13-SDMS-01

REV. 00

SPECIFICATIONS
FOR
FIBER OPTIC CONNECTIVITY COMPONENTS

(PATCH CORDS, PIGTAILS, FAN-OUT CABLES
AND CONNECTORS FOR INTERNAL INSTALLATIONS)

CONTENTS

1 Scope

This document specifies the minimum technical requirements for design, engineering, construction, manufacture, inspection, testing and performance of fiber optic connectivity components, consisting of patch cords, pigtails, fan-out cables and associated connectors to provide internal interconnectivity for Distribution fiber optic network deployments within Saudi Electricity Company (SEC).

The fiber optic connectivity components will be used for interconnection of fiber optic infrastructure and systems installed at various locations within the FTTx network, including but not limited to buildings and collocation centres, equipment racks, street or pole mounted cabinets and customer premises

The fiber optic connectivity components are typically used for:

- Cross-connection between fiber optic patch panels
- Interconnecting patch panels to optical equipment
- Interconnection of OSP circuits with Fiber Optic Transmission System equipment circuits, Head End equipment, or cross-connection between cable plant segments
- Distribution and termination of indoor fiber optic cables both within the SEC FTTX Network or a customer premises
- Termination of OSP fiber optic cables (entering the OLT or customer building) in Optical Distribution Frame (ODF)/Optical Termination Box (OTB) or termination panels
- Termination of fibers by using field installable mechanical connectors as an alternative to fusion splices as per field requirements

2 Applicable codes and standards

This Distribution Material Standard Specification shall be read in conjunction with the latest revision of Distribution General Specification 01-SDMS-01 which shall be considered as an integral part of this standard.

The international and national standards mentioned below shall be applied, and deemed to be an integral part of this specification.

- ASTM G 21 Resistance of Synthetic and Polymeric materials to fungi and bacteria
- IEC 60304 Standard colours for low frequency cables and wires
- IEC 60874-Series Connectors for Optical Fibers and Cables Standards – IEC 60874-1 General and Guidance, and other relevant standards (IEC 60874-4, IEC 60874-7, IEC 60874-14 and IEC 60874-20).

- IEC 61300-2-5 — IEC 61300 Series: Fiber Optic Interconnecting Devices and Passive Components – Basic Test and Measurement Procedures; such as IEC 61300-2-5– Test
- IEC 60332 — Fiber Optic Interconnecting Devices and Passive Components – Test of LSZH – Low Smoke Zero Halogen Characteristics.
- IEC 61754-7 — Fiber Optic Interconnecting Devices and Passive Components – Fiber Optic Connector Interfaces
- IEC 61755-1 single — Fiber optic connector optical interfaces - Part 1: Optical interfaces for single mode non-dispersion shifted fibers - General and guidance.
- ISO 9001:2008 — Quality Management Systems – Standardized Requirements
- ITU-T G 657 A single network. — International Telecommunication Union Recommended standard for single mode fiber for bend insensitive performance, primarily for access network. Fully compatible with ITU-T G 652 D standard
- TIA/EIA 568 A — Optical Fiber Cabling Components Standard.
- TIA/EIA 598 D — Optical Fiber Cable Color Coding.
- TIA/EIA 455 Series — TIA/EIA 455 of Fiber Optic Test Procedures, such as TIA/EIA 455 21A (Connector Mating Durability), TIA/EIA 455 107 (Return Loss), TIA/EIA- 455-171 (Insertion Loss: Method D1 & D3).
- TIA/EIA 604 — Standards for Connector Intermateability for Fiber Optic Interconnecting Devices (TIA/EIA 604-2, 604-3, 604-4, 604-5, 604-10, 604-12).
- Telcordia GR 409 — GR 409-CORE Generic Requirement for Premises Fiber Optic Cable, the media on which connector plugs are mounted
- UL 94 V-0 — Tests of Flammability of Plastic Materials for Parts in Devices and Appliances- Polymeric material used shall have UL 94 V-0 rating

3 Definitions

- Adapter or Through-Connector: A device, either mounted on a patch panel or used in-line, to mechanically align, couple and mate or join two plug-in optical connectors of either the same or different types.
- Connector: A device means for providing a removeable plug-in connection between two optical fibers using a matching adapter. In general, the insertion loss of a connector will be higher than the transmission loss of a splice, **Figure 1**
- LC connector: A type of optical connector conforming to the Lucent or Local Connector form factor.
- SC connector: A type of optical connector also known with the Subscriber or Square Connector form factor. LC and SC connectors are not directly compatible.

- UPC: A connection where the ends of the two joined fibers are polished at 90 degrees to provide a direct physical contact, also known as Ultra Physical Contact, **Figure 2**.

APC: A connection where the ends of the two joined fibers are polished at an angle of 8 degrees to provide an Angled Physical Contact,

- **Figure 3**.
- Field installable connector: A type of connector suitable for on-site installation onto suitable fiber optic cables. May be used as an alternative to fusion or mechanical splicing to quickly terminate individual fibers, particularly at the customer end.
- Fan-Out Cable: An interconnectivity cable consisting of bundled tight-buffered fiber cords, with or without connectors, intended to be used for equipment interconnection. Fan outs are typically used for high density installations (e.g. data centres) or in situations where there is insufficient space for individual patch cords (e.g. self-contained equipment cabinets), **Figure 4**.

Patch Cord: Single fiber cable pre-assembled with similar or a combination connectors types at both ends (hybrid), such as SC/APC, LC/APC etc.

- **Figure 5**.
- Patch Panel: A plate used to mount standard adapters or through connectors, e.g. SC or LC type adapters.

Pigtail: A short length of single fiber cable pre-assembled with a connector at one end, the other end remaining unterminated for direct splicing to another fiber/cable,

- **Figure 6**.

Tight-Buffered: A protective material extruded directly onto and in contact with the fiber cladding to protect it from the environment,

- **Figure 7**.

Abbreviations used in this specification document include the following:

APC	Angle Physical Contact
ASTM	American Society for Testing and Materials.
dB/km	Decibels per kilometre.
EIA/TI	Electronic industries Association / Telecommunications Industry Association.
FTTH	Fiber To The Home
FTTx	Fiber To The ‘x’ where x= ‘building’, ‘pole’, ‘cabinet’, ‘curb’, ‘home’ etc..
IEC	International Electro Technical Commission.

IL	Insertion Loss
ITU-T	International Telecommunications Union (Telecommunications Sector).
OSP	Outside Plant
RL	Return Loss
SEC	Saudi Electric Company
UL	Underwriters Laboratories.
UPC	Ultra (or direct) Physical Contact

4 Requirements

4.1 General requirements

4.1.1 The fiber optic connectivity components shall be compatible with SEC Distribution installation standards where provided and with telecommunications industry best practices.

4.1.2 Any alternative proposals for type approval and acceptance testing will be subject to technical evaluation by SEC to ensure satisfactory compliance with the material and product qualities implied by this specification.

4.1.3 The connectivity components shall be able to be efficiently handled and managed during termination, splicing, routing, securing and storage.

4.1.4 All metallic parts, where applicable shall be corrosion-proof.

4.1.5 The patch cords, pigtails, fan-out cables and mechanical connectors shall be of high quality design, workmanship and finish.

4.1.6 A protective dust cap shall be immediately placed on every fiber connector ferrule upon satisfactory completion of testing.

4.1.7 Test result data and individual characteristics shall be supplied by manufacturer with every patch cords, pigtails, fan-out cables and mechanical connectors.

4.1.8 All materials used in the cable shall be non-toxic and dermatologically safe and shall be chemically and biologically inert over the full environmental range.

4.2 Design requirements

4.2.1 General

4.2.1.1 The minimum & maximum ambient temperature shall be -10°C to +70°C

4.2.1.2 The patch cords and pigtails, which consist of fiber cords and connectors, shall be designed to offer proper protection, rendering it suitable for installation in different environments as per the specifications stated in Sections 4.2.2-4.2.7

4.2.1.3 Connectivity components shall be constructed using single mode optical fiber compatible with ITU-T G.652D or ITU-T G.657A2.

4.2.2 Construction

4.2.2.1 Tight buffered cord:

All Fiber core and cladding with primary coating of thermoplastic material tightly surrounding it with a final outer diameter of 900µm

a) **Figure 7**.
b) Colour of primary coating (outer jacket) shall be blue conforming to IEC 60304 or RAL 5015

4.2.2.2 Simplex cord shall be constructed of:

a) Tight buffered fiber conforming to 4.2.2.1.
b) Aramid yarn (Kevlar) reinforcement
c) Flame retardant outer jacket made up of LSZH or PVC, 1.6mm diameter (nominal), as shown in Appendix 5.2
d) Colour of outer jacket shall be yellow conforming to IEC 60304 or RAL 5015.

4.2.2.3 Duplex cord shall be constructed of:

a) Tight Buffered fiber conforming to 4.2.2.1
b) Aramid yarn (Kevlar) reinforcement.
c) Flame retardant outer jacket made up of LSZH or PVC, where two 1.6mm diameter (nominal) cords are paired in duplex configuration by zip cord twinning, as shown in Appendix 5.2
d) Colour of outer jacket of each fiber cord shall be yellow, conforming to IEC 60304 or RAL 5015.
e) Clear markings shall be provided for pair identification between the two cords

4.2.3 Cord marking

4.2.3.1 Marking intervals: Sequentially numbered in longitudinal intervals of 1 m and length accuracy of 1% (maximum)

4.2.3.2 Marking details: Manufacturer's name or trademark, Fiber Type, Year of Manufacture, length marking in (m) and country of origin

4.2.4 Connectors

4.2.4.1 Connectors shall be factory pre-assembled onto cables where specified: LC and SC types may be specified constructed with either APC or UPC polished end face configurations.

4.2.4.2 Field Installable Connectors shall also be available in LC and SC form factors and both UPC and APC variants. Field installable connectors shall use a similar construction to factory installed components and connectors installed according to the manufacturers recommendations shall have similar mechanical and optical characteristics similar to factory installed components.

4.2.4.3 Unless otherwise specified, connectors shall be constructed from the materials stated in Table 1. General connector construction is indicated in Figure 9.

4.2.4.4 The boot shall provide protection against excessive cable bending at the point of entry of the cable/cord I to the connector

4.2.4.5 The boot shall be coloured to match the shell (housing) of the connector.

4.2.4.6 The optical characteristics of both factory installed and field installed connectors shall be in accordance with Table 5.

Table 1 – Connector Materials

Connector	Colour	Shell (housing)	Ferrule	Boot
LC / APC	Green	Plastic	Zirconia Ceramic	Polyester
SC / APC	Green	Brass, stainless steel (Ni-plated)		
LC/ APC	Blue	Plastic		
SC / UPC	Blue	Brass, stainless steel (Ni-plated)		

4.2.5 Patch cords

4.2.5.1 Simplex patch cords: A simplex fiber cord (Section 4.2.2.2), with connectors at both ends, either LC, SC, Figure 8.

4.2.5.2 Duplex patch cords: A duplex fiber cord (Section 4.2.2.3), with connectors at both ends, either LC or SC types or a combination any two of those types (hybrid).

4.2.6 Pigtails

4.2.6.1 Types of pigtails: Tight buffered fiber cord (Section 4.2.2.1) or simplex fiber cord (Section 4.2.2.2), with connector at one end, either LC, or SC type.

4.2.7 Fan-out cables

4.2.7.1 Types of fan-out cables:

a) 12 tight buffered fibers each of maximum diameter 0.9mm, bundled together in High strength LSZH jacket, having connectors pre-assembled at both ends.

b) 8 tight buffered fibers each of maximum diameter 0.9mm, bundled together in High strength LSZH jacket, having connectors pre-assembled at both ends.

4.2.7.2 For identification, each tight buffered fiber shall be coloured as below in Table 2 in accordance with TIA-598-D or IEC-60304/IEC-304. The colours for optical fibers shall be clearly identifiable and easily differentiated from one another.

4.2.7.3 For fan-outs larger than 12 fiber, where fibers are grouped into tubes the tubes shall be colour coded according to **Table 3**.

Table 2 – Colour Coding of Tight Buffer Fibers

F 1	Blue
F 2	Orange
F 3	Green
F 4	Brown
F 5	Grey
F 6	White
F 7	Red
F 8	Black
F 9	Yellow
F 10	Violet
F 11	Pink
F 12	Aqua

Table 3 – Colour Coding of Loose Tubes

T1	Blue
T 2	Orange
T 3	Green
T4	Brown
T 5	Grey
T 6	White
T 7	Red
T 8	Black

4.2.7.4 The cable shall be constructed as:

a) Bundle of 8 or 12 tight buffered fibers conforming to Section 4.2.2.1 and color-coded, conforming to IEC 60304.
b) Minimum of 25cm length for each fiber fan-out sand shall be pre-assembled with LC/APC connectors on each end.
c) Aramid (Kevlar) yarn reinforcement shall be used surrounding the tight buffered fibers.
d) Flame retardant outer jacket made up of LSZH, PVC, polyurethane or other resins.
e) Colour of outer jacket of Fan out cable shall be Grey, conforming to IEC 60304 or RAL 9023.
f) The length of jacketed section of the cable shall be either 1, 2 or 3 meters as specified in the purchase order.

4.3 Material properties and test requirements

4.3.1 The connectivity components shall comply with the performance and test requirements specified in Table 4. The requirements of this section apply to manufactured and fully assembled components.

Table 4 – Cable Properties and Performance

S. No	Properties	Requirements	Test method
1	Physical Requirements		
1.1	Attenuation	≤ 0.75 dB	TIA/EIA-455-34B
1.2.	Low Temperature Life	0°C for 4 days, ≤ 0.3 dB change	TIA/EIA-455-188
1.3.	High Temperature Life	55°C for 14 days, ≤ 0.3 dB change	TIA/EIA-455-67
1.4.	Humidity	90 to 95% at 40°C for 4 days, ≤ 0.3 dB change	TIA/EIA-455-5B

1.5.	Impact	8 drops from 1.8 meters; IL ≤ 0.75 dB and RL ≥ - 26 dB	TIA/EIA-455-2B
1.6.	Connection Durability	500 mating cycles, < 0.2 dB change	TIA/EIA-455-21A
1.7.	Cable Retention	0° and 90°; IL ≤ 0.75 dB and RL ≥ - 26 dB	TIA/EIA-455-6B
1.8.	Flex Test	100 cycles; IL ≤ 0.75 dB and RL ≥ - 26 dB	TIA/EIA-455-1A
1.9.	Twist Test	100 cycles; IL ≤ 0.75 dB and RL ≥ -26 dB	TIA/EIA-455-36
1.10.	Vibration Test	Sinusoidal vibrations; IL ≤ 0.75 dB and RL ≥ -26 dB	TIA/EIA-455-11C
1.11.	Strength of coupling mechanism	33N at 0° Tensile pull for 5 sec (minimum); IL ≤ 0.75 dB and RL ≥ -26 dB	TIA/EIA-455-185
1.12.	Intermateability Standards	Fiber Connectors shall conform to applicable TIA/EIA intermateability standards; Visual and mechanical inspection.	TIA/EIA-604 series SC: TIA/EIA-604-3 LC: TIA/EIA-604-10

4.4 Optical characteristics and transmission requirements

4.4.1 The patch cords, pigtails, Fan-out Cables and mechanical connectors shall meet the optical characteristics and transmission requirements as specified below in Table 5:

Table 5 – Connector Properties and Performance

S.No	Parameters	Requirements		Test method
1	**Polishing Type**	**UPC**	**APC**	
	Value ranges	**Min / Max**	**Min / Max**	
	Radius of curvature (RoC)	7.0/25 .0 mm	5.0/12.0 mm	IEC 61300-3-15; IEC 61300-3-16; IEC 61300-3-17
	Fiber height (spherical fit)	-50.0 / +50.0 nm	-100.0/+100.0 nm	
	Apex offset	0.0 / 50.0 µm	0.0 / 50.0 µm	
	Angle	(-)0.3/0.3 degree	7.5/8.5 degree	
	Key error	N/A	-0.25/0.25 degree	
	Fiber surface roughness	0.0 / 50.0 nm	0.0 / 50.0 nm	
	Ferrule roughness	0.0 / 50.0 nm	0.0 / 50.0 nm	
2	Return loss Random mated	>50 dB	>60 dB	TIA/EIA-455- 107
3	Insertion loss Random mated 97% of time	≤0.5 dB		TIA/EIA-455- 17 (A3 or D3) IEC 61755-1
	Insertion loss Random mated average	≤0.25 dB		
	Insertion loss Random mated Reference	≤0.4 dB		

4.5 Other Requirements

4.5.1 Packing and marking

4.5.1.1 The patch cords, pigtails and mechanical connectors shall be supplied in drums according to the requirements specified below:

a) Patch cord lengths shall be supplied in 3m, 5m, 10m or 20m lengths
b) Pigtail with diameter 900 µm shall be supplied in 3m lengths
c) Pigtail with diameter 1.6 mm shall be supplied in 3m lengths
d) Patch cords and pigtails shall be supplied with protective end-caps or covers over connector and bare fiber ends.
e) Each patch cord and pigtail shall be individually packed and wrapped in a protective re-sealable plastic and placed in a box with test result data and design criteria, in Arabic and English.
f) Each patch cord and pigtails will have date and printed test-results of IL and RL.
g) The individual patch cord or pigtail shall be package in multi-packed in a strong, weather resistance carton boxes, suitable for shipping, handling and storage

4.5.1.2 Each individual package and multi-packed carton shall be marked with QR-code with the following information, in Arabic and English, on at least two sides of the package and the multi-packed carton box as per Table 6.

Table 6 – Package Marking

Parameters	Requirements
Company	SEC Distribution
Category	Fiber Optic Components
Item description	e.g. Patch Cord, SM, LC/APC, 1.6mm Dia. x 3m Length
DMSS document Number	DMSS ”xxxxxxx”
Manufacturer Name	“xxxxxxxx”
Manufacturer Part Number	“xxxxxxx”
SEC Part Number	xxxx
Type Approval Certificate Number	00/00
SEC Contract/PO Number	"xxxxxxxx"
Manufacturer Order Number	"xxxxxxxx"
Production Date (mmm-yyyy)	"Month - Year"
Items Quantity	(Numbers) Each
Weight (Kg)	"xxxxxxxx" kg

5 Figures & Illustrations

Figure 1 – Optical Connector Form Factor

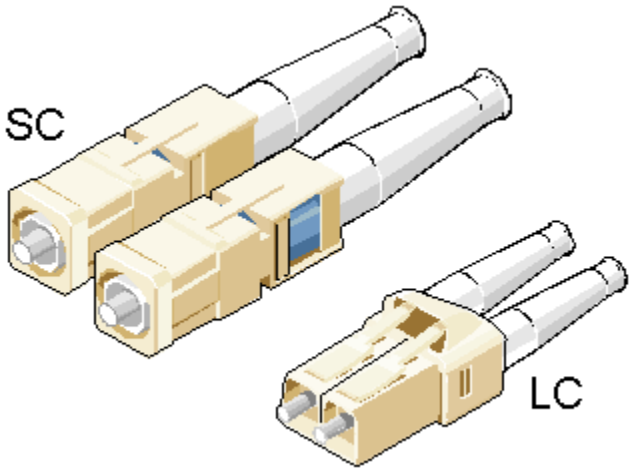


Figure 2 – UPC Connection

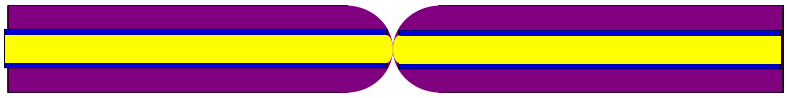


Figure 3 – APC Connection

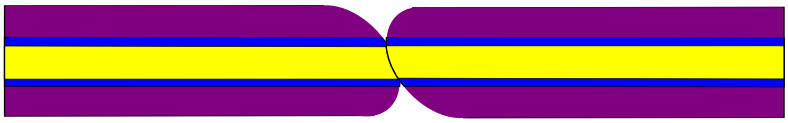


Figure 4 – Fan-Out Cable Illustrative Example

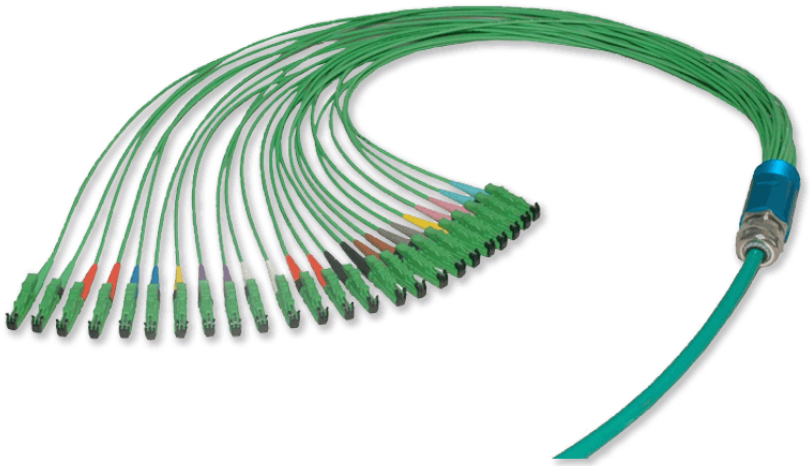


Figure 5 – Patch Cord - Illustrative Example

Figure 6 – Pigtail - Illustrative Example

Figure 7 – Tight Buffered Construction

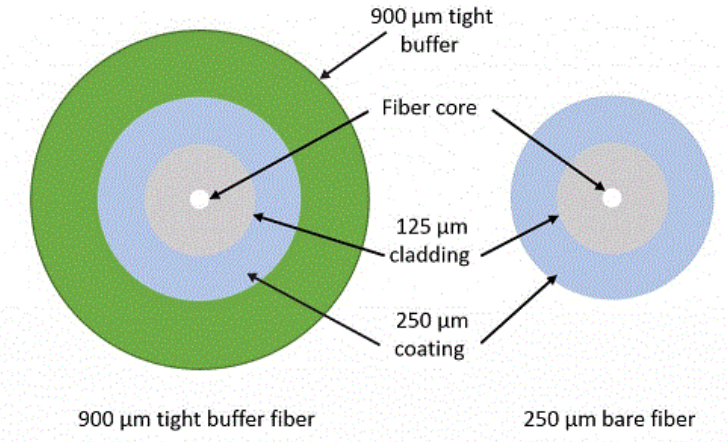


Figure 8 – Simplex and Duplex Construction

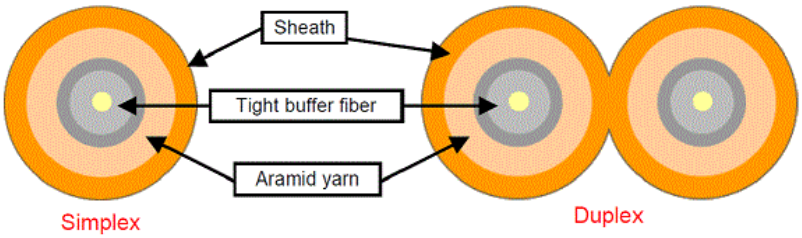


Figure 9 – Connector Construction

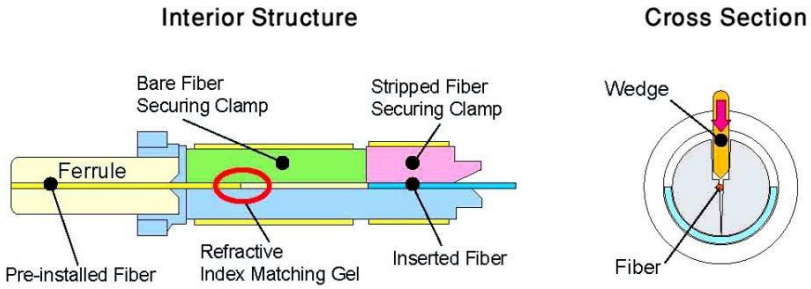


Figure 10 – Connector Components (SC)

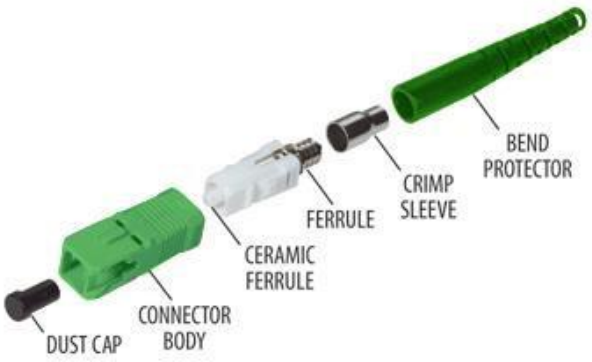
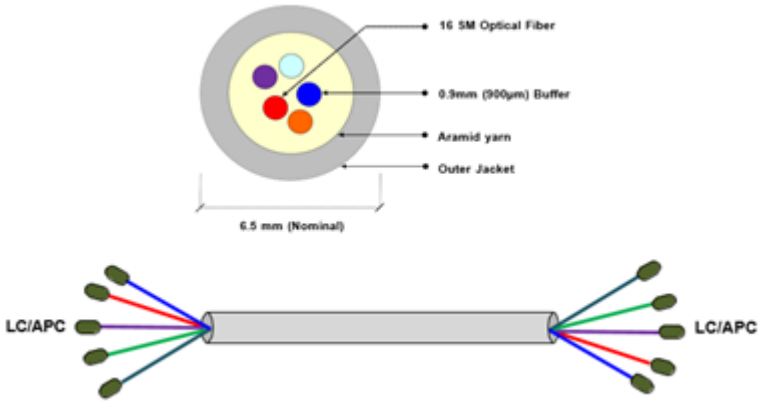


Figure 11 – Fan-out Construction



TECHNICAL DATA SCHEDULE

FIBER OPTIC CONNECTIVITY COMPONENTS

Enquiry No. _____ **Item No. _____**

Ref No.	Description	Unit	Specified values	Vendor proposed values
3.0	Applicable Codes and Standards		*	
4.0	Requirements			
	Manufacturers drawings & dimensions		*	
	Type of fiber		*	
	Attenuation @1310 nm without connectors	dB/km	≤0.40	
	Attenuation @1550 nm without connectors	dB/km	≤0.25	
	Insertion Loss (fully assembled)	dB	≤0.5	
	Return Loss (fully assembled)	dB	≥45 UPC ≥60 APC	
	Outer jacket material and colour		*	
	Type of connector		*	
	Connector contact type	UPC/APC	*	
	Connector colour		*	
	Connector housing material		*	
	Ferrule material		*	
	Connector inter-mateable	Yes/No	*	

TECHNICAL DATA SCHEDULE

FIBER OPTIC CONNECTIVITY COMPONENTS

Enquiry No. _____ **Item No. _____**

Ref No.	Description	Unit	Specified values	Vendor proposed values
	Cable type	Simplex/Duplex		