सत्यमेव जयते

वर्गीय आवश्यकताओं के लिए मानक
टीईसी ७२०४०: २०२५

(सं:टीईसी/जीआर/एफए/एमडीएस-001/02/मार्च-2020 को अधिक्रमित करता है)

STANDARD FOR GENERIC REQUIREMENTS

TEC 72040:2025

(Supersedes No. No. : TEC/GR/FA/MDS-001/02/MAR-20)

माइक्रो डक्ट फॉर एंडोर एंड आउटडोर एप्लिकेशनस

MICRODUCT FOR INDOOR & OUTDOOR APPLICATIONS

ISO9001:2015

दूरसंचार अभियांत्रिकी केंद्र

खुर्शीदलाल भवन, जनपथ, नई दिल्ली–110001, भारत

TELECOMMUNICATION ENGINEERING CENTRE

KHURSHIDLAL BHAWAN, JANPATH, NEW DELHI–110001, INDIA

www.tec.gov.in

Release 3: March , 2025

FOREWORD

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

- Framing of Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE) Policy
- 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 in New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This document describes the Generic Requirements of Microduct for Optical Fibre Cable for Indoor & Outdoor applications. These Microducts are permanently lubricated High Density Polyethylene. It is a new concept of ducting the micro cables for carrying fibre to the home. Microducts are small diameter cable ducts used with the new generation of air blown Micro optical fibre cables. Indoor & outdoor installation of Microducts can be in various conditions like directly into the trench, existing pipes, aerial applications and access to buildings. There is broad interest in this technology by telecommunication installation companies and operators for

the deployment of optical networks, because it helps in the reutilization and optimization of the space inside existing pipes (e.g., large ducts), as well as the minimization of civil works, the social impact and the cost of the plant.

CONTENT

HISTORY SHEET

Name of the Generic Requirements	No. of the Generic Requirements	Remarks
Microduct for FTTH Applications	GR/MDS-01/01. FEB 2010	First issue
Microduct for Indoor & outdoor Applications	TEC/GR/FA/MDS-001/02/MAR-20	Second issue
Microduct for Indoor & outdoor Applications	TEC 72040:2025	Third issue

REFERENCES

TEC SPECIFICATION

1.	TEC/GR/TX/CDS-008/04/AUG-19	Specification for PLB Telecom Ducts

OTHER STANDARDS (EIA/IEC/IS/ASTMCISPR/ISO/Bell Core etc.)

1.	IS 7328	Specification for High Density Polyethylene Materials for Moulding & Extrusion
2.	IS 2530	Method of test for polyethylene moulding material & polyethylene compounds
3.	IS 5175	Specification for Polypropylene rope
4.	IS 12235(Part 9)	Test method for Impact Strength
5.	IS 4984	Specification for HDPE Pipes for water supply for Hydraulic Characteristics
6.	ASTM D 1505	Test method for density of plastics by density Gradient technique
7.	ASTM D 1238	Test Method for flow rates of thermoplastic by Extrusion plastometer
8.	ASTM D 638	Standard test method for Tensile properties of plastic
9.	ASTM D 790	Test methods for Flexural Properties of Reinforced and un-reinforced Plastics & Electrical Insulating Material.
10.	ASTM D 2240	Standard Test Method for Rubber Hardness.
11.	ASTM D 648	Test method for heat deflection temperature
12.	ASTM D 1693	Test method for environmental stress - cracking of ethylene plastics.
13.	ASTM F 2160	Standard specification for solid wall HDPE conduit based on controlled OD
14.	ASTM D 1712	Test method for resistance of plastics to sulphide staining

15.	ASTM G 154	Standard practice for operating fluorescent light apparatus for UV exposure of non metallic materials
16.	ISO 2505	Thermoplastics Pipes- Longitudinal reversion – Test method and parameters.
17.	IS: 9938	Recommended colours for PVC insulation for LF wires and cables.
18.	ASTM D 3895	Test Method for Oxidative- Induction Time of Polyolefins by DSC
19.	ASTM D 2412	Standard method for Determination of External loading Characteristics of Plastic Pipe by Parallel Plate loading
20.	IEC- 60794-1-21	Generic specification Basic optical cable test procedures – Mechanical test methods
21.	IEC -60794-1-22	Generic specification – Basic optical cable test procedures Environmental test method
22.	IEC -60795-5-10	Family specification – Outdoor Microduct optical fibre cables, Microducts and protected Microducts for installation by blowing

PART I – TECHNICAL SPECIFICATION

1.0 Introduction :

This document describes the Generic Requirements of Microduct for Optical Fibre Cable for Indoor & Outdoor applications. These Microducts are permanently lubricated High Density Polyethylene. It is a new concept of ducting the micro cables for carrying fibre to the home. Microducts are small diameter cable ducts used with the new generation of air blown Micro optical fibre cables. Indoor & outdoor installation of Microducts can be in various conditions like directly into the trench, existing pipes, aerial applications and access to buildings. There is broad interest in this technology by telecommunication installation companies and operators for the deployment of optical networks, because it helps in the reutilization and optimization of the space inside existing pipes (e.g., large ducts), as well as the minimization of civil works, the social impact and the cost of the plant.

2.0 Functional Requirements:

2.1 Microducts shall be small ducts, in the range of 5mm - 16mm (OD), which can be blown into an empty duct.

2.2 It shall be possible to place several Microducts into the larger empty ducts.

3.0 Technical Requirements:

3.1 Construction of Microduct:

3.1.1 Permanently solid lubricated Microducts shall consist of two concentric layers. The Outer layer being High-Density Poly-ethylene (HDPE) for Outdoor application and Low Smoke Zero Halogen(LSZH) for Indoor application, shall be co-extruded with the Inner layer of solid permanent lubricant to reduce the Internal co-efficient of friction (ICF). The configuration of the Microduct shall

be smooth-out, micro-ribbed inside with a co-extruded permanent lubrication layer.

3.1.2 The inner lubricant layer shall be so formulated to provide a permanent, low friction boundary layer between the inner surface of the duct and OF micro cable. The lubricant layer shall be clearly visible in cross-section, concentric with outer layer. The life of Microduct shall not be less than 50 years.

Note: Certificate from resin manufacturer shall be submitted in support of 50 years of life.

3.1.3 Microducts shall be co-extruded tubes made up of an inner 'blowable' layer. The choice of tube size is dependent upon route configuration and length. All Microducts shall have a permanently bonded silicone pre-lubricated inner bore to reduce friction and enhance blowing performance.

3.1.4 **Sheathing of Microducts**: Several Microducts can be bundled together by HDPE sheath for Outdoor application (ODA) and LSZH for indoor application (IDA) in a single unit. Numbers and sizes of the Microducts shall be defined by Purchaser. Sheath thickness and tests on bundle is defined in Annexure-4. A single unit (bundle) may contain 2 to 32 Microducts.

3.1.5 For indoor applications, false roofing & hazardous areas the Microduct shall be of LSZH material.

3.2 **Two layer construction:** Microduct is two layer construction where outer layer is of HDPE for outdoor applications and of LSZH for indoor application. Inner layer material shall be of friction reducing, polymeric material, which shall be integral part of outer layer.

3.2.1A **Outer Layer for ODA:** The base HDPE resin used for the outer layer of the Microduct shall conform to designation of IS-7328 or to any equivalent

standard meeting the following requirements. However, the manufacturers shall furnish the designation for the HDPE resin as per IS 7328, as applicable.

Table-1: Requirement for ODA

a)	Density	0.940 to 0.958 g/cc at 27° C when tested as per ASTM D1505 (IS: 2530 or IS: 7328)
b)	Melt Flow Rate (MFR)	0.2 to 1.1 g/10 minutes at 190° C & 5 kg load, when tested as per IS: 2530
c)	Tensile Strength at Yield	20 N/mm² minimum when tested as per ASTM D 638, Type-V specimens
d)	Elongation at break	>600% when tested as per ASTM D 638, Type-V specimens
e)	Flexural Modulus at 1% strain	690 N/mm² minimum, when tested as per ASTM D 790
f)	Hardness, Shore-D	Between 60 and 65 units, When tested as per ASTM D 2240
g)	Heat Deflection Temperature at 45g/mm²	65° C minimum, when tested as per ASTM D 648
h)	Environmental Stress Crack resistance (when tested with 10% Igepal, CO 0630 Solution at 50° C)	> 96 Hrs when tested as per ASTM D 1693 (No cracks)
i)	Weathering in artificial (UV) light (Specimens shall be as per ASTM D 638 Type-IV) and cut from compression moulded sheet.	After exposure for 720 hrs., Tensile strength shall be tested. The variation shall not be greater than 20% compared to tensile strength obtained at c) above. For detail of cycle time etc., refer clause 4.19
j)	OIT (in Aluminium Pan)	30 minutes minimum,

	(Oxidation Induction Test)	when tested as per Annexure-1
k)	UV Stabilizer Content	Hindered Amine Light Stabilizer minimum 0.15%, When analysed as per FT-IR method

Note: The raw material shall contain required additives such as antioxidants, UV stabilizers etc. in the raw material itself, to meet the above parameters.

3.2.1B Outer Layer for IDA: The base LSZH resin used for the outer layer of the Microduct shall conform the following requirements.

Table-2: Requirement for IDA

Sr. No.	PARAMETER	UNIT	REQUIRMENT	TEST METHOD
1	Melt Flow index at 190°C and 5 kg load	Gm/10min	1.0 to 3.0	IS 2530
2.	Density	Gm/cc	0.95 to 1.50	IS 7328
3.	Tensile strength at yield	N/mm^2	Min 11	ASTM D 638
4.	Elongation at break	%	Min 40	ASTM D 638
5.	Limited Oxygen Index	%	Min 26	ASTM D 2863
6.	Hardness	Shore-D	Min 40	ASTM D 2240
7.	Halogen Acid Gas generation	mg/g	5	IEC 60754-1
8.	Halogen Acid Gas Emission: pH: Conductivity:	 pH	 >4.3 <10	IEC 60754-2

3.2.2 Inner Layer: The inner lubrication material shall be of friction reducing, polymeric material, which shall be integral part of outer layer. The lubricant materials shall have no toxic or dermatic hazards for safe handling. In the finished Microduct, the co-extruded inner layer of solid permanent lubricant shall be integral part part of outer layer and shall be white in colour and clearly

visible in cross-section of duct. The inner layer of solid permanent lubricant shall be continuous all through and shall not come out during storage, usage and throughout the life of the duct.

3.2.3 **Dimensions of Microducts:** The dimensions of Microduct shall be as below, **However the exact sizes will be specified by the purchasing authority**.

Table-3

Dimension	**5/3mm**	**7/4 mm**	**10/6 mm**	**12/8 mm**	**14/10mm**	**16/12mm**
a) Outside diameter	5+/-0.1 mm	7 +/-0.1 mm	10 ±0.1 mm	12 ±0.1 mm	14 ±0.1 mm	16±0.1 mm
b) Average Wall thickness	1.00 ±0.1mm	1.50± 0.1mm	2 ± 0.1mm	2.0± 0.1mm	2.0 ± 0.1mm	2.0± 0.1mm
c) Ovality (mm)	0.25 max	0.35 max.	0.5 max.	0.60 max.	0.70 max.	0.80 max.
d) Standard length (+/- 10%)	As per customer Specification	As per customer Specification	As per customer Specification	As per customer Specification	As per customer Specification	As per customer Specification
e) Max. outer diameter of Micro Cable that can be installed by	1.5 mm	2.5 mm	3.5 mm	6.5 mm	6.5 mm	7.5 mm

blowing technique						

Note: Selection of Microduct size will depend on the outside diameter of the Optical Fibre cable to be installed in the Microduct.

4.0 Performance Test Requirements:

The Microduct shall meet the following test requirements :

4.1 Visual Inspection: The Microducts shall be checked visually for ensuring good workmanship. The Microducts shall be free from blisters, shrink holes, flaking, chips, scratches, roughness, break and other defects. The Microducts shall be smooth, clean and round. The ends shall be cleanly cut and shall be square with axis of the Microduct.

4.2 Tensile Performance:

Test conditions:

Method: Generally, to IEC 60794-1-21, Method E1

Microduct length under tension: >1 m

Tensile load on Microduct: 1 × W;

W-Weigh of 1Km Microduct.

Duration of load: 10 min

Observation: Under visual examination, without magnification, there shall be no damage after the test and the test shall pass the inner clearance test (Annex 3).

4.3 Crush Performance:

Test conditions:

Method: IEC 60794-1-21, Method E3A

Sample length: 250 mm

Load: 500N

Duration time: 1 min

Recovery time: 1 h

Observation: Under visual examination, without magnification, the Microduct shall show no damage. After the recovery time the Microduct shall pass the inner clearance test (Annex 3) and there shall be no splitting or permanent damage. The imprint of the plate is not considered as mechanical damage.

4.4 Impact Test:

Test conditions:

Method: IEC 60794-1-21, Method E4

Striking surface radius: 300 mm

Impact energy: 1J

Recovery time: 1 h

Number of impacts: One in 3 different places spread not less than 500 mm apart

Observation: Under visual examination without magnification there shall be no damage to the Microducts. The Microduct shall pass the inner clearance test (Annex 3) and there shall be no splitting permanent damage. The imprint of the striking surface on the Microduct is not considered as mechanical damage.

4.5 Torsion

Test conditions

Method: IEC 60794-1-2, Method E7

Maximum gauge length: 2 m

Rotation: 180^0 clock wise and 180^0 anti-clock wise.

Number of cycle : 10

Observation: Under visual examination without magnification there shall be no damage to the Microducts. The Microduct shall pass the inner clearance test (Annex 3) and there shall be no splitting or permanent damage.

4.6 Kink Test

Test conditions

Method: IEC 60794-1-21, Method E10

Minimum diameter: 20 × OD

The purpose of this test is to determine the minimum loop diameter at the onset of the kinking of a Microduct.

Sample:

The sample length shall be sufficient to carry out the specified test.

Procedure:

Testing shall be in accordance with standard atmospheric conditions.

A loop shall be made (see in below Figure). The diameter of the loop shall be reduced to the onset of kinking by pulling slowly on the two ends. The forces at the bottom of the loop shall be applied in one plane.

Observation: Under visual examination, without magnification, there shall be no damage to the Microducts after the test and shall pass the inner clearance test (Annex 3). The Microduct shall attain the required minimum diameter without kinking.

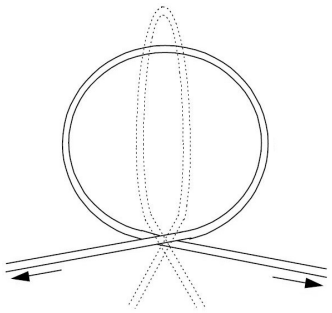


Figure-1:

4.7 Bend Test:

Test conditions

Method: IEC 60794-1-21, Method E11B

Minimum diameter: 40 × OD

Number of Cycles: 3

Observation: Under visual examination, without magnification, there shall be no damage to the Microducts after the test and shall pass the inner clearance test (Annex 3).

4.8 Microduct route verification test:

Test shall be conducted as per Annexture-3

4.9 Microduct pressure withstand Test:

Test conditions

Sample Length : 250mm to 750mm.

Method: IEC 60794-1-22, Method F13.

Observation:

a. All Microducts shall resist an air pressure of at least 2.5 × the installation pressure (8Kg/cm2) at a temperature of 20 °C for a period of 0.5 h.

b. All Microducts shall resist a proof test pressure of at least 1.3 ×the installation pressure (8Kg/cm2) at a temperature of room temperature for a period of 2h.

   After the test, under visual examination, without magnification, there shall be no damage to the Microducts.

4.10 Heat Reversion test: Test is to be carried out as per IS: 4984. A sample of Microduct of approximately 200 mm shall be placed horizontally in the hot air oven for 30 minutes at 110 +/-2^{O}C so that the dimensional changes in the Microduct section shall not be impeded. After cooling at room temperature, the dimensional change in the Microduct section shall be measured in the longitudinal direction & the deviation from the initial length shall be calculated & stated in the percentage. The dimensions shall not change by more than 3% in the longitudinal direction.

4.11 **Environmental Stress Crack Resistance Test (ESCR):** The test has to be carried out as per ASTM – D 1693. The specimen cut from the Microduct shall be bent into a U shape around a mandrel of diameter 10 times to the outside diameter of the Microduct. The bent portion of the U shall be placed in a solution of 10% Igepal (CO–630) at 50 +/-2^{O}C for 96 hours. The Microduct shall show no signs of cracks.

4.12 **Oxidation Induction Test:** The induction time in oxygen when tested with an Aluminium pan as per method in Annexure-1, shall not be less than 30 minutes.

4.13 **Internal Co-efficient of Friction**: The Internal Co-efficient of Friction when tested, as per the method given in Annexure 2, shall not exceed 0.06**,** when tested with respect to Nylon jacketed unarmoured Microduct Optical Fibre cable depending on the size of Microduct.

4.14 **Ovality Test :** Ovality is the difference between maximum outside diameter and the minimum outside diameter at the same cross-section of the Microduct, at 300mm away from the end. The ovality for Microduct, when measured as per IS-4984, shall not exceed as per the table shown in clause No. 3.2.3.

4.15 **Density of Finished Microduct :** The density of the Outdoor Microduct shall be between 0.940 and 0.958 gms/cc at 27°C and shall not differ from that of the raw material by more than 0.003 gm/cc and the density of the Outdoor Microduct shall be between 0.95 and 1.5 gms/cc at 27°C and shall not differ from that of the raw material by more than 0.020 gm/cc, when tested as per ASTM D 1505 (1S:2530 or IS:7328). The same test method shall be used for determining the density of the raw material as well as the completed Microduct. The test will be conducted by collecting raw material from the hopper during extrusion and finished Microduct made from the same material.

4.16 **Melt Flow Rate (MFR) of Finished Duct :** The change in the MFR caused by processing of raw material into Microduct, i.e. the difference between the

measured value for the outer layer material from the Microduct and measured value for the raw material shall not be more than 30%, when tested as per ASTM D 1238 (IS:2530). The test will be conducted by collecting raw material from the hopper during extrusion and finished duct made from the same material.

4.17 **Ash Content :** The Ash Content of Microduct for outdoor application shall not be more than 0.3% when tested as per method outlined in clause No. 6.1(g). This test is not applicable to Microduct for indoor application since the material is LSZH.

4.18 **Test for fading of colours of Microduct:** The Microduct shall be tested for the fading of colours as per ASTM D 1712. There shall be no discolouration.

4.19 **UV Stabiliser Test (ODA Microduct):** The test shall be conducted on specimens taken (as per type V of ASTM D 638) from the Microduct. The aging shall be done with UV-B lamps at a typical irradiance of 0.63 W/m²/nm as per cycle No. 2 of ASTM G 154.

Table-4

Lamp	------	UV-B lamp
Cycle	------	4 hrs. UV exposure at 60° C 4 hrs. Condensation at 50° C
Total cycle time	------	720 hrs.
Reference	------	ASTM D 638 (Type IV specimens)

After aging, the specimens shall be tested for tensile strength at a speed of 50 mm/minute. The variation compared to the value obtained before aging as in clause 4.2 shall not be more than 20%.

Note: This test is not applicable for indoor application (LSZH)

4.20 **Identification Markings:** The Microduct shall be prominently marked with indelible ink with ink jet printing, with the following information at intervals every meter to enable identification of the Microduct. The size of ink markings shall be distinct, clearly and easily visible.

a) Service Provider / Purchaser's Cable Microduct
b) Telephone /Purchaser's emblem
c) Manufacturer's name (also can be in abbreviated form)
d) Microduct with size
e) Machine number/Specific serial number of the Microduct
f) Date of manufacture (DD/MM/YYYY)
g) Sequential length marking at every meter with arrow mark in ascending order
h) In case of bundled Microduct, individual Microduct identification number shall be as per Annexure-4.

4.21 **Anti Rodent Test :** The test detailed in Annexure-5. Effect of anti-rodent chemical on LSZH chemical is not tested. Since LSZH is a regulatory requirement, it is preferred over anti-rodent requirement in Microducts for indoor applications. However purchaser may specify anti rodent requirement for Microduct for outdoor applications.

PART II - GENERAL REQIREMENTS

5.0 Engineering Requirements:

5.1 Colour of the Microduct (ODA Microduct): The Microducts shall be made in eight colours viz. Green, Orange, Blue, Yellow, Brown, Violet, Grey and Red. The colour of the duct shall be uniform throughout. The purchasing authority shall specify the colours of the duct ordered for.

The colour of Indoor application Microduct shall be White/Natural colour as of base Material colour.

5.1.1 The colour of the Outdoor application Microduct shall be identifiable under normal lighting conditions and shall conform to IS: 9938.

5.1.2 In the two layer construction the inner layer (Solid Lubricant) shall be white in colour.

5.2 The length of the Microduct in reel (wooden/metal/plywood) shall be 2 Km ± 10 % / 4Km ± 5% and shall be supplied as per the order. The variation in length of Microduct, as specified above (in each drum), shall be acceptable. It shall be suitably packed for shipping and handling purposes.

6.0 Quality Requirements:

6.1 Material:

6.1.1. The raw material used for Outdoor application Microduct shall meet the following requirements:

a) The antioxidants used shall be physiologically harmless.

b) None of the additives shall be used separately or together in quantities as to impair long term physical and chemical properties of the duct.

c) The raw material used for extrusion shall be dried to bring the moisture content to less than 0.1%.

d) Suitable UV stabilizers shall be used for manufacture of the duct to protect against UV degradation, when stored in open for a minimum period of 8 months.

e) The raw material used in the manufacturing of the duct shall be such that the service life of the duct and all its accessories can be expected to be more than 50 years including the life of permanent lubricant.

f) No rework material shall be used during Microduct Manufacturing.

g) Ash Content of Colour Master Batch: The Ash Content of Colour Master Batch shall not be more than 12%, when tested as per Method given below:

Test Method for Ash Content: About 1 gm of colour Master Batch sample, under test, shall be taken and dried at 105° C for two hours in a platinum or glazed porcelain or silica or quartz crucible. The weight of the sample shall be noted. Subsequently, the sample with the crucible shall be transferred to a muffle furnace maintained at 600 ± 50° C and allowed to remain there for three hours. The ash content may be calculated as a percentage of the weight of the original sample.

Note: The HDPE resin raw material used in the manufacturing of Outdoor application Microducts shall have source approval of CACT/ TEC designated CAB/Accredited laboratory. The source approval for the HDPE resin raw material will be granted by CACT/ TEC designated

CAB/Accredited laboratory if the material conforms to above clause No.3.2.1A.

6.1.2. The raw material used for indoor application Microduct shall meet the following requirements:

a) None of the additives shall be used separately or together in quantities as to impair long term physical and chemical properties of the duct.

b) The raw material used for extrusion shall be dried to bring the moisture content to less than 0.1%.

c) Suitable UV stabilizers shall be used for manufacture of the duct to protect against UV degradation, when stored in open for a minimum period of 8 months.

7.0 Microduct Accessories:

7.1 The following accessories are required for joining the Microducts and shall be supplied along with the ducts. The manufactures shall provide complete design details, procedure for method of installation and type/grade of the material used for the accessories. The required quantity shall be indicated by the Purchasing Authority in the purchase order.

a) **Plastic Coupler :** The coupler shall be of Push-fit type having Push-Lock mechanism, which enables them to be installed on Microducts without pre-dismantling. It is used to couple two Microducts. The design of this shall be simple, easy to install and shall provide air tight and water tight leak proof joint between the two Microducts. The coupler shall ensure that the two Microducts are butted smoothly without any step formation in the inner surface. The joining shall meet the air pressure test of 12 kg/cm^2 for a minimum period of 2 hours without any leakage.

b) **End Plug:** The end plug shall be Push-fit type. This is for sealing the ends of empty ducts, prior to installation of Optical Fibre Microcable and shall be fitted immediately after laying of duct, to prevent the entry of any dirt, water, moisture, insects etc into ducts. End Plug shall be tested for air tightness with a pressure of 1 bar for 30 minutes. For carrying out the test, suitable length of duct shall be taken.

d) **End Cap:** This cap, made of hard rubber/suitable plastic material, shall be fitted onto both ends of duct coil after manufacturing the duct. This shall avoid entry of dust, mud and rain water into the duct during the transit and storage.

Test for Accessories :

Pulling force required to pull out two pieces of Microduct joined by coupler: The test may be conducted by loading the coupler joined by two pieces of Microduct for 15 minutes using a dead load or by using Universal Tensile machine. The minimum pulling force required shall be as below.

Table-5

Microduct Size (mm)	Pulling Force required (Kgf)
5/3	9
7/4	13
10/6	25
12/8	30
14/10	35
16/12	40

Ageing Test for Accessories: The accessories, viz., coupler, and End plug covered in clause 7.1 of the GR shall be subjected to an ageing test. In this test, the accessory under test shall be installed on a piece or pieces of Microduct as the case may be. It shall then be tested for tightness as per the GR and it shall pass the test. The accessory thus installed shall then be aged

in an air circulating oven at 70 ± 2° C for 168 hours. At the end of the period, it shall be allowed to cool to room temperature and then be tested for tightness as per the GR and it shall pass the test.

Tools for Accessories :

The following additional tools are required for joining of the ducts and installation of Microduct optical fibre cable. These items can be procured as per the Manufacturer/Supplier's specification, as and when required by the Purchasing Authority.

Microduct Cutter: This is required to cut the Microduct ends squarely without any burr or notch.

Blowing Equipment: The equipment used for installing optical fibre cable by blowing technology shall be capable of pushing 1 km (minimum) cable into the duct with powerful air stream generated by a compressor. The compressor shall have the following characteristics:

Pressure :	Min. 8 bar
	Max. 12 bar
Flow rate :	10 m^3/minute

The mechanical feeder of the equipment shall not cause any damage to the sheath/jacket of the Microduct optical fibre cable.

Note: It shall also be possible to pull the Microduct optical fibre cable manually over shorter sections (up to 200 meters).

7.4 Following accessories shall be supplied along with the Microduct/Km:

Coupler	-	4 nos.
End Plug	-	2 nos.
Cable sealing plug	-	4 nos.

End Caps - 4 nos.

However the required quantity of accessories shall be indicated by the purchasing authority.

8.0 Acceptance Tests :

The acceptance tests shall be carried out on samples selected from the lot as per Table-A for Dimensional and Visual requirements. The requirements for Tensile Performance, Crush Performance, Impact Test, Torsion, Kink Test, Bend Test, Microduct route verification test, Microduct pressure withstand Test, Heat Reversion test, Environmental Stress Crack Resistance Test (ESCR), Oxidation Induction Test, Internal Co-efficient of Friction, Ovality Test, Density of Finished Microduct, Melt Flow Rate (MFR) of Finished Duct, Ash Content, Test for fading of colours of Microduct, UV Stabiliser Test and Identification Markings shall be carried out as per Table-B.

Note: The Acceptance Tests and the Sampling plan can be modified by the purchaser at his discretion at any point of time.

9.0 Type Approval/ Technical Specification Evaluation:

9.1 All the tests mentioned in this document shall be carried out on the 5 standard lengths (2000mtrs) of Microducts and the samples must pass these tests before according the Type Approval/TSEC. The supplier shall furnish 5 standard lengths for carrying out these tests for according Type Approval/TSEC. Bulk manufacturing and supply shall start only after issue of Type Approval/TSEC. The Type Approval certificate/TSEC shall clearly indicate the Type/Grade/Source of High-Density Polyethylene raw material, the Size of the Microduct and the Construction of the Microduct, i.e. Two layer.

9.2 OEMs/Manufacturers shall inform the purchaser whenever grade/source of raw material(s) is changed, along with valid source approval certificate in accordance with the provision of clause 3.2 above.

In case, the grade/source of raw material(s) like HDPE resin or Solid Lubricant, is changed, the OEM/ Manufacturer shall obtain Fresh Type Approval Certificate (TAC) /TSEC, on furnishing compliance to the following incremental tests:

i) Impact strength;
ii) Crush Resistance;
iii) Environmental Stress Crack Resistance;
iv) Oxidation Induction Test;
v) Density and Melt Flow Rate.

However, the purchaser may specify the exact requirement of incremental tests in modification of above tests, if any.

Type Approval Certificate/TSEC shall be issued for each grade/source of raw material in accordance with the above-mentioned incremental test(s) as applicable. Further initially issued TAC/TSEC in respect of particular source of raw materials shall remain valid till its validity Period.

9.3 The product shall be subjected to Field Trial test, as mentioned below, before issue of the first Type Approval/TSEC to any manufacturer.

Field Trial Installation Test:

The manufacturer should demonstrate blowing of 1 km of Micro cable in the Microduct with no deterioration in the fibre cable characteristics. Successful demonstration of the above shall be essential for the Type Approval Certificate/TSEC.

10.0 Storage:

10.1 All the materials shall be stored in the manufacturer's premises in such a manner that it will not affect the performance of the product.

11.0 Packing and Delivery:

11.1 The store shall be supplied in coils of suitable size for delivery in such a manner that they arrive at their destination in a safe and undamaged condition and will permit the loading, unloading and handling the stores using standard moving equipment. The minimum inner bending diameter of the Microduct on reel shall be 25 times the outer diameter of the duct.

12.0 The quality requirement of the manufacturing system.

The item shall be manufactured in accordance with International quality standards ISO 9001: 2015 for which the manufacturer should be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer would be required to the submitted.

GUIDELINES FOR THE PURCHASER

1. COLOUR OF MICRODUCT:

The Microducts for outdoor application are made of eight colours viz., Green, Orange, Blue, Yellow, Brown, Violet, Grey and Red and Microduct for indoor application is white/natural as of colour of resin. The colour of the Microduct is uniform throughout. The purchasing authority shall specify the colour/colours of the Microduct ordered for. The colour of Indoor application Microduct shall be White/Natural colour as of base Material colour.

2. SIZE OF MICRODUCTS:

The PLB HDPE Microducts are available in different sizes as mentioned in clause no.3.2.3. The selection of Microduct size will depend on the outside diameter of the Microduct Optical Fibre Cable to be installed. The purchasing authority shall specify the size of the Microduct ordered for.

3. PLASTIC COUPLER:

Push-fit type of coupler may be used to couple two Microducts. The purchasing authority shall specify the type of the coupler ordered for.

4. The required quantity of tools & accessories shall be indicated by the Purchaser.

5. Requirement of Anti-rodent Property (described in annexure-5) in Microduct can be indicated by Purchaser for Outdoor applications, if required.

6. In direct burial application of Microduct, protection to the Microduct will be similar to those of normal ducts.

7. In case, the grade/source of raw material(s) like HDPE resin or Solid Lubricant, is changed, the purchaser may specify the exact requirement of incremental tests in

modification of the tests prescribed at Section 9.2, Part-II above, if any for issuing fresh Type Approval Certificate (TAC) /TSEC.

TABLE – A

SCALE OF SAMPLING FOR VISUAL AND DIMENSIONAL REQUIREMENTS

No. of coils (Ducts) in the Lot	Sample No.	Sample Size	Cumulative Sample Size	Acceptance No.	Rejection No.
(1)	(2)	(3)	(4)	(5)	(6)
Up to 150	First	13	13	0	2
	Second	13	26	1	2
151 to 280	First	20	20	0	3
	Second	20	40	3	4
281 to 500	First	32	32	1	4
	Second	32	64	4	5
501 to 1200	First	50	50	2	5
	Second	50	100	6	7
1201 to 3200	First	80	80	3	7
	Second	80	160	8	9
3201 to 10000	First	125	125	5	9
	Second	125	250	12	13
10001 to 35000	First	200	200	7	11
	Second	200	400	18	19

Criteria: The number of ducts given for the first sample in Column 3 shall be examined for dimension and visual requirements. A duct failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed to have satisfied these requirements, if the number of defectives found in the first sample are less than or equal to the corresponding acceptance number given in Column 5. The lot shall be deemed not to have met these requirements if the number of defectives found in the first sample is greater than or equal to the

corresponding rejection number given in Column 6. If, however, the number of defectives found in the first sample lies between the corresponding acceptance and rejection number given in Column 5 and 6, the second sample of the size given in Column 3 shall be taken and examined for these requirements. The lot shall be considered to have satisfied these requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in Column 5; otherwise not.

TABLE – B

SAMPLING FOR ACCEPTANCE TESTS

A separate sample size for each of the tests shall be taken as stipulated at random from the samples already examined for dimensions and visual inspection. All the ducts in each of the sample size shall be tested for compliance for the requirements for:

i. Tensile Performance(Clause 4.2)
ii. Crush Performance(Clause 4.3)
iii. Impact Test(Clause 4.4)
iv. Torsion(Clause 4.5)
v. Kink Test(Clause 4.6)
vi. Bend Test(Clause 4.7)
vii. Microduct route verification test(Clause 4.8)
viii. Microduct pressure withstand Test(Clause 4.9)
ix. Heat Reversion test(Clause 4.10)
x. Environmental Stress Crack Resistance Test (ESCR) (Clause 4.11)
xi. Oxidation Induction Test(Clause 4.12)
xii. Internal Co-efficient of Friction(Clause 4.13)
xiii. Ovality Test (Clause 4.14)
xiv. Density of Finished Microduct (Clause 4.15)
xv. Melt Flow Rate (MFR) of Finished Duct (Clause 4.16)
xvi. Ash Content (Clause 4.17)
xvii. Test for fading of colours of Microduct(Clause 4.18)
xviii. UV Stabiliser Test (Clause 4.19)

xix. Identification Markings(Clause 4.20)

The lot shall be considered to have met the requirements of these tests, if none of samples tested fails.

No. of coils	Sample Size
Up to 150	3
151 to 1200	5
1201 to 35000	8

ANNEXURE – 1

OXIDATION INDUCTION TEST

A short length of completed Microduct (approximately 30 cm) shall be sealed at the ends and placed in an oven at temperature of 68 ± 1° C for 8 hours. The sample shall then be allowed to cool at room temperature for at least 16 hours. The sample shall be clean and dry. The sample shall then be tested by means of a Differential Scanning Calorimeter (DSC)

Instrument Test Procedure:

Cell Cleaning: The cell shall be held at approximately 400° C for 10 minutes in Nitrogen. The cell shall be cleaned after standing over night and between testing of different formulations.

Temperature Calibration: This has to be done according to the instrument manual. The temperature scale should be adjusted until the determined melting point of pure Indium metal is 156.6° C at a heat rate of 5° C per minute or any other heat rate as indicated in the manual of the equipment is permitted.

Aluminium Pan Preparation: Standard Aluminium DSC pans, as per ASTM D4565, are required to hold specimens during testing. A fresh pan shall be used for each test.

Sample Preparation: Take the sample weighing about 5 mg from the Microduct conditioned as indicated above. Position the sample in the centre of the pan.

Nitrogen Purge: Place the sample pan and reference pan in instrument cell. Flush for 5 minutes wit cylinder of nitrogen (99.6% extra dry grade) at 60 ± 10 cc per minute.

Oxidation Test: Rapidly increase the temperature of the sample (20° C/min or greater) from 100° C or lower initial temperature to 199 ± 1° C. After thermal equilibrium is obtained (steady recorder signal) switch to 80 ± 20 cc per minute oxygen flow and simultaneously start time-base recording. The oxygen used for the test should be equivalent to or better than 99.6% extra dry grade.

Induction Period: The oxygen induction point shall be recorded as time zero, and the chart speed shall be sufficient to provide a clearly discernible slope at the start of the exothermic reaction. The test in the pure dry oxygen atmosphere shall continue until the exothermic peak is produced. The intersection of the tangent of the exothermic sloped line with the extended base line will be drawn. The time zero to this intersection point is read from the base line and recorded as the oxidative induction time.

Automatic OIT equipment" (Differential Scanning Calorimeter) for testing the Oxidation Induction Time shall be available as the test equipment for testing OIT parameter.

ANNEXURE– 2

INTERNAL CO-EFFICIENT OF FRICTION

SCOPE: This procedure details the method employed to determine internal friction properties of the Microduct.

APPARATUS: Extensometer machine, circular test fixture of diameter 750 mm (capable of having secured to it), 2.3 kg weight, Microduct optical fibre cable and pulley wheel.

TEST CONDITION: The test shall be carried out as per method with following test settings:

Cable	: Microduct Optical Fibre Cable of diameter upto 4mm.
Tail Weight	: 2.3 Kgs
Test Speed	: 500 mm/Min
Test Travel	: 150 mm

METHOD:

a. The section of the duct under test shall be coiled in a circular arc approximately 450 degree around a drum with a diameter measuring approximately 75cm.

b. The test Microduct cable shall be installed in the duct. The micro cable is then attached at one end to the Universal tensile machine (UTM). The other end is loaded with 2.3kg load weight.

c. The Universal tensile machine shall initiate the pulling of the cable at an approximately rate of 500mm / minutes. Apply tension to the micro cable (2.5 to 3.5mm dia) to lift the weight until 150mm from its initial position and

stop the UTM when weight reaches the 150mm height. Record the maximum force.

d. The coefficient of friction is calculated as:

$$\mu = \frac{\log (f / N)}{\Theta}$$

Where μ = Sliding coefficient of friction

f = Measured pulling tension required to move the microcable

N = The applied weight (2.3kg)

Θ = The total angle of the duct around the drum (7.8534 radians)

ANNEXURE – 3

Microduct Inner clearance test

(Route Verification Test)

1 Purpose:

The purpose of this test is to confirm the clearance of inner bore of a Microduct.

2 General:

An inner clearance test consists of passing a sphere/bead ball through the section of Microduct or Microduct assembly after manufacture. A successful test indicates that the Microduct has not been significantly damaged by the manufacturing process or the test applied. For practical considerations, the sphere/bead ball shall be approximately 85% of the nominal Microduct bore diameter as per below table.

3 Sample:

The sample after conducting mechanical test or full length of finish product of Microduct or bundled Microduct.

4 Test equipment:

A test object, such as a sphere/bead ball of around 85% of the nominal Microduct bore diameter, air pressure of 12±1kg/cm2, and a safe method to catch the sphere at the far end of the Microduct.

5 Procedure:

Install the catcher at the far end of the Microduct, place the sphere/bead ball into the Microduct and allow it to travel through to the far end Applying air pressure of 12±1kg/cm2.

6 Requirements:

The sphere/bead shall pass through the Microduct.

Microduct size	Diameter of Sphere/Bead Ball
5/3 mm	2.5 +/-0.1 mm
7/4 mm	3.5 +/-0.1mm
10/6mm	5.0 +/-0.1mm
12/8 mm	6.5 +/-0.1 mm
14/10 mm	8.5 +/-0.1 mm
16/12mm	10.0+/-0.1mm

ANNEXURE –4

Test on Bundled Microduct

In General, numbers, sizes and colours of Microducts in bundle is to be defined by Purchaser.

1. Sheathing Thickness:

Sheathing thickness of bundled Microduct shall be 1.2mm±0.2mm.

2. Colour of Outer Sheat:

For outdoor application bundle Microduct outer sheath is made of eight colours viz., Green, Orange, Blue, Yellow, Brown, Violet, Grey and Red. The colour of sheathing is uniform throughout. The purchasing authority shall specify the colour/colours of the of the outer sheathing during order.
For Indoor application bundle Microduct outer sheath is made of Natural white colour as per the base material.

3. Impact Test:

Under visual examination without magnification there shall be no damage to the Microducts. The Microduct shall pass the inner clearance test (Annex 3) and there shall be no splitting permanent damage. The imprint of the striking surface on the Microduct is not considered as mechanical damage.

Test conditions:
Method: IEC 60794-1-21, Method E4
Striking surface radius: 300 mm
Impact energy: 3J
Recovery time: 1 h

Number of impacts: One in 3 different places spread not less than 500 mm apart

4. Crush Performance:

Under visual examination, without magnification, the Microduct shall show no damage. After the recovery time the Microduct shall pass the inner clearance test (Annex 3) and there shall be no splitting or permanent damage. The imprint of the plate is not considered as mechanical damage.

Test conditions:

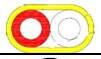
Method: IEC 60794-1-21, Method E3A
Sample length: 250 mm
Load: 2kN
Duration time: 1 min
Recovery time: 1 h

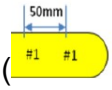
5. Identification Markings:

The Bundled Microduct shall be prominently marked with indelible ink with ink jet printing, with the following information at intervals every meter to enable identification of the bundled Microduct. The size of ink markings shall be distinct, clearly and easily visible.

a) Service Provider / Purchaser's Cable Bundled Microduct
b) Telephone /Purchaser's emblem
c) Manufacturer's name (also can be in abbreviated form)
d) Nos of Microducts with size
e) Machine number/Specific serial number of the Microduct
f) Date of manufacture (DD/MM/YYYY)
g) Sequential length marking at every meter with arrow mark in ascending order

Bundled Microduct Examples - Shape Options

Sr. No	Number of Microduct	Shape	Colour sequencing of Microduct for outdoor application	Colour sequencing of Microduct for IDA
1	1 Way		Blue:#1	Natural #1
2	2Way		Blue:#1, Orange:#1	Natural #1, Natural #2
3	3Way		Blue:#1, Orange:#1, Green:#1	Natural #1, Natural #2 Natural #3
4	4Way		Blue:#1, Orange:#1, Green:#1, Brown:#1	Natural #1 to Natural #4
5	5Way		Blue:#1, Orange:#1, Green:#1, Brown:#1,Grey:#1	Natural #1 to Natural #5
6	7Way		Blue:#1, Orange:#1, Green:#1, Brown:#1, Grey:#1 Red:#1,Yellow:#1 at centre	Natural #1 to Natural #7
7	12Way		Blue:#1, Orange:#1, Green:#1, Brown:#1, Grey:#1, Red:#1, Yellow:#1, Violet:#1, Blue:#2, Orange:#2, Green:#2, Brown:#2	Natural #1 to Natural #12
8	19Way		Blue:#1, Orange:#1, Green:#1, Brown:#1, Grey:#1, Red:#1, Yellow:#1, Violet:#1, Blue:#2, Orange:#2, Green:#2, Brown:#2, Grey:#2, Red:#2, Yellow:#2, Violet:#2, Blue:#3, Orange:#3, Green:#3	Natural #1 to Natural #19
9	24Way		Blue:#1, Orange:#1, Green:#1, Brown:#1, Grey:#1 Red:#1, Yellow:#1, Violet:#1, Blue:#2, Orange:#2, Green:#2, Brown:#2, Grey:#2, Red:#2, Yellow:#2, Violet:#2, Blue:#3, Orange:#3, Green:#3, Brown:#3, Grey:#3, Red:#3, Yellow:#3, Violet:#3, Blue:#4, Orange:#4, Green:#4, Brown:#4, Grey:#4, Red:#4, Yellow:#4, Violet:#4	Natural #1 to Natural #24
10	25Way		Blue:#1, Orange:#1, Green:#1, Brown:#1, Grey:#1 Red:#1, Yellow:#1, Violet:#1, Blue:#2, Orange:#2, Green:#2, Brown:#2, Grey:#2, Red:#2, Yellow:#2, Violet:#2, Blue:#3, Orange:#3, Green:#3, Brown:#3, Grey:#3, Red:#3, Yellow:#3, Violet:#3, Blue:#4, Orange:#4, Green:#4, Brown:#4, Grey:#4, Red:#4, Yellow:#4, Violet:#4, Blue:#5 at center	Natural #1 to Natural #25

Note: 1.Additional feature of rip cord and copper tracer wire shall be provided as per purchasers requirement.
2.Shape of the bundled Microduct shall differ as per the configuration of numbers of Microducts.
3. For identification of Microduct sequencing in bundle, # number marking shall be provided and #number (

) shall be printed on each Microduct at a distance of around 50mm.

ANNEXURE – 5

Anti Rodent Test:

Test Procedure for Anti Rodent Test :

Rodents are burrowing animals and are major threat in agriculture, storage, godowns, houses, underground cables, pipes and other commodities. In recent years the country is witnessing a great revolution in telecommunication technology. Use of optical Fiber (OF) cables is the major component in this revolutionary field. Since these OF cables are laid underground in various regions of the country, the cables are well exposed to the threats of subterranean organism especially the rodents. Safety of these cables from the direct attack of subterranean organism anti-rodent material are of utmost importance. Our past experience reveals that rodents have shown their devastating potential in damaging the OF cables/ HDPE ducts in many parts of the country. It is, therefore, necessary to evaluate these cables for their safety against rodents before laying them in the fields. The test against rodent may be conducted as per following procedures.

The ducts/cables are to be laid underground in fields and also near urban or rural settlements. Therefore they should be exposed to 3-4 most predominant rodent species inhabiting these locations. The test rodent species may include the lesser bandicoot rat, Bandicota bengalensis. The Indian gerbils, tatera indica, the soft furred field rats, Millardia meltada and the house rats, Rattus rattus.

The test cables/ducts should be exposed to these rodent species housed individually in iron mesh cages under laboratory conditions. Only freshly captured rodents are to be utilized for the study. The rodents are first acclimatized in laboratory cages for 7-10 days and then the tests be initiated. For each trial, 3-4 rodents of uniform body weight are to be used for the trial. Two different types of tests may be undertaken for all the cables.

Choice Tests:- In this trial the cables/ducts of 15-30 cm length (one sample each of treated and untreated/ control sample) are exposed to the test rodents along with food, thus the rodents have a choice between food and the test duct/cable This test may be run for longer periods (30-45 days). Tap water should be provided ad libitum to the rodents.

No choice test: The rodents are exposed to the test ducts/cables only and no food is given to the rodents during the period of trial. The test ducts/cables (one sample each of treated and untreated/ control sample) are exposed to the test rodents. This trial may be run for 5-7 days depending upon the health status of starved test rodents. Tap water should be provided ad libitum to the rodents.

Observation of tooth marks, rodent behaviour toward exposed cables, relative extent of damage in treated and untreated samples should be computed for both types of cables/ducts. Health status of test animals in choice and no choice test must also be monitored for the record of any ill effect of exposure of treated/ control ducts/cables on these animals. Number of cases and the extent of rodent bites/ scratch marks in control and anti-rodent treated ducts/cables may indicate the relative deterrent/ repellent properties of the test ducts/cables.

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
Cc	Cubic Centimeter
cm²	Square Centimeter
°C	Degree Centigrade
DOT	Department of Telecommunications
DSC	Differential Scanning Calorimeter
DTA	Differential Thermal Analyser
F	Fibre
G	Gram
GR	Generic Requirements
HDPE	High Density Polyethylene
ICF	Internal Co-efficient of Friction
IS	Indian Standard
Kg	Kilogram
MFR	Melt Flow Rate
Mm	Millimetre
mm²	Square millimetre
MPa	Mega Pascal
N	Newton
OF	Optical Fibre
PLB	Permanently Lubricated
%	Percentage
TQA	Telecom Quality Assurance
UV	Ultraviolet

LSZH	Low Smoke Zero Halogen
ODA	Outdoor Application
IDA	Indoor application