I to Type –IV) and Hybrid Jumpers (Type-I to Type-IV) & Hybrid Adapters (Type-I to Type –IV)

(GR No.TEC/GR/TX/OFJ-01/05/NOV-09)

i. Background:

The revised GR for Optical Fibre Jumpers & Adapters and Hybrid Jumpers & Hybrid Adapters (GR No.TEC/GR/TX/OFJ-01/05/NOV-09) was issued in November'09. Some typographical error has been noticed while evaluating the product, in the following clause of GR which require correction and issue of errata. The corrected sub-clause may be read as below:

ii. Errata:

Clause No. 4.1
Requirement:
(c)(iii) Radius of Curvature for SC-APC connector shall be read as **"5 to 12mm".**

iii. Date of effect: This errata will be applicable with immediate effect.

iv) Remarks: There is no change in TS&TP and category.

v) Category for the incremental test fee in case of revision of TAC/IAC: Nil

----------End of the Errata----------

(Alok Jaimal)
Director (T)

To

1. Sr. DDG (TEC), New Delhi for information please.
2. DDG (T), New Delhi for information please.
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TRANSMISSION
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OPTICAL FIBRE JUMPERS
(Type-I to Type-IV)
&
ADAPTERS
(Type-I to Type-IV)
AND
HYBRID JUMPERS
(Type-I to Type-VI)
&
HYBRID ADAPTERS
(Type-I to Type-VI)

GENERIC REQUIREMENTS
NO. TEC/GR/TX/OFJ-01/05/NOV-09
(Supersedes GR No. GR/OFJ-01/04 APR 2004 & GR/OFJ-02/01 MAY 2004)

TELECOMMUNICATION ENGINEERING CENTRE
KHURSHIDLAL BHAVAN, JANPATH
NEW DELHI-110001.

HISTORY SHEET

Name of the GR	No. of the GR	Remarks
Single mode optical Fibre Jumper (FC-PC Type) (Patch cord and Pig tails) and FC-PC adapter	TO 710 G92 Aug 92	1st Issue
Single mode optical Fibre Jumper (FC-PC Type) (Patch cord and Pig tails) and FC-PC adapter	G/OFJ-01/02 SEP. 94	2nd Issue
Single mode optical Fibre Jumper (FC-PC Type) (Patch cord and Pig tails) and FC-PC adapter	G/OFJ-01/03. June 99	3rd Issue
Single mode optical Fibre Jumper (FC-PC Type) (Patch cord and Pig tails) and FC-PC adapter	GR/OFJ-01/04 APR 04	4th Issue
Single mode Optical fibre Jumper (Patch cord & Pig Tail) SC-PC (Type-I) & SC-APC (Type-II) and Adopter SC-PC (Type-I) & SC-APC (Type-II) and Hybrid Jumpers	GR/OFJ-02/01 MAY 2004	1st Issue
Optical Fibre Jumper (Type-I to Type-IV) & Adapter (Type-I to Type-IV) and Hybrid Jumpers (Type-I to Type-VI) & Hybrid Adapters (Type-I to Type-VI)	TEC/GR/TX/OFJ-01/05/NOV-09	5th Issue (Both GRs of Optical fibre Jumpers & Adapters (FC-PC and SC-PC) have been merged into a single GR.

CONTENTS

REFERENCES

TEC STANDARDS

1.	TEC/GR/TX/ORM-01/04/SEP-09	Specification for Raw Material
2.	GR/OFJ-01/04 MAR 2004	Specification for Optical fibre jumper (FC-PC) & Adapter (FC-PC)
3.	GR/OFJ-02/01. MAY 2004	Specification for Optical Fibre Jumper (Patch Cord And Pig Tails) SC-PC (Type- I) & SC-APC (Type-II) And Adapter SC-PC (Type- I) & SC-APC (Type-II) And Hybrid Jumpers
4.	QM 333 (Latest Issue)	Specification for Environmental Testing

OTHER STANDARDS (EIA/IEC/Bell core/CISPR/ISO)

5.	G.657 A	ITU-T Recommendation
6.	GR-326	Telcordia standards for connector
7.	EIA/TIA-455-73, IEC 60874 -1, IEC 61300-3-26, IEC 61300-2-41, IEC 61300-3-18, IEC 61300-3-24, IEC 61300-3-19, IEC 61300-3-25, IEC 61300-3-17, IEC 60793-1-30, IEC 603793-1-31 IEC 60793-1-32, IEC 60793-1-33, IEC 60793-1-34, IEC 60793-1-47, IEC 60793-1-51, IEC 60793-1-52, IEC 60793-1-53, IEC 60793-2-50, IEC 60794 -1, IEC 60794-1-2-E1, IEC 60794-1-2-E3 IEC 60794-1-2-E6, IEC 60794-1-2-E7 IEC 60794-1-2-E18, IEC 60794-1-E8, IEC 60794-1-E11, IEC 68-2-1, IEC 68-2-6, IEC 68-2-11, IEC 68-2-17, IEC 68-2-27, IEC-189,	Test Methods
8.	BS 249,	Specification for Brass material
9..	UL-94-V-0/ISI 10810,	Specification for Flame retardancy
10.	ISO-9001:2000	International Quality Management System.

PART I – TECHNICAL SPECIFICATION

1.0 Introduction:

This document describes generic requirements for Single mode Optical Fibre Jumpers (Patch cords and Pigtails) (Type-I to Type-IV), Adapters (Type-I to Type-IV), Hybrid Jumpers (Type-I to Type-VI) and Hybrid Adapters (Type-I to Type-VI). These are used for terminations, connecting the Optical Line Systems to outdoor / Indoor optical fibre cables and other optical measurement purposes.

2.0 Functional Requirements:

2.1 The Optical fibre jumper and Hybrid Jumpers shall be manufactured with secondary coated optical fibre reinforced with Aramid yarn equally distributed over the periphery and with overall protective sheathing.

2.2 The mechanical design and construction of the component parts of each sub-assembly shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage and transport.

2.3 Special tools required, if any, for handling & maintenance of the Optical Fibre Jumper, Hybrid jumpers, Adapters and Hybrid Adapters shall be clearly indicated and supplied.

2.4 The manufacturer shall also have maintenance/repair facilities. Trader seeking TAC/TSEC shall be fully equipped with all test facilities which shall be mandatory.

2.5 The detail of the source of the components/accessories, from where these have been procured shall be submitted by the manufacturer.

2.6 The component parts which are available from multiple sources shall be used.

2.7 The optical fibre jumper shall be flame retardant and meet the requirement of UL-94-V-0 / ISI 10810(Part 53) specifications.

3.0 Technical Requirements of Optical Fibre Jumper:

Single Mode Optical Fibre used in manufacturing Optical Fibre Jumper (Optical patch cords and pigtails) and Hybrid jumpers shall have the following characteristics:

3.1	**Type of fibre** (Wavelength band optimized nominal 1310 nm)	:	Single mode Optical fibre as per ITU-T Rec. G.657 A
3.2	**Geometrical Characteristics:**		
3.2.1	Mode Field Diameter	:	8.2µm - 9.4 µm
3.2.2	Cladding Diameter	:	125 µm ± 0.7 µm

3.2.3	Cladding Non-circularity	:	≤ 0.8 %
3.2.4	Core Clad concentricity error	:	≤ 0.5 µm
3.2.5	Diameter over primary coated with double UV cured acrylate. (Shall be measured on un coloured fibre)	:	245µm ± 10µm
3.2.6	Coating / Cladding Concentricity	:	≤ 12 µm
3.2.7	Primary coating material	:	UV Acrylate
3.2.8	Secondary coating Diameter **Note:** The secondary coating shall be natural in colour	:	900 µm ± 5 %
3.2.9	Secondary coating Material	:	Polyamide -12

3.3 Transmission Characteristics:

3.3.1 Attenuation:

a) Fibre attenuation before Cabling

i) At 1310 nm	:	≤ 0.34 dB/Km
ii) Between 1285 to 1360 nm	:	≤ 0.37 dB/Km
iii) Between 1360 – 1480nm	:	≤ attenu. at 1310nm
iv) Between 1480 to 1525 nm	:	≤ 0.34 dB/Km
v) At 1550 nm	:	≤ 0.21 dB/Km
vi) Between 1525 to 1625 nm	:	≤ 0.24 dB/Km

b) Fibre attenuation after cabling

i) At 1310 nm	:	≤ 0.36 dB/km
ii) At 1383nm	:	≤ attenu. at 1310nm
iii) At 1550 nm	:	≤ 0.23 dB/Km
iv) At 1625 nm	:	≤ 0.26 dB/Km

Note:

1. Attenuation in the band 1380-1390nm shall be checked at every 2nm after Hydrogen ageing as per IEC 60793-2-50. Hydrogen ageing test is to be carried out by CACT, Bangalore or any other recognized laboratory for type test.
2. Sudden irregularity in attenuation shall be less than 0.1 dB
3. The spectral attenuation shall be measured on un-cabled fibre.
4. The Spectral attenuation in the 1250 nm–1625 nm band shall be measured at an interval of 10nm and the test results shall be submitted

3.3.2 Dispersion:

a) Total Dispersion

i) In 1285-1330 nm band	:	≤ 3.5 ps/nm.km
ii) In 1270-1340 nm band	:	≤ 5.3 ps/nm. Km
iii) At 1550 nm.	:	≤ 18.0 ps/nm. Km
iv) At 1625 nm	:	≤ 22.0 ps/nm. Km

Note: The dispersion in the 1250 nm–1625 nm band shall be measured on un-cabled fibre at an interval of 10nm and the test results shall be submitted.

b) Polarization mode dispersion at 1310 & 1550 nm

i) Fibre	:	≤ 0.2 ps/√ km
ii) Cabled Fibre	:	≤ 0.3 ps/√ 'km

Note: Measurement on un-cabled fibre may be used to generate cabled fiber statistics and correlation established.

c) Zero Dispersion Slope : ≤ 0.092 ps/(nm ^{2} Km)

d) Zero dispersion wave length range : 1300 -1324 nm

3.3.3 Cut off wavelength
For fibres used in Patch cords & Pig-tails : 1240 nm Max.

Note - The above cut off wavelength is w.r.t. 2M sample length of fibre.

3.3.4 Cable Cut off wavelength : 1260nm Max.

3.4 Mechanical Characteristics:

3.4.1 Proof test for minimum strain level : 1%
(Test method IEC-60793-1-30)

3.4.2 Peak Stripability force to remove primary : $1.3 \leq F \leq 8.9$ N
coating of the fibre. (Test method IEC-60793-1-32)

Note: The force required to remove 30 mm ± 3 mm of the fibre coating shall not exceed 8.9 N and shall not be less than 1.3 N.

3.4.3 Strippability force to remove secondary coating : $\geq$ 5.0 Newton
of fibre
(The secondary coated fibre shall be easily strippable so that primary and secondary coating can be removed separately).

3.4.4 Dynamic Tensile Strength
(Test method IEC- 60793-1-31)

a) Un-aged	:	≥550 KPSI (3.80 Gpa)
b) Aged	:	≥440 KPSI (3.00 Gpa)

3.4.5 Dynamic Fatigue (Test method IEC- 60793-1-33)	:	≥ 20
3.4.6 Static Fatigue (Test method IEC- 60793 - 1 - 33)	:	≥ 20

3.4.7 Fibre Macro bend
(Test method FOTP-62/ IEC- 60793 -1 -47)

a) Change in attenuation when fiber is coiled with 10 turns on 15 mm radius mandrel	:	≤ 0.25 dB at 1550nm ≤ 1.0 dB at 1625nm
b) Change in attenuation when fiber is coiled 1 turn around 10 mm radius mandrel	:	≤ 0.75 dB at 1550nm ≤ 1.5 dB at 1625nm
3.4.8 Fibre Curl (Test method as per IEC 60793-1 - 34)	:	≥ 4 meters radius of curvature

3.5 Material Properties:

3.5.1 Fibre Materials:

a) The substances of which the fibres are made	:	To be indicated by the manufacturer
b) Protective material requirement:		
i) The physical and chemical properties of the material used for the fibre primary coating and for single jacket fibre.	:	It shall meet the requirement of fibre stripping force as per clause No. 3.4.2
ii) The best way of removing protective coating material.	:	To be indicated by the manufacturer
c) Group refractive Index of fibre	:	To be indicated by the manufacturer

Note: The manufacturer shall indicate the variation in group refractive index of fibre during bulk production.

3.6 Environmental Characteristic of Fibre (Type test):

3.6.1 Operating Temperature
(Test Method IEC – 60793 – 1-52)

Temperature Dependence of Attenuation	:	- 60° C to +85° C
Induced Attenuation at 1550nm at -60°C to +85°C	:	≤ 0.05 dB/km

3.6.2 Temperature – Humidity Cycling
(Test method EIA/TIA-455-73)

Induced Attenuation at 1550nm at -10°C to +85°C and 95% relative humidity.	:	≤ 0.05 dB/km

3.6.3 Water Immersion 23°C
(Test method IEC- 60793 – 1 -53)

Induced Attenuation at 1550 nm due to Water Immersion at 23 ± 2°C	:	≤ 0.05 dB/km

3.6.4 Accelerated Aging (Temperature) 85°C
(Test method IEC- 60793 – 1- 51)

Induced Attenuation at 1550 nm due to Temperature Aging at 85 ± 2°C	:	≤ 0.05 dB/km

3.6.5 Retention of Coating Color
(Test method IEC- 60793 – 1 - 51)

Coated Fiber shall show no discernible change in color, when aged for relative humidity.	:	30 days at 85°C with 95% Humidity and then 20 days in 85°C dry heat

3.7 Primary coating Test (Type test):

a) Fourier Transform Infrared Spectroscopy (FTIR) Test:
To be tested to check the curing level of coating on the surface of natural fibre. The curing level shall be better than 90%.

b) Adhesion Test:
To be tested by using soaked (Solvent) tissue paper for ten strokes unidirectional on 10 cm length of fibre. No coating shall be observed on the tissue paper after testing.

3.8 Fibre Reinforcement: Secondary coated fibre shall be covered with Aramid yarn and shall be distributed equally over the entire periphery. The manufacturer shall indicate the Detex value and quantity of the Aramid yarn used in the patch cord and pigtails. The specification for Aramid yarn shall be as per GR No. TEC/GR/TX/ORM-01/04/SEP-09 (Section–XVII).

3.9 Outer Jacket Sheath:

A circular sheath of suitable low smoke zero halogen (LSZH) grade of material and of yellow in colour free from pinholes and scratches and other defects etc. shall be provided. The specification for Low smokes zero halogen (LSZH) shall be as per GR No. TEC/GR/TX/ORM-01/04/SEP-09 (Section–XX).

a) Outer sheath diameter	:	2.90 mm $\pm$ 0.15 mm (FC-PC & SC) 2.00mm $\pm$ 0.2 mm (LC)
b) Thickness of sheath (Refer to test method IEC – 189 para 2.2.1 and para 2.2.2)	:	0.45 mm to 0.55 mm (FC-PC & SC) 0.30mm to 0.35 mm (LC)

3.10	Length of Patch cord and Pigtails.	:	5 meter +10cm / -5 cm | or as 10 meter +10cm / -5 cm | per 20 meter +10cm / -5 cm | order

3.11 CONNECTOR

3.11.1	Type of connector	:	i) Type-I (FC-PC) ii) Type-II (SC– PC) iii) Type-III (SC- APC) iv) Type-IV (LC)

Note: Design of each connector to be specified by manufacturer along with the diagram showing the dimensions.

3.11.2	Polish			
	i)	Type-I (FC-PC)	:	Convex (PC)
	ii)	Type-II (SC– PC)	:	Convex (PC)
	iii)	Type-III (SC- APC)	:	Angled polish (Ferrule shall be polished to 8°± 0.2° angle)
	iv)	Type-IV (LC)	:	Convex (PC)

3.11.3	Ferrule with metallic flange	:	Zirconia ceramic/Conical Zirconia ceramic (spring loaded anti-rotation keyed)

Note: Type of ferrule used for each type of connector to be specified by manufacturer.

3.11.4	Ferrule Hole diameter	:	125µm - 126 µm

Note: Length of the ferrule to be specified by manufacturer.

3.11.5	Connector Body			
	a)	FC-PC	:	Ni plated brass body (Ni plating shall be as per BIS Standards.)
	b)	SC – PC & SC- APC	:	Engineering thermoplastic (Glass filled PBT)
	c)	LC	:	PEI (Polyetherimide) / PPS (Polyphenylene Sulphide)"

3.11.6 Colour of connector body

a) FC-PC connector	:	Ni plated Brass
b) SC-PC connector	:	Blue
c) SC-APC connector	:	Green
d) LC connector	:	Blue

3.11.7 Strain Relief Boot

a) Material	:	Polyester (Modified Thermo polyester ethylene)
b) Length	:	≥ 35mm for FC-PC & SC connector ≥ 25 mm for LC connector.

3.12 ADAPTER (COUPLING)

3.12.1 FC-PC to FC-PC (Type-I)

a) Housing design	:	Square Flanged (screwed)
b) Material		
i) Alignment Sleeve	:	Zirconia Ceramic Split sleeve.
ii) Housing	:	Ni plated brass body

Note: Mounting screws are to be provided for FC-PC Adapter.

3.12.2 SC- PC to SC- PC (Type-II) and SC–APC to SC- APC (Type III)

a) Housing design	:	Rectangular Flanged (snap fit type)
b) Material		
i) Alignment Sleeve	:	Zirconia Ceramic Split sleeve
ii) Housing	:	Glass filled PBT ultrasonic welded

3.12.3 LC to LC (Type-IV)

a) Housing design	:	Rectangular Flanged (snap fit type)
b) Material		
i) Alignment Sleeve	:	Zirconia Ceramic Split sleeve
ii) Housing	:	PEI / PPS

3.12.4 Colour

a) FC-PC connector adapter	:	Ni plated Brass
b) SC-PC connector adapter	:	Blue
c) SC-APC connector adapter	:	Green
d) LC connector adapter	:	Blue

Note 1: The connector and adapter shall be compatible with NTT-FC or JIS-FC connectors or Telcordia GR 326 standards. FC and SC Connector shall be supplied with dual dust covers (Ferrule cap and hanging type dust cover), while LC connector shall be supplied with Ferrule dust cover. FC adopter shall have threaded type dust covers and SC & LC adapters shall have compatible dust covers meeting the requirements of vibration test (clause no. 4.6).

Note 2: The body of the FC-PC connector and connector adapter shall be made by machining alone using machine grade brass. It shall not be made by forging, pressure die casting, casting, power metallurgy or moulding methods. The parts such made shall have composition of brass material as per specifications given below:

1.	Material	:	Brass Extruded Type
2.	Specifications	:	BS 249
3.	Chemical composition		
	i) Copper	:	56.5 to 58.5 %
	ii) Lead	:	2.5 to 3.5 %
	iii) Iron	:	0.33 % (Max)
	iv) Zinc	:	Remainder
	v) Impurities	:	0.7% (MAX)
4.	Physical Properties		
	i) UTS	:	42.0 Kg /mm^2
	ii) Elongation on 50 mm	:	8% (MIN)

Note 3: The manufacturer supplying the parts of the optical connector and optical connector adapter shall also are required to have ISO 9001-2000 accreditation/ISO certified manufacturing facility. The infrastructure of such vendor shall be checked and approved by the evaluation / testing team. In case of such vendor, being outside India, it is essential to have an ISO 9001:2000 certified manufacturing facility The complete quality plan of such vendors from whom the parts are being procured by the manufacturer seeking type approval shall also be required to be submitted along with the drawings & dimensions of each parts clearly marked with tolerances of individual parts.. Manufacturer/ Vendor marking shall also be provided. Change in supplier of connector and connector adapter parts will have to be intimated to CACT for approval.

Note 4: The test certificate of Ceramic Zerconia Sleeve used along with its drawing & dimensions and the test report shall also be required to be submitted which shall be mandatory. The material for screws shall be of suitable copper alloy or stainless steel. The mounting screws of M2 (NTP) size are to be provided for FC adapters and may be separately ordered for SC adapters, if required by the buyer.

Ceramic Zerconia Sleeve shall be tested for following parameters:

1.	Material of Zirconia Sleeve	:	Min. 94% Zirconia ceramic
2.	Withdrawal Force	:	0.2Kg to 0.6Kg for FC and SC sleeves; 0.1Kg to 0.250 Kg for LC sleeves
3.	Durability	:	Change in attenuation after 500 mating shall be less than 0.05 dB

Note 5: The applicable tests shall be conducted on the connector adapters (as per Annexure-I)

3.13HYBRID JUMPER:

a) FC-PC to SC-PC (Type –I)
b) FC-PC to SC- APC (Type–II)
c) FC-PC to LC (Type –III)
d) SC-PC to SC-APC (Type –IV)
e) SC-PC to LC (Type –V)
f) SC-APC to LC (Type –VI)

3.14 HYBRID ADAPTER:

a) FC-PC to SC-PC (Type –I)
b) FC-PC to SC- APC (Type–II)
c) FC-PC to LC (Type –III)
d) SC-PC to SC-APC (Type –IV)
e) SC-PC to LC (Type –V)
f) SC-APC to LC (Type –VI)

Note: The applicable tests shall be conducted on the Hybrid connector adapters (as per Annexure-I).

4.0 Testing of Optical & Mechanical Parameters of the Optical connector, Optical connector adapter and Patch cord:

Note: 1 Measurement is to be taken for both 1310 nm and 1550 nm wavelength

Note: 2 Five specimens randomly selected from the offered specimens shall be subjected to tests including Environmental test.

Note: 3 The reference Master patch cord used as a standard shall have the following characteristics:

1)	Ferrule outer diameter	:	2.499 ± 0.0003 mm
2)	Eccentricity	:	0.00020 mm (max) or 0.2 micron
3)	Deviation of angle	:	$\leq 0.2^{o}$
4)	Dome offset	:	$\leq$ 30 microns
5)	Insertion Loss	:	$\leq$ 0.05 dB against an identical reference plug.
6)	Return Loss	:	$\geq$ 60 dB (FC, SC & LC) $\geq$ 70 dB (APC)

4.1 Quality of the pre-domed ferrule End face of the connector, radius of curvature and Concentricity / Eccentricity of the connectors.

Purpose: To check the surface topography of the fibre connector and the fibre core and ferrule eccentricity measurement, to check ferrule roundness error measurement., to check angular mismatch fibre/ferrule. The concentricity of the fibre core axis with outer diameter of the ferrule of a Connector set and the examination and measurement of the angular misalignment between fibre and ferrules axes.

Method: IEC 60874-1 (1994-03 Clause 4.4.16) and instrument (Interferometer) to monitor surface topography.

Requirement:

(a)	Under cut		:	- 0.10 µm
(b)	Protrusion		:	+ 0.05 µm
(c)	Radius of curvature			
	i)	FC-PC	:	10 to 25 mm
	ii)	SC-PC	:	10 to 25 mm
	iii)	SC-APC	:	10 to 30mm
	iv)	LC	:	10 to 25 mm
(d)	Offset of Polish		:	Maximum 50 Microns off centre
(e)	Concentricity (X = 2D)		:	$\leq$ 1.3 microns

where X is Concentricity and D is Eccentricity, which is distance between axis of the fibre and the axis of the ferrule or Eccentricity is distance between centre of the fibre core and ideal centre of the ferrule, (Concentricity = 2 X Eccentricity).

Note: IEC test methods 61300-3-26, IEC 61300-2-41, IEC 61300-3-18,IEC 61300-3-24, IEC 61300-3-19, IEC 61300-3-25 IEC61300-3-17 may be referred

4.2 (a) Insertion loss of complete patch cord including adapter when tested from each direction in all conditions of operations : $\leq$ 0.3 dB

(b) Insertion loss of Adapters : $\leq$ 0.1 dB

Test method: IEC 60874 - 1 (clause no. 4.4.7) or any other suitable test method

4.3 Return loss for each Connector of patch cord

a)	Type - I FC-PC	:	$\geq$ 50 dB
b)	Type - II SC - PC	:	$\geq$ 50 dB
c)	Type - III SC- APC	:	$\geq$ 65 dB
d)	Type - IV LC	:	$\geq$ 50 dB.

Test method: IEC 60874 -1 Clause no. 4.4.12 or any other suitable test method.

4.4 Change in insertion loss of the patch cords due to change in environmental conditions : $\leq$ 0.10 dB.

a) Cold & Heat test

Purpose: To check the stability behaviour and attenuation of on optical fibre cable & on the connector set due to temperature changes.

Method: IEC 60874-1(clause no.4.5.17and 4.5.18)

Temperature:	TA1	-	(-5^oC)
	TA2	-	(-25^oC)
	TB1	-	($+60^oC$)
	TB2	-	($+70^oC$)
	Time Duration		16 Hrs at each temperature.
	Rate of change of temp:		1 degree per minute
	Number of cycles	:	2 (Two).

Requirement: Change in the attenuation of the patch cord during the test shall be $\leq$0.10 dB (each sample shall be checked separately). After the recovery period of 30 minutes, **insertion loss** shall not exceed the specified value of clause no. 4.2 of GR.

b) Damp Heat test

Purpose: To check the effects on the sample for use and /or storage under conditions of high relative humidity at a constant temperature for a given period.

Method: IEC 68-2-1.

a)	Temperature	:	40^oC
b)	Relative Humidity	:	93% to 95%
c)	Exposure time	:	4 days.

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2of this GR.

4.5 High Temp. Endurance test:

Purpose: The purpose of this test is to check the suitability of the connector for use and/or storage at high temperature for extended period.

Method: IEC 60874-1 (clause no. 4.5.33)

1.	Temperature of test	:	70^oC
2.	Duration of test	:	100 hours

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR

4.6 Vibration Test for Terminated Connector set:

Purpose: To check the effects of the vibration on the samples at the predominant frequency ranges and magnitudes that may be encountered during field service.

Method	:	FC of IEC 68-2-6.
Frequency Range	:	10 to 55 Hz
Vibration Amplitude		0.75mm constant displacement (up to 60 Hz)
Endurance duration per direction.	:	10 Min in each specified axis

Requirement: Change in the attenuation during the test shall be ≤ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

Note: The specimen shall be subjected to vibration in three mutually perpendicular directions, one of which shall be parallel to the optical axis. The test shall be conducted on complete set of two connectors and one adapter connected together.

4.7 Mechanical endurance test:

Purpose: The purpose of this test is to evaluate the effects of successive cycles of engagement and separation on a specific coupling mechanism.

Method: IEC 60874-1 (Clause no. 4.5.32)

Number of connection and disconnection	:	500

Requirement: Change in the attenuation shall not exceed 0.05 dB.

4.8 Tensile Test (Connectorized Cable Pulling Test):

Purpose: The purpose of this test is to ensure that the captivation attachment of the cable to the specimen will withstand the load during normal service.

Method	:	IEC 60794-1-2-E1
Diameter of chuck drums and transfer devices	:	250 mm approx.
Velocity of transfer device	:	100 mm/min
Magnitude of load applied for 5 min	:	8 Kg (FC-PC) 0.8 Kg (SC). 0.36 Kg for LC
Length of the sample		As per the requirement of the test.
Point of the application of the load	:	After the chuck drum

Requirement: Change in the attenuation during the test shall be ≤ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

Note: The observation is to be taken before the start of the test and after the recovery period of 30 minutes.

4.9 Effectiveness of clamping device against cable nutation with a Connector set:

Purpose: To check the ability of the cable clamping and boots of optical fibre connectors to withstand the severe mechanical stresses associated with cable nutation and maintain their role in preventing damage to the fibre in the vicinity of the connector and of the fibre termination.

Method	:	IEC 60874-1 (1993-02 Clause 4.5.35)
Load	:	8 kg (FC-PC & SC) 0.36 Kg (LC)
No. of cycles	:	10

Requirement:

1) Check the visual signs of damage to the cable structure in the vicinity of the connector.
2) There should be no fibre break.
3) Angular misalignment.
4) The attenuation shall not exceed the specified value as per clause no. 4.2.

4.10 Minimum Bending Radius of the cable:

a) Loaded	:	50 mm.
b) Unloaded	:	30 mm.

Requirement: The jumper cable shall meet the above requirement and shall not suffer any physical damage under the above conditions. Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.11 Flexibility Test for cable:

Purpose: To check the flexibility of the jumper cable.

Method: The fibre and the component part of the optical fibre & jumper cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel of 24D.

Requirement:

1. Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.
2. Sheath of the optical jumper cable shall not show any damage.

4.12 Repeated Bending test of the connectorised cable:

Purpose: To check the ability of optical fibre connectorised cable to withstand repeated bending.

Method	:	IEC 60794-1-E8
Number of cycles	:	1000
Carrier speed	:	10 cycle per min.
Pulley Diameter	:	100 mm.
Load	:	2 Kg

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.13 Cable bend test under tension

Purpose: To check the ability of a small diameter optical fibre cable to withstand bending around the test mandrel.

Method	:	IEC 60794-1-E11
Mandrel diameter	:	50 mm.
Number of turns	:	(1 cycle) 6.
Number of cycles	:	10
Bending speed	:	1 revolution in 5 sec.
Load	:	10 N
Length of the sample	:	As per the requirement of the test.

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.14 Cable bend at low temperature:

Method	:	IEC 794-1-2-E11.
Bending radius	:	2.5 times cable diameter.
Length of the sample	:	Jumper cable
Test temperature	:	- 25^{o}C.
Number of bends	:	10

Requirement:

1) Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.
2) There shall be no fibre break.

4.15 Torsion Test of the cable:

Purpose: To check the ability of an Optical Fibre Cable to with stand torsion.

Method	:	IEC60794-1-2-E7.
Number of rotations	:	20 ($\pm$ 180^o, not less than 30 per min.)
Distance between fixed and the rotating clamp	:	250 mm.
Length of the sample	:	As per the requirement of the test.
Axial load	:	20 N

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.16 Bending moment test of the Coupling mechanism of the connector:

Purpose: To check the coupling mechanism of a connector to with stands the bending moment to be applied in the field.

Method: IEC -60874-1 Clause No. 4.5.7

Force	:	10 N
Rate of force	:	It shall be applied slowly and smoothly
Duration of force to be applied	:	1 minute

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.17 Crush Test (Axial compression):

Purpose: To check the capacity of the cable for the compressive loads likely to be applied on the cable during normal service.

Method : IEC 60794-1-2-E3

Load	:	50 Kg
The edges of the movable plate shall have a radius of curvature of at least	:	5 mm
Duration	:	1 min

Requirement:

1) Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 f this GR.
2) No permanent physical damage to the cable.

Note: The observation is to be taken before the start of the test and after the recovery period (30 minutes).

4.18 Impact test of the cable

Purpose: To check the impact resistance of the single fibre cable.

Method: IEC 60794-1-2-E4.

Radius of intermediate piece.	:	12.5 mm
Starting energy	:	1.0 Nm
Number of impacts	:	3
Length of sample	:	As per the requirement of the test.

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.19 Crush Resistance test of the connector

Purpose: To evaluate the effect of loads on the connectors when exposed to critical situations such as being stepped on, being run over by vehicle tyres etc.

Method: IEC 60874-1 Clause No. 4.5.10

Duration of the load to be applied	:	10 sec.
load	:	1000 N

Requirement:

1) Change in the attenuation during the test shall be $\leq$ 0.10dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.
2) No physical deformation to the cable.

4.20 Static load of the connector:

Purpose: To check the effects of shearing forces likely to be applied on the connector during the normal field operations.

Method: IEC 60874-1 (Clause 4.5.3)

Time Duration	:	1 minute.
Load	:	8 Kg (FC-PC) 0.8 Kg (SC) 0.45 Kg (LC)
Direction of the force	:	Optical axis
Rate of application of the load	:	10 mm/minute.

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.21 Drop Test:

Purpose: To evaluate the ability of a connector to withstand impacts to be encountered during usage.

Method	:	IEC-60874-1 (Clause no. 4.5.14)
Number of drops	:	25
Drop height	:	1500 mm

Requirement: The insertion loss shall not increase the specified value of clause no. 4.2 of this GR after the test.

4.22 Strength of coupling mechanism (Coupling proof torque):

Purpose: To check the effects of axial loads likely to be applied on the coupling mechanism of a connector.

Method: IEC 60874-1 (Clause 4.5.15)

Load	:	8Kg (FC-PC)
	:	0.8Kg (SC)
	:	0.36Kg (LC)
Time Duration	:	5 minutes
Direction of the force	:	Optical axis

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.23 Sealing Test (water immersion for Connector set with Cable):

Purpose: To check the integrity of the seals when the samples shall be subjected to immersion under water.

Method: IEC 60874-1 (Clause 4.5.24)

Procedure	:	IEC 68 -2-17 (Test Qf)
Water head	:	1 meter
Duration	:	24 hrs.

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.24 Corrosive atmosphere (Salt mist):

Purpose: To check the resistance of samples from deterioration when it shall be exposed to salty environment.

Method: IEC 60874-1 (Clause 4.5.26) or as per QM 333

Procedure	:	IEC 68-2-11 (Test Ka).
Temperature	:	35^oC
Duration	:	16 hrs.

Requirement:

1) Change in the attenuation during the test shall be $\leq$0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.
2) No corrosion observed

4.25 Effect of Dust on Connector set:

Purpose: To check the effects of dust on the connectors.

Method	:	IEC 874-1 (Clause 4.5.27)
Temperature	:	$35^oC \pm 2^o C$
Relative humidity	:	$\leq$ 60 %
Rate of dust concentration	:	25 g $\pm$5g for 5 minutes.
Size of the dust	:	Capable to pass through a sieve of 150 um aperture
Duration	:	10 minutes.

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

4.26 Shock Test

Purpose: To check the mechanical weakness and or degradation after samples subject to non-repetitive mechanical shocks encountered on the connector during the normal field operations.

Method	:	IEC 60874-1 (Clause 4.5.9)
Procedure	:	IEC 68-2-27 (Test Eb).

Severity

a)	No. of Shocks	:	5
b)	Peak acceleration	:	294 m/s^2
c)	Pulse duration	:	18 ms

Requirement: Change in the attenuation during the test shall be $\leq$ 0.10 dB. After the recovery period of 30 minutes, insertion loss shall not exceed the specified value of clause no. 4.2 of this GR.

PART II –GENERAL REQUIREMENTS

5.0 Marking and Packing:

5.1 Identification and Marking:

5.1.1 Marking on the optical fibre jumpers and hybrid jumpers shall be of durable quality and it shall withstand the rubbing (20 times) with dry tissue paper in both the directions.

5.1.2 Marking on Jumpers shall include the following:

a) Name of cable manufacturer
b) Name of Jumper manufacturer
c) Type of fibre
d) LSZH material
e) Manufacturer's identification mark
f) Manufacturer's part number.
g) Manufacturing date code (year/month etc.)
h) Variant identification number(s)/ (Sr. No. of product)
i) Any other additional marking required.
j) TEC GR. No.

5.1.3 Marking on the adapters shall include the following:

a. Type of adapter
b. (FC-PC to FC-PC, SC-PC to SC-PC, SC- APC to SC-APC or LC-LC)
c. Manufacturer‘s name/ model no.
d. Manufacturer's part number.
e. Manufacturer's identification mark.
f. Manufacturing date code (year/month etc.)

Note: Additional information if required by the buyer may be provided on the packing or as separate test report.

5.2 Packing:

5.2.1 Each Optical Fibre Jumper (Patch cord/Pigtail) and Hybrid jumpers shall be packed separately in transportable packing with the test report on manufacturer’s letter head which shall include the following:

(a) Insertion loss at 1310 nm and 1550 nm
(b) Return loss at 1310 nm & 1550 nm.
(c) Length of the patch cord/pigtail.
(d) Precautions for handling and cleaning.
(e) Radius of curvature in mm of the optical connecter.
(f) Under cut or protrusion of fibre in optical connector in microns.
(g) Linear off set of polish of connecter in microns
(h) Concentricity details.
(i) Refractive Index of fibre
(j) Interference diagram

Note: The test report for the parameters (e to j) shall be provided batch-wise and individual batch may be decided by the purchaser.

5.2.2 Each connector adapter shall be packed separately and supplied with following details:

a) Insertion loss at 1310 nm and 1550 nm

5.2.3 Each connector and Adapter shall be covered with dust cover. FC and SC connectors will be supplied with Dual dust covers (Ferrule cap and hanging type dust cover), while LC connector shall be supplied with Ferrule dust cover. FC adapter shall have threaded type dust cover and SC & LC adapters shall have compatible dust covers.

6.0 Quality Requirements:

6.1 The Optical Fibre Jumpers, Hybrid jumpers, Adapters and Hybrid Adapters should be manufactured in accordance with International Quality Standards ISO 9001-2000 for which the manufacturer should be duly accredited. A quality manual shall be submitted by the manufacturer.

6.2 The Optical Fibre Jumper, Hybrid jumpers, Adapters and Hybrid Adapters shall conform to the requirements for Environment test specified in IEC Document No. 60874-1 (1993-02), IEC 60874-1 (1994-03) and IEC 60794-1. The requirements of the particular test has been specified in the relevant test.

7.0 Documentation:

Complete technical literature in English with detailed construction diagram of various sub components with dimensions & test data of optical fibre jumper and the optical connector and optical connector adapter and its parts shall be provided. The details of the ferrule used shall also to be submitted. All aspects of installation, operation and maintenance shall also be covered in the manual. The manual shall include the following:

a) Safety measures to be observed in handling the Optical fibre Jumper.
b) Cleaning method of optical fibre connectors and adapters / ferrule end face using lens paper and Ethanol (Ethyl Alcohol lab grade)
c) Precautions during measurements.
d) Test equipment required for routine maintenance and calibration including their procedures.
e) Each sub-assembly/component shall be clearly marked to show its function, schematic reference so that they are identifiable from the assembly/component layout diagram in the manual.
f) List of components used, including their sources and the approving authority.
g) Detailed ordering specifications for all the components, sub-assemblies, shall be listed in the manual to facilitate re-ordering as and when required.

8.0 Safety Requirements:

The manufacturer shall make available sufficient information to alert the user about the potential hazard and shall indicate the required precautions and working practice.

9.0 Issue of Type/TSEC Approval:

The manufacturer may seek Type Approval Certificate/TSEC on following basis:

Case I Optical Fibre Jumper (Patch Cord & Pig Tail)

Manufacturer may offer one or all types of Jumpers and testing shall be carried out for one or all types. A common TAC shall be issued for all types of Jumpers.

Case II Adapter

Manufacturer may offer one or all types of Adapters and testing shall be carried out for one or all types. A common TAC shall be issued for all types of Adapters.

Case III Hybrid Jumper

Manufacturer may offer one or all types of Jumper and testing shall be carried out for one or all types. A common TAC shall be issued for all types of Hybrid Jumpers.

Case IV Hybrid Adapter

Manufacturer may offer one or all types of Adapters and testing shall be carried out for one or all types. A common TAC shall be issued for all types of Hybrid Adapters.

NOTE:

1. Manufacturer shall submit 25 samples with all in house test reports for evaluation and testing officer shall select five numbers of samples for testing randomly.
2. Raw Material tests shall be conducted during Bulk Production.
3. The fibre (G.657 A) used in simplex cable shall be CACT approved.
4. The Optical fibre cable used for the optical fibre Jumpers shall be CACT approved.
5. Separate approval shall be obtained for patch cords using 2.00 mm diameter simplex cable & 3.00 mm diameter simplex cable.

ANNEXURE - I

TESTS FOR ADAPTER

1. Return Loss Test
2. Cold & Heat Test
3. Damp Heat Test
4. High Temp. Endurance Test
5. Vibration Test
6. Mech. Endurance Test
7. Bending Moment Test
8. Crush Resistance Test
9. Static Load Test
10. Drop Test
11. Strength of Coupling Mechanism Test
12. Salt Mist Test
13. Shock Test
14. Dimensional Test

ABBREVIATIONS

ASTM	- American Society for Testing Materials
BIS	- Bureau of Indian Standards
FC-PC	- Physical Contact Type of Fibre Connector
GR	- Generic Requirement
IEC	- International Electro -Technical Commission
IS	- Indian Standards
ISO	- International Standard Organisations
ITU	- International Telecommunication Union
QM	- Quality Manual
SM	- Single Mode
LSZH	- Low smoke zero halogen