

ISSUED: June, 2023

# **SPECIFICATION**

## **FOR**

### **Loose Tube Figure-8 Single Armor Double Jacket OPTICAL CABLE**

- ▶ SINGLE MODE G652D/G657A1
  - ▶ LOOSE TUBE TYPE
  - ▶ FRP CENTRAL STRENGTH MEMBER
  - ▶ INNER PE SHEATH
  - ▶ MESSENGER WIRE(GAL. STEEL WIRES)
  - ▶ STEEL TAPE + FIGURE-8 TYPE
- OUTER PE/FLAME RETARDENT PE SHEATH

Prepared by : \_\_\_\_\_ J.Y. Lee \_\_\_\_\_

Approved by: \_\_\_\_\_ S.H. Kim \_\_\_\_\_

Optical Cable Engineering Team

#### 1. SCOPE

**ES-TECH INTERNATIONAL, INC.**

### 1.1 General

This specification covers the requirements and constructional details for up to 288 cores single-mode optical fiber cable, which consist of loose tube for aerial installation.

### 1.2 Cable Description

Figure-8 Type Single Armor Double Jacket

Color-coded optical fibers in ultraviolet cured acrylate ink, jelly filled color-coded loose tubes, PE fillers (if required), SZ-stranding around central strength member, water swellable yarn/tape, rip cord, inner PE jacket, steel tape, steel strand wire and outer PE jacket.

## 2. REFERENCE

- EIA/TIA 598 Color Coding of fiber Optic Cables.
- GR-20 Optical Fiber Cables.
- ITU-T G.650 Definition and test methods for the relevant parameters of single-mode fibers
- ITU-T G.652 Characteristics of a single-mode optical fiber cable.
- ITU-T G.657 Characteristics of a single-mode optical fiber cable.
- IEC – 794 – 1

## 3. OPTICAL FIBER

### 3.1 Optical Fiber Material

Core: Silica (SiO<sub>2</sub>) doped with Germanium Dioxide (GeO<sub>2</sub>)

Cladding: Silica (SiO<sub>2</sub>)

Coating: Dual Layers of UV-Curable Acrylate

3.2 The optical and geometrical performance of the optical fiber shall be in accordance with table 1,2.

Table 1 The Optical and Geometrical Performance of the Fiber (ITU-T G.652D)

Parameters	Value
<b>Physical Characteristics</b>	
Clad Diameter	125±0.7 μm
Core-Clad Concentricity Error(Offset)	≤0.5 μm
Cladding Non-Circularity, maximum	≤0.7%
Coating Diameter (Colored)	253 μm±0.7 μm
Coating Diameter (Uncolored)	240 μm±0.5 μm
Coating-Clad Concentricity Error(Uncolored)	≤12 μm
Tensile Proof Test	100 kpsi (0.69 GPa)
Coating Strip Force	Range: 1.0N ≤ CSF ≤ 8.9N
<b>Optical Specification</b>	
Attenuation (After cable) at 1310nm at 1550nm	Maximum ≤ 0.35dB/km ≤ 0.25 dB/km
Dispersion, maximum	* 18 ps(nm-km) at 1550nm * 3.5 ps(nm-km) from 1285nm to 1330nm at 1310nm

Group Refractive Index at 1310 nm at 1550 nm	1.467 1.468
Mode Field Diameter at 1310 nm at 1550 nm	9.2 ± 0.4 μm 10.4 ± 0.5 μm
Polarization Mode Dispersion (PMD) <sup>1</sup> Fiber PMD Link Design Value (LDV) <sup>2</sup>	< 0.04 ps/√km
Chromatic Dispersion Zero Dispersion Wavelength (λ <sub>0</sub> ) Zero Dispersion Slope (S <sub>0</sub> ) Typical Dispersion Slope	1302 – 1322 nm ≤ 0.090 ps/nm <sup>2</sup> -km 0.087 ps/nm <sup>2</sup> -km
Cut-off Wavelength (λ <sub>CC</sub> )	≤ 1260 nm
Attenuation Uniformity / Point Discontinuities at 1310 nm and 1550 nm	≤ 0.05 dB
<b>Mechanical Specifications</b>	
Macro bending Attenuation: The maximum attenuation with bending does not exceed the specified values under the following deployment conditions:	
Deployment Condition	Wavelength
1 turn, 32 mm (1.2 inch) diameter	1550 nm
100 turns, 50 mm (2 inch) diameter	1310 nm
	1550 nm
100 turns, 60 mm (2.4 inch) diameter	1550 nm
	1625 nm
	Induced Attenuation
	< 0.05 dB
Coating Strip Force, maximum	8.9N
Coating Strip Force, minimum	1.3N
<b>Environmental Characteristics (at 1310, 1550 &amp; 1625 nm)</b>	
Temperature Cycling (-60° + 85° C)	≤ 0.05 dB/km
High Temperature Aging (85 ± 2° C)	≤ 0.05 dB/km
Temperature & Humidity Cycling (at -10° C to +85° C and 95% RH)	≤ 0.05 dB/km
Water Immersion (23 ± 2° C)	≤ 0.05 dB/km

**Table 2 The Optical and Geometrical Performance of the Fiber (ITU-T G.657 A1)**

Parameter	Specification
<b>Optical Characteristics</b>	
Attenuation (After cable) at 1310nm at 1550nm	Maximum ≤ 0.35dB/km ≤ 0.25 dB/km
Dispersion coefficient @ 1285 ~ 1330 nm @ 1550 nm	≤ 3.4 ps/(nm <sup>2</sup> .km) ≤ 18.0 ps/(nm <sup>2</sup> .km)
Zero-dispersion wavelength	1300 ~ 1324 nm
Zero-dispersion slope	≤ 0.092 ps/(nm <sup>2</sup> .km)

PMD Maximum Individual Fiber	$\leq 0.2 \text{ ps/km}^{1/2}$
Cable cut-off wavelength	$\leq 1260 \text{ nm}$
Mode field diameter @ 1310 nm	$8.9 \pm 0.4 \text{ um}$
<b>Geometrical Characteristics</b>	
Cladding diameter	$125.0 \pm 0.7 \text{ um}$
Cladding non-circularity	$\leq 0.7 \%$
Coating diameter	$245 \pm 10 \text{ um}$
Coating-Cladding concentricity error	$\leq 12.0 \text{ um}$
Coating Non-circularity error	$\leq 6.0 \%$
Core-Clad concentricity error	$\leq 0.5 \text{ um}$
Curl (Radius)	$\geq 4\text{m}$
<b>Mechanical Specification</b>	
Proof test level	$\geq 100 \text{ kpsi}$
Micro-bend induced attenuation 10 turns around a mandrel of 30mm diameter 10 turns around a mandrel of 30mm diameter 1 turn around a mandrel of 20mm diameter 1 turn around a mandrel of 20mm diameter	$\leq 0.25 \text{ dB at } 1550 \text{ nm}$ $\leq 1.0 \text{ dB at } 1625 \text{ nm}$ $\leq 0.75 \text{ dB at } 1550 \text{ nm}$ $\leq 1.5 \text{ dB at } 1625 \text{ nm}$
Coating strip force Average force	1.7 N

#### 4. CABLE DESIGN

##### 4.1 Cable Core

The cable contains loose tubes and the number of PE fillers (if required), which are stranded around the central strength member. The cable core is dry core with water swellable yarn and tape.

##### 4.2 Figure-8 Type Single Armor Double Jacket

The rip cord, inner PE jacket, corrugated steel tape, galvanized steel strand wire and outer black PE jacket shall be applied over the cable core.

4.3 The construction of the cable shall be in accordance with table 3.1, 3.2, 3.3 and annex 1,2.

**Table 3.1 Construction of the Cable Core**

Items	Description
Number of Fibers	2~288C
Type of Fiber	Single mode G652D or G657A1
Number of Fibers within Tube	Max 12 Cores
Loose Tube	PBT (Polybutylene terephthalate)
Filling Compound in Tube	Thixotropic jelly compound
Central Strength Member	FRP Rod or PE coated FRP Rod
Filler (If required)	PE or PP
Water blocking in Cable Core	Water swellable yarn / Water blocking Tape

**Table 3.2 Construction of the Cable (Figure-8 Type Single Armor Double Jacket)**

Items	Description
Cable Core	Table 3.1
Rip Cord	One rip cords
Inner Jacket	Black PE or Black Flame Retardant PE Thickness : Nom. 1.0mm
Steel Tape	Corrugated Steel Tape Steel .tape thickness : 0.15mm Copolymer coating thickness : 0.05mm/one side * Both side
Messenger Wire	Galvanized Steel Strand Wire - 2C~72C : 1.6mm * 7C - 74C~288C : 1.8mm * 7C PE Thickness: Nom. 1.5 mm
Web	Nom. W2.0mm * H2.0mm
Outer Jacket	Black PE or Black Flame Retardant PE - General PE Thickness: Nom. 1.5 mm - Flame retardant PE Thickness : Nom. 2.0mm

**Table 3-3 Composition of Cable Core**

Fiber Counts	Fiber count /tube	No. of tube	No. of Filler	Cable Core Composition	
~12	~12	1	5	Single Layer	1*6 Tubes
24	12	2	4	Single Layer	1*6 Tubes
36	12	3	3	Single Layer	1*6 Tubes
48	12	4	2	Single Layer	1*6 Tubes
60	12	5	1	Single Layer	1*6 Tubes
72	12	6	0	Single Layer	1*6 Tubes
96	12	8	0	Single Layer	1*8 Tubes
120	12	10	0	Single Layer	1*10 Tubes
144	12	12	0	Single Layer	1*12 Tubes
288	12	24	0	Double Layer	1*9T*15Tubes

## 5. OPTICAL FIBER AND LOOSE TUBE IDENTIFICATION

The color code of the loose tubes and the individual fibers within each loose tube shall be in accordance with table 4.

**Table 4-1 The Color Code of the Individual Optical Fibers**

Optical Fiber Identification			
No.	Color	No	Color
1	Blue	7	Red
2	Orange	8	Black
3	Green	9	Yellow
4	Brown	10	Violet
5	Gray	11	Pink
6	White	12	Aqua

**Table 4-2 The Color Code of the Individual Loose Tubes**

Number	1 <sup>st</sup> Layer	2 <sup>nd</sup> Layer	
		1 <sup>st</sup>	2 <sup>nd</sup>
1	Blue	Blue	Violet
2	Orange	Orange	Pink
3	Green	Green	Aqua
4	Brown	Brown	Blue-Black stripe
5	Gray	Gray	Orange-Black stripe
6	White	White	Green-Black stripe
7	Red	Red	Brown-Black stripe
8	Black	Black	Gray-Black stripe
9	Yellow	Yellow	White-Black stripe
10	Violet	-	Red-Black stripe
11	Pink	-	Black-White stripe
12	Aqua	-	Yellow-Black stripe
13	-	-	Violet-Black stripe
14	-	-	Pink-Black stripe
15	-	-	Aqua-Black stripe

## 6. MECHANICAL AND ENVIRONMENTAL PERFORMANCE AND TESTS

The mechanical and environmental performance of the cable shall be in accordance with table 5. All attenuation measurements required in this section shall be performed at 1550 nm.

**Table 5 The Mechanical and Environmental Performance of the Cable**

Items	Test Condition and Acceptance Criteria
Tensile Test	<ul style="list-style-type: none"> <li>● Test method: IEC 60794-1-2 Method E1                             <ul style="list-style-type: none"> <li>- Tensile load: Max Allowable Tension(refer to Annwx 2) for 1 hour</li> </ul> </li> <li>● Acceptance criteria                             <ul style="list-style-type: none"> <li>- Attenuation increment: <math>\leq 0.10</math> dB</li> <li>- No Jacket cracking and fiber breakage</li> </ul> </li> </ul>
Crush Test	<ul style="list-style-type: none"> <li>● Test method: IEC-60794-1-2 Method E3                             <ul style="list-style-type: none"> <li>- Crush load: 2000 N/10 cm for 10 min</li> </ul> </li> <li>● Acceptance criteria                             <ul style="list-style-type: none"> <li>- Attenuation increment: <math>\leq 0.10</math> dB</li> <li>- No Jacket cracking and fiber breakage</li> </ul> </li> </ul>
Impact Test	<ul style="list-style-type: none"> <li>● Test method: IEC 60794-1-2 Method E4                             <ul style="list-style-type: none"> <li>- Impact load: 1kg</li> <li>- Impact height: 1 m</li> <li>- Number of impact: 1 times x 3 position</li> </ul> </li> <li>● Acceptance criteria                             <ul style="list-style-type: none"> <li>- Attenuation increment: <math>\leq 0.10</math> dB</li> <li>- No Jacket cracking and fiber breakage</li> </ul> </li> </ul>
Cable Torsion Test	<ul style="list-style-type: none"> <li>● Test method: IEC-60794-1-2 Method E7                             <ul style="list-style-type: none"> <li>- Cable Length twisted: 2 m</li> <li>- Torsion angle : <math>\pm 180^\circ</math></li> <li>- Number of cycles: 10 cycles</li> </ul> </li> <li>● Acceptance criteria                             <ul style="list-style-type: none"> <li>- Attenuation increment: <math>\leq 0.10</math> dB</li> <li>- No Jacket cracking and fiber breakage</li> </ul> </li> </ul>
Cable Bend Test	<ul style="list-style-type: none"> <li>● Test method: IEC-60794-1-2 Method E11A                             <ul style="list-style-type: none"> <li>- Mandrel diameter: 20 D (D = cable diameter)</li> <li>- Angle: <math>\pm 180^\circ</math></li> <li>- Number of cycles: 4</li> </ul> </li> <li>● Acceptance criteria                             <ul style="list-style-type: none"> <li>- Attenuation increment: <math>\leq 0.10</math> dB</li> <li>- No Jacket cracking and fiber breakage</li> </ul> </li> </ul>
Temperature cycling Test	<ul style="list-style-type: none"> <li>● Test method: IEC-60794-1-2 Method F1                             <ul style="list-style-type: none"> <li>- Temperature cycling step : <math>+23^\circ\text{C} \rightarrow -40^\circ\text{C} \rightarrow +70^\circ\text{C} \rightarrow +23^\circ\text{C}</math></li> <li>- Soak time at each temperature step: 12 hours</li> <li>- No. of cycles : 2</li> </ul> </li> <li>● Acceptance Criteria                             <ul style="list-style-type: none"> <li>- Attenuation increment : <math>\leq 0.20</math> dB/km(during testing) <math>\leq 0.10</math> dB/km(after testing)</li> </ul> </li> </ul>
Water Penetration Test	<ul style="list-style-type: none"> <li>● Test method: IEC-60794-1-2 Method F5                             <ul style="list-style-type: none"> <li>- Length of specimen: 3 m</li> <li>- Height of pressure head: 1 m</li> <li>- Test time: 24 hours</li> </ul> </li> <li>● Acceptance criteria                             <ul style="list-style-type: none"> <li>- No leakage through the open cable end</li> </ul> </li> </ul>

Vertical Tray Flame Test(Only Flame Retardent Cable)	<ul style="list-style-type: none"><li>● Test method : IEEE 1202<ul style="list-style-type: none"><li>- Cable Length:2.4m±0.1m</li><li>- Flame :20KW(70,000Btu/h)</li><li>- Time : 20min</li></ul></li><li>● Acceptance criteria<ul style="list-style-type: none"><li>- Length of cable damage : &lt;1.5m±25mm/after 2times testing</li></ul></li></ul>
--	--

## 7. CABLE MARKING

7.1 The completed cable shall have sequentially numbered length markers in meters at intervals of 1 meter along the outside of the cable jacket. Continuous sequential numbering shall be employed in a single length of cable and started from zero at the inner end of the cable.

7.2 Agreement between the actual length of the cable and the length marking on the cable jacket shall be within the limits of plus one percent, minus nothing.

7.3 Required information can be marked on the outer jacket at intervals of 1 meter sequentially.

- (1) Cable type & counts
- (2) Year of manufacture
- (3) Name of manufacturer (ES CABLE)
- (4) Serial No.
- (5) Length marking (m)

7.4 Cable marking of the outer jacket shall be distinctly printed by white color.

## 8. PACKING AND MARKING

### 8.1 Cable Packing

8.1.1 Standard length of the cable shall be 2~4 km. Other cable length is also available if required by customer.

8.1.2 Each length of the cable shall be wound on a separate strong wooden drum.

8.1.3 Both ends of the cable shall be sealed with a suitable heat shrinkable caps or PVC cap to prevent the entry of moisture during transportation and storage.

8.1.4 The cable end shall be securely fastened to the drum to prevent the cable from becoming loose during transit or becoming loose during placing operations.

8.1.5 The inner end of the cable is housed into a slot on the side of the reel without extra cable length for testing

8.1.6 The reels must have a number of rotations that there is a min. free space of 50mm between the upper layer and the edge of the flanges.

8.1.7 Circumference battens or Wood-fiber board shall be secured with steel band to protect the cable during normal handling and storage.

### 8.2 Cable Drum

8.2.1 Details given below shall be distinctly marked on a weatherproof material on both outer sides of the drum flange:

- (1) Customer's name
- (2) Type and size of cable
- (3) Length of cable in meters
- (4) Net weight and gross weight in kilograms
- (5) Drum number
- (6) Name of manufacturer
- (7) Year of manufacture
- (8) Arrow showing the direction of the drum should be rolled when handling
- (9) End mark of cable
- (10) Caution plate (label)

The other shipping mark is also available if required by buyer.

8.2.2 The minimum barrel diameter of the drum shall be 30 times to the overall cable diameter

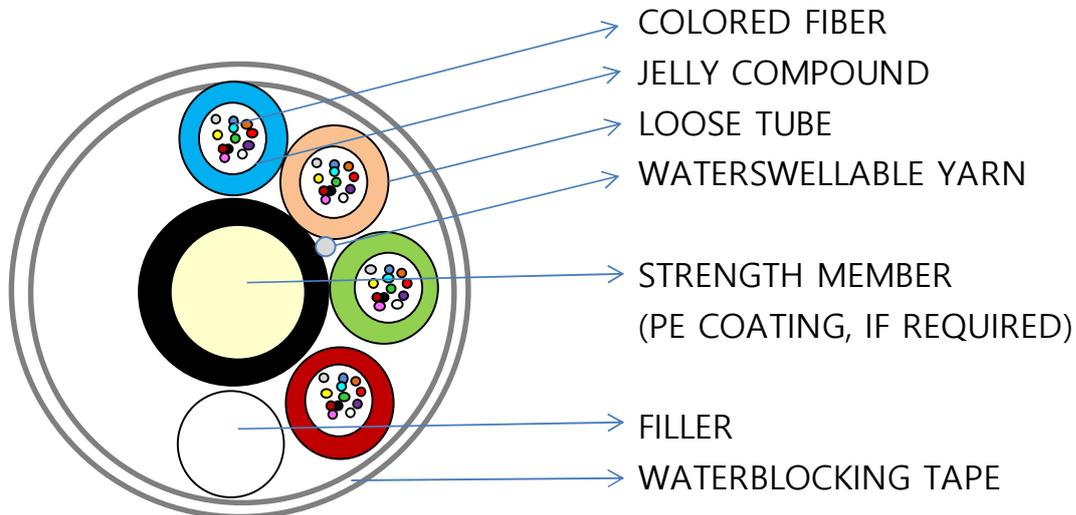
8.2.3 The arbor holes provided in the reels shall be 75 ~ 125 mm in diameter.

## **9. INSTALLATION AND OPERATING**

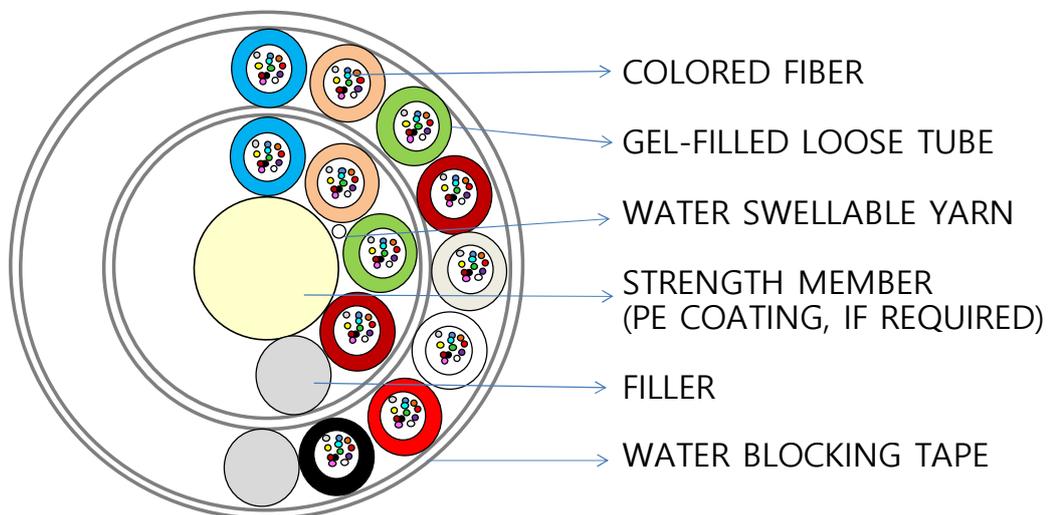
The available span length, dip and tension during installation, max.dip and tension under operation shall be in accordance with annex3.

## Annex. 1: Cross-sectional Drawing of the Cable

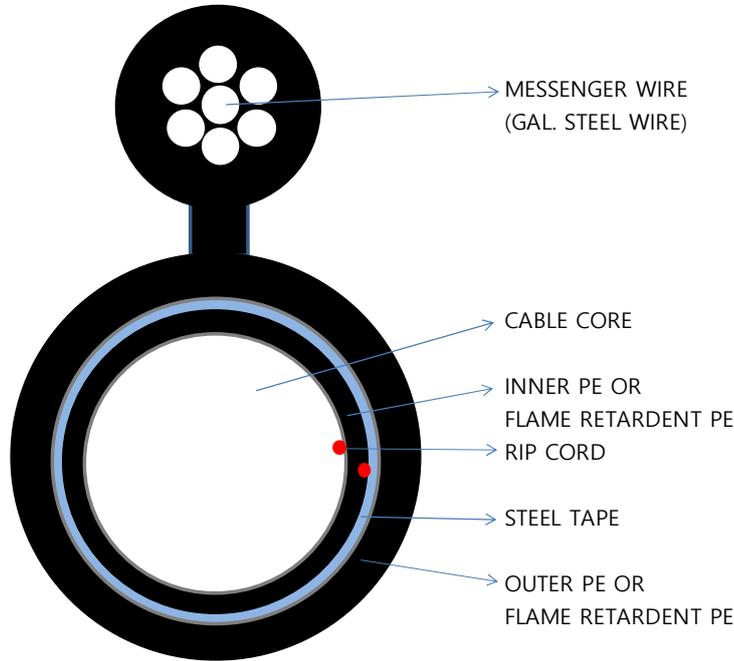
### ■ CABLE CORE (SINGLE LAYER)



### ■ CABLE CORE (DOUBLE LAYER)



**■ CABLE JACKET**



“The drawing appearing on this page may be subject to change or modification without any prior notice”

**Annex. 2: Diameter, Weight, Tension & Min. Bending radius**

- Fig-8 Type Single Armor Double Jacket Cable

No. of Fiber	Nom. Cable Diameter (mm)	Approx. Cable Weight (kg/km)	Max. Allowable Tension (kgf)		Min. Bending Radius (mm)	
			Long Term	Short Term	No Load	Load
~ 72C	13.6 X 23.4	315	800	1150	10D	20D
96C	14.8 X 25.2	375	1100	1450		
120C	16.1 X 26.5	410	1100	1450		
144C	17.6 X 28.0	450	1100	1450		
288C	20.2 X 30.6	530	1100	1450		

### Annex. 3: Span Length, Dip and Tension

- Fig-8 Type Single Armor Double Jacket Cable

No. of Fiber	Span Length(m)	Installation		Operation	
		Dip(%)	Tension(kg)	Max.Dip(%)	Tension(kg)
~72C	100	1.5	256	2.6	470
96C	100	1.5	308	2.5	550
120C	100	1.5	335	2.5	579
144C	100	1.5	366	2.5	612
288C	100	1.5	435	2.5	682

Note 1) Environmental Condition : NESC Light

-Wind Pressure 430pa-Wind Speed 26m/s,

-Ice Thickness : 0mm

Note 2) Installation Temperature : 25°C

Note 3) Operating Temperature : -40°C ~ +70°C