Tender No.	:	Spec. No.	: LSSS-OC0056-10
User / Customer	:	Page No.	: 1 of 11
Tender Title	:		
Bidder	: LS Cable & System Ltd.		
Document Title	:		

Specification

For

Fiber Optic Cable
Loose Tube / Dry Cored
Non-Armored / Single Jacket

Rev. No.	Date	Descriptions	Prepared By	Reviewed By	Approved By
10	Jul. 3, 2019	Added color stripe option on jacket	Lee, Mansu	Jun, YoungHo	Lee, YuHyoung
9	Jun. 20, 2019	Added color jacket option	Lee, Mansu	Jun, YoungHo	Lee, YuHyoung
8	Mar.30, 2017	Added - G.655E & G.656 Characteristics	Ham, Hyungjae	Jun, Youngho	Seo, Jaetae
7	Dec.09, 2016	Revised - G.657A1 Characteristics	Kim, Jungmok	Jun, Youngho	Seo, Jaetae
6	OCT.28, 2014	Revised - SMF Characteristics - Table 7 color code of fiber	Hyung Jae Ham	Tae-Gyoung Kim	Yu-Hyoung Lee
5	JUL.13, 2012	G.657 & OM4 fiber added Editorial amendments	Eun-kyung Min	Chang-Ahn Kim	Yu-Hyoung Lee
4	JAN.05, 2012	Giga grade Multimode fiber added 50 Multimode fiber bandwidth revised	Eun-kyung Min	Chang-Ahn Kim	Yu-Hyoung Lee
3	JAN. 24, 2011	Macro Bending Loss for G652D has been revised (at 1310 & 1550nm → at 1625nm)	Mansu Lee	Chang-Ahn Kim	Yu-Hyoung Lee
2	DEC.09, 2010	G.655D fiber newly included; Color code of tubes has been revised; Extended to include 432F and 576F	Chang-Ahn Kim	-	Yu-Hyoung Lee
1	SEP. 12, 2007	Multi Mode Fiber Added	Chang-Ahn Kim	-	Yu-Hyoung Lee
0	JAN. 22, 2007	Original Issue	Chang-Ahn Kim	-	Yu-Hyoung Lee

1. SCOPE

1.1 Application

This specification covers the general requirements for fiber optic telecommunication cables used for outdoor applications.

1.2 Cable Description

Color coded optical fibers, jelly filled color coded loose tubes, PE filler (if necessary), water blocking yarn around central strength member, SZ-stranded around the dielectric central strength member, core wrapping tape, outer strength member if necessary, ripcord and outer PE jacket

2. OPTICAL FIBER

The optical, geometrical, mechanical and environmental characteristics of the optical fiber shall be in accordance with Table 1 ~ Table 5 below.

Table 1. Characteristics of Single Mode Fiber (ITU-T G.657A1 & A2)

ITEMS	UNITS	SPECIFICATION	
		G.657.A1	G.657.A2
Attenuation	dB/km	≤ 0.36 at 1310nm ≤ 0.35 at 1383nm ≤ 0.22 at 1550nm	
Chromatic Dispersion	ps/nm.km	≤ 3.5 at 1285nm ~ 1330nm ≤ 18 at 1550nm	
Zero Dispersion Wavelength	nm	1300 ~ 1324	
Zero Dispersion Slope	$ps/nm^2.km$	≤ 0.092	
Cable PMD (PMD_Q)	$ps/\sqrt{km}$	≤ 0.2 (20 section link)	
Cut-off Wavelength (λcc, Cabled fiber)	nm	≤ 1260	
Attenuation vs. Bending (15mm radius x 10turns)	dB	≤ 0.25 at 1550nm ≤ 1.0 at 1625nm	≤ 0.03 at 1550nm ≤ 0.1 at 1625nm
Attenuation vs. Bending (10mm radius x 1turn)	dB	≤ 0.75 at 1550nm ≤ 1.5 at 1625nm	≤ 0.1 at 1550nm ≤ 0.2 at 1625nm
Attenuation vs. Bending (7.5mm radius x 1turn)	dB	-	≤ 0.5 at 1550nm ≤ 1.0 at 1625nm
Mode Field Diameter at 1310nm	μm	8.9 ± 0.4	8.6 ± 0.4
Core/Cladding Concentricity Error	μm	≤ 0.5	
Cladding Diameter	μm	125 ± 0.7	
Cladding Non-circularity	%	≤ 1.0	
Coating Diameter	μm	245 ± 10	
Proof Test	GPa	≥ 0.69	

Table 2. Characteristics of Single Mode Fiber (ITU-T G.652D)

ITEMS	UNITS	SPECIFICATION
Attenuation	dB/km	≤ 0.36 at 1310nm ≤ 0.35 at 1383nm ≤ 0.22 at 1550nm
Chromatic Dispersion	ps/nm.km	≤ 3.5 at 1285nm ~ 1330nm ≤ 18 at 1550nm
Zero Dispersion Wavelength	nm	1300 ~ 1322
Zero Dispersion Slope	$ps/nm^2.km$	≤ 0.092
Cable PMD (PMD_Q)	$ps/\sqrt{km}$	≤ 0.2 (20 section link)
Cut-off Wavelength (λcc, Cabled fiber)	nm	≤ 1260
Attenuation vs. Bending (30mm radius x 100turns)	dB	≤ 0.1 at 1625nm
Mode Field Diameter	μm	9.2 ± 0.4 at 1310nm 10.4 ± 1.0 at 1550nm
Core/Cladding Concentricity Error	μm	≤ 0.6
Cladding Diameter	μm	125 ± 1
Cladding Non-circularity	%	≤ 1.0
Coating Diameter	μm	245 ± 10
Proof Test	GPa	≥ 0.69

Table 3. Characteristics of Single Mode Fiber (ITU-T G.655D, G.655E & G.656)

ITEMS		UNITS	SPECIFICATION	
			G.655D	G.655E & G.656
Attenuation		dB/km	≤ 0.24 at 1550nm ≤ 0.26 at 1625nm	≤ 0.40 at 1460nm ≤ 0.24 at 1550nm ≤ 0.26 at 1625nm
Chromatic Dispersion	1530 ~ 1565nm	ps/nm.km	2.0 ~ 6.0	5.5 ~ 10.0
	1565 ~ 1625nm		4.5 ~ 11.2	7.5 ~ 13.4
Dispersion Slope at 1550nm		$ps/nm^2.km$	≤ 0.09	≤ 0.06
Cable PMD (PMD_Q)		$ps/\sqrt{km}$	≤ 0.1 (20 section link)	
Cut-off Wavelength (λcc, Cabled fiber)		nm	≤ 1450	
Attenuation vs. Bending (30mm radius x 100turns)		dB	≤ 0.1 at 1625nm	
Mode Field Diameter at 1550nm		μm	9.6 ± 0.5	9.2 ± 0.6
Core/Cladding Concentricity Error		μm	≤ 0.6	
Cladding Diameter		μm	125 ± 1	
Cladding Non-circularity		%	≤ 1	
Coating Diameter		μm	245 ± 10	
Proof Test Level		GPa	≥ 0.69	

Table 4. Characteristics of the Multi Mode Fiber

ITEMS	UNITS	SPECIFICATION	
		50 Multi Mode (OM2)	62.5 Multi Mode (OM1)
Attenuation	dB/km	≤3.0 at 850nm ≤1.0 at 1300nm	≤3.5 at 850nm ≤1.0 at 1300nm
Overfilled Launch Bandwidth (LED based sources)	MHz.km	≥500 at 850nm ≥500 at 1300nm	≥200 at 850nm ≥500 at 1300nm
Numerical Aperture	-	0.20±0.015	0.275±0.015
Core Diameter	μm	50±3.0	62.5±3.0
Core Non-circularity	%	≤6.0	≤6.0
Cladding Diameter	μm	125±2.0	125±2.0
Cladding Non-circularity	%	≤2.0	≤2.0
Core/Cladding Concentricity Error	μm	≤3.0	≤3.0
Coating Diameter	μm	245±15	245±15
Proof Test	GPa	≥0.69	≥0.69

Table 5. Characteristics of the Multi Mode Fiber (10Giga grade)

ITEMS	UNITS	SPECIFICATION	
		OM3	OM4
Attenuation	dB/km	≤3.0 at 850nm ≤1.0 at 1300nm	≤ 3.0 at 850nm ≤ 1.0 at 1300nm
Overfilled Launch Bandwidth (LED based sources)	MHz.km	≥1500 at 850nm ≥500 at 1300nm	≥ 3500 at 850nm ≥ 500 at 1300nm
Effective Modal Bandwidth (Laser based sources)	MHz.km	≥2000 at 850nm	≥4700 at 850nm
10 Gigabit Ethernet Maximum Link Distance	m	≥300 at 850nm	≥550 at 850nm
Numerical Aperture	-	0.20±0.015	0.20 ± 0.015
Core Diameter	μm	50±3.0	50 ± 3.0
Core Non-circularity	%	≤6.0	≤ 6.0
Cladding Diameter	μm	125±2.0	125 ± 2.0
Cladding Non-circularity	%	≤2.0	≤ 2.0
Core/Cladding Concentricity Error	μm	≤3.0	≤ 3.0
Coating Diameter	μm	245±15	245 ± 15
Proof Test	GPa	≥0.69	≥0.69

3. CABLE CONSTRUCTION

The construction of the cable shall be in accordance with Table 6 below.

Table 6. Construction of the Cable

ITEMS		DESCRIPTION
Number of Fibers		Max. 576
Max. No. of Fibers per Tube		6 or 12 or 24
Loose Buffer Tube		PBT (Polybutylene Terephthalate)
Filling Compound in Loose Buffer Tube		Thixotropic Jelly Compound
Filler		Polyethylene Rod (if necessary)
Central Strength Member		FRP (with PE over-coat if needed)
Water Blocking Material		Water Blocking Yarn or tape around CSM
Core Wrapping Tape		Water Blocking Tape
Auxiliary Strength Member		Glass yarns if necessary
Rip Cord		One Ripcord
Outer Jacket	Material	Black or Colored MDPE or HDPE with optional stripe
	Thickness	Nom. 1.5mm

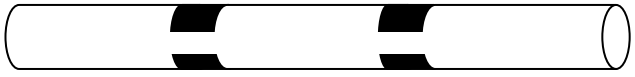
4. FIBER AND LOOSE BUFFER TUBE IDENTIFICATION

The color code of the loose buffer tubes and the individual fibers within each loose buffer tube shall be in accordance with Table 7 and Table 8 below.

Table 7. Color code of the individual fibers

No.	Color	No.	Color
1	Blue	13	Blue / Single Dot Marking*
2	Orange	14	Orange / Single Dot Marking *
3	Green	15	Green / Single Dot Marking *
4	Brown	16	Brown / Single Dot Marking *
5	Slate	17	Gray / Single Dot Marking *
6	White	18	White / Single Dot Marking *
7	Red	19	Red / Single Dot Marking *
8	Black	20	Natural
9	Yellow	21	Yellow / Single Dot Marking *
10	Violet	22	Violet / Single Dot Marking *
11	Rose	23	Rose / Single Dot Marking *
12	Aqua	24	Aqua / Single Dot Marking *

* Single Dot Marking



(Black Intermittent Ring)

Table 8. Color code of the loose buffer tubes

No.	Color	No.	Color
1	Blue	19	Red/BK stripe(S)
2	Orange	20	Black/WH stripe(S)
3	Green	21	Yellow/BK stripe(S)
4	Brown	22	Violet/BK stripe(S)
5	Slate	23	Pink/BK stripe(S)
6	White	24	Aqua/BK stripe(S)
7	Red	25	Blue/BK stripe(D)
8	Black	26	Orange/BK stripe(D)
9	Yellow	27	Green/BK stripe(D)
10	Violet	28	Brown/BK stripe(D)
11	Pink	29	Slate/BK stripe(D)
12	Aqua	30	White/BK stripe(D)
13	Blue/BK stripe(S)	31	Red/BK stripe(D)
14	Orange/BK stripe(S)	32	Black/WH stripe(D)
15	Green/BK stripe(S)	33	Yellow/BK stripe(D)
16	Brown/BK stripe(S)	34	Violet/BK stripe(D)
17	Slate/BK stripe(S)	35	Pink/BK stripe(D)
18	White/BK stripe(S)	36	Aqua/BK stripe(D)

S : Single; D : Double

5. PHYSICAL / MECHANICAL / ENVIRONMENTAL PERFORMANCE AND TESTS

The mechanical and environmental performance of the cable shall be in accordance with Table 9 below. Unless otherwise specified, all attenuation measurements required in this section shall be performed at 1550nm for single mode fiber (SMF) and at 1300nm for multi mode fiber (MMF).

Table 9. The Mechanical and Environmental Performance of the Cable

ITEMS	TEST METHOD AND ACCEPTANCE CRITERIA
Tensile Strength	▪ Test method: IEC 60794-1-21 Method E1 - Mandrel diameter: 30D (D = cable diameter) - Length under tension: ≥ 50 m - Load: 2,700N for 1 hour ▪ Acceptance Criteria - Attenuation increment: ≤ 0.1 dB for SMF ≤ 0.2 dB for MMF

ITEMS	TEST METHOD AND ACCEPTANCE CRITERIA
Crush Resistance	▪ Test method: IEC 60794-1-21 Method E3 - Applied load: 1,100 N/10 cm for 10 minutes - No of points: 1 point ▪ Acceptance Criteria - Attenuation Increment: ≤ 0.1 dB for SMF ≤ 0.2 dB for MMF after completion of the test - No jacket cracking and no fiber breakage
Impact resistance	▪ Test method: IEC 60794-1-21 Method E4 - Impact Energy: 5J - Radius of impact mass: 25mm - No. of impact per point: 1 time at 3 points each ▪ Acceptance Criteria - Attenuation Increment : ≤ 0.1 dB for SMF ≤ 0.2 dB for MMF after completion of the test - No jacket cracking and no fiber breakage
Cable bend	▪ Test method: IEC 60794-1-21 Method E11A - Mandrel diameter: 20D (D = cable diameter) - No. of turns: 4 turns(wrapped and unwrapped) - No. of flexing cycles: 10 cycles ▪ Acceptance Criteria - Attenuation Increment: ≤ 0.1 dB for SMF ≤ 0.2 dB for MMF after the completion of the test - No jacket cracking and no fiber breakage
Torsion	▪ Test method: IEC 60794-1-21 Method E7 - Cable length twisted: 2m - No. of twist cycles: 10 cycles - Twist angle: ± 180° ▪ Acceptance Criteria - Attenuation Increment: ≤ 0.1 dB for SMF ≤ 0.2 dB for MMF after the completion of the test - No sheath cracking and no fiber breakage
Water Penetration	▪ Test method: IEC 60794-1-22 Method F5 - Length of specimen: 3m - Height of pressure head: 1m - Test time: 24 hours ▪ Acceptance Criteria - No leakage through the open cable end

ITEMS	TEST METHOD AND ACCEPTANCE CRITERIA
Temperature Cycling	▪ Test method: IEC 60794-1-22 Method F1 - Cable length: at least 1000m - At least 6 fibers shall be spliced and tested. - Temperature cycling schedule : 23°C → -40°C → 70°C - Soak time at each temperature: 24 hours - No of cycles: 2 ▪ Acceptance Criteria - Attenuation increment: ≤ 0.1 dB/km for SMF ≤ 0.2 dB/km for MMF

6. PACKING AND MARKING

6.1 Cable Marking

The jacket shall be marked with white characters at intervals of one meter with the following information. Other marking is also available if requested by customer.

1) Cable type and fiber counts
2) Manufacturer's name
3) Year of manufacture
4) Length marking

Ex.1) For a single mode 36-fiber cable

0000M SJNA SM36C LS Cable & System 2019 0001M …

6.2 Cable Re-marking

The re-marking shall be marked, preferably with yellow characters, on a different position of the outer cable jacket, and shall have a numbering scheme differing by a minimum of 1000 from the original number. Any cable that contains two sets of cable markings shall be marked to indicate the color of the marking to be used.

6.3 Cable Packing

6.3.1 Standard length of cable shall be 4,000 meters. Other cable length is also available if required by customer.

6.3.2 Each length of the cable shall be wound on a separate wooden reel.

6.3.3 Both ends of the cable shall be sealed with a suitable plastic cap to prevent the entry of moisture during shipping, handling and storage.

6.3.4 The cable ends shall be securely fastened to the reel to prevent the cable form becoming loose in transit or during placing operations.

6.3.5 Circumference battens or Wood-fiber board shall be secured with steel bands to protect the cable during normal handling and shipping.

6.4 Cable Reel

6.4.1 Details given below shall be distinctly marked with a weather proof material on the both outer sides of the reel flange. Other shipping mark is also available if requested by customer.

1) Purchaser's name
2) Cable type and fiber counts
3) Length of cable in meter
4) Gross weight in kilogram
5) Reel number
6) Name of the manufacturer
7) Year of manufacture
8) Arrow showing the direction the drum shall be rolled

6.4.2 The cable shall be shipped on reels designed to prevent damage to the cable during shipment and installation.

6.4.3 The arbor holes provided in the reels shall be at least 65 mm and at most 120 mm in diameter.

7. SAFETY

7.1 ROHS DIRECTIVE

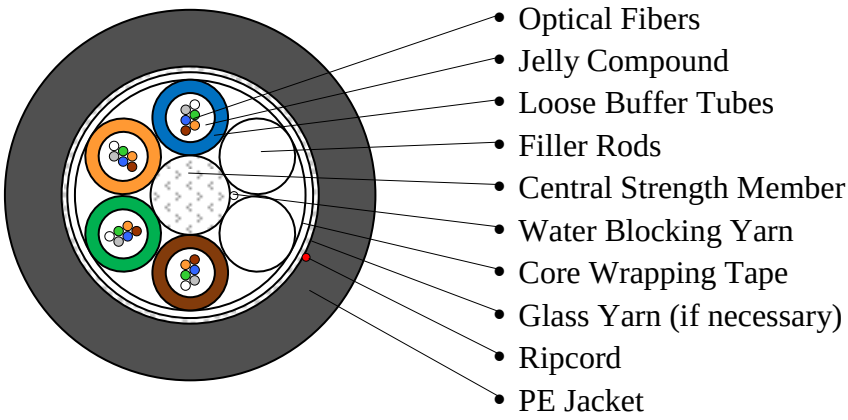
All cables and any associated packing and labelling materials shall meet RoHS (Restriction of the Use of certain Hazardous Substances) regulations as appropriate.

7.2 ISPM 15 DIRECTIVEF

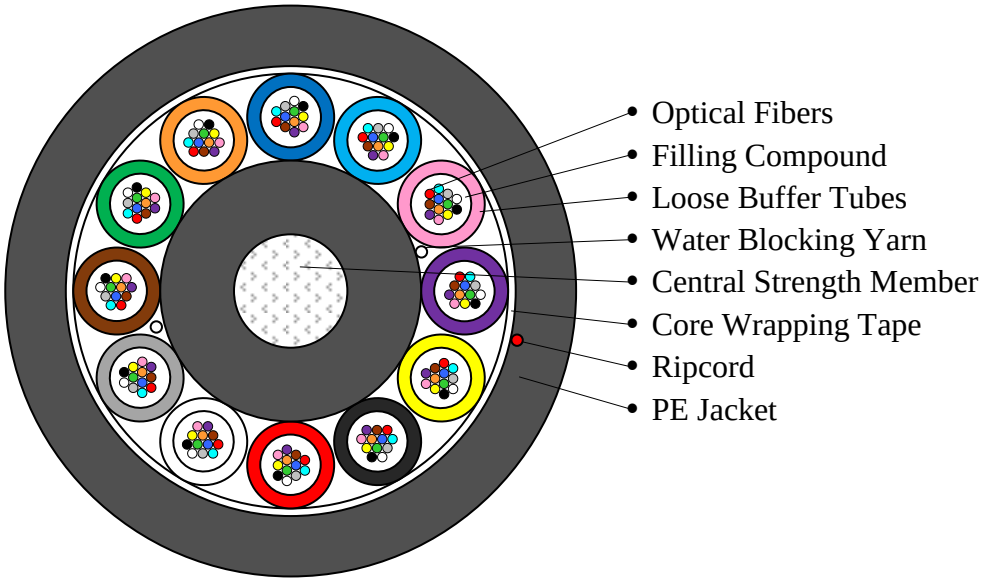
All wooden packing materials shall meet ISPM (International Standards for Phytosanitary Measures) regulations as appropriate.

< Cross-sectional Drawing of Cable >

Ex1) 24-Fiber Cable



Ex2) 144-Fiber Cable



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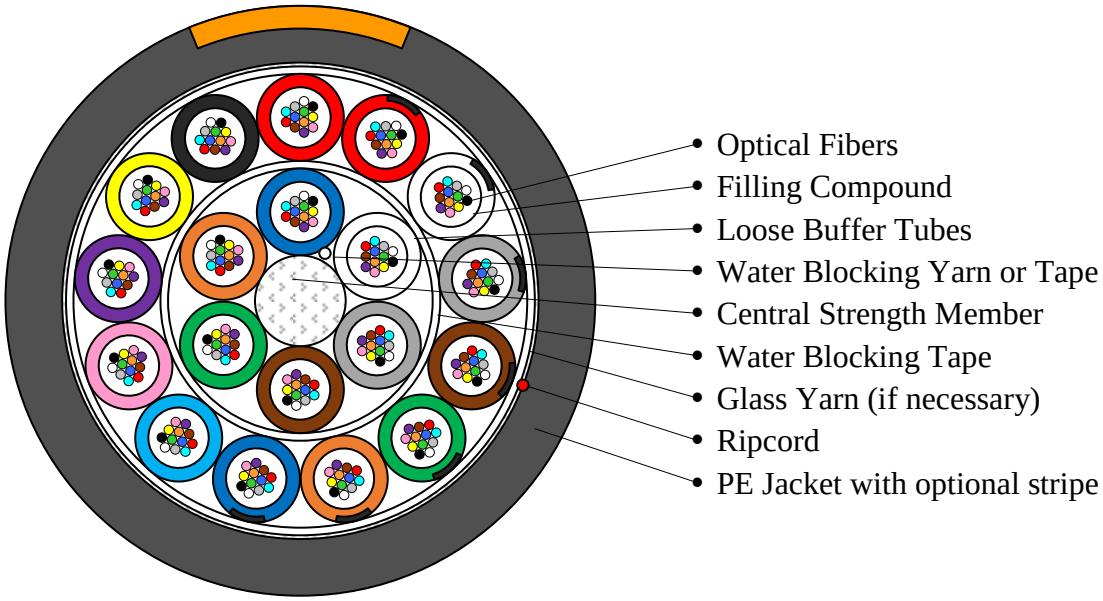
Ex3) 228-Fiber Cable



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No. of Fibers	No. of fibers per tube	Nominal Cable Diameter(mm)	Approx. Cable Weight(kg/km)	Min. Bending Radius(mm)	
				No Load	Under Load
~ 36	6	10.0	77	100	200
~ 72	12	10.7	88	107	214
~ 96	12	12.1	115	121	242
~ 120	12	13.6	141	136	272
~ 144	12	15.0	170	150	300
~ 228	12	15.7	180	157	314
~ 288	12	17.7	230	177	354
~ 324	12	18.5	252	185	370
~ 432	12	22.3	388	223	446
	24	19.1	350	191	382
~ 576	24	22.1	366	221	442

*Actual values for cable weight and diameter may deviate from the calculated values given in the table above.

= End of Specification =