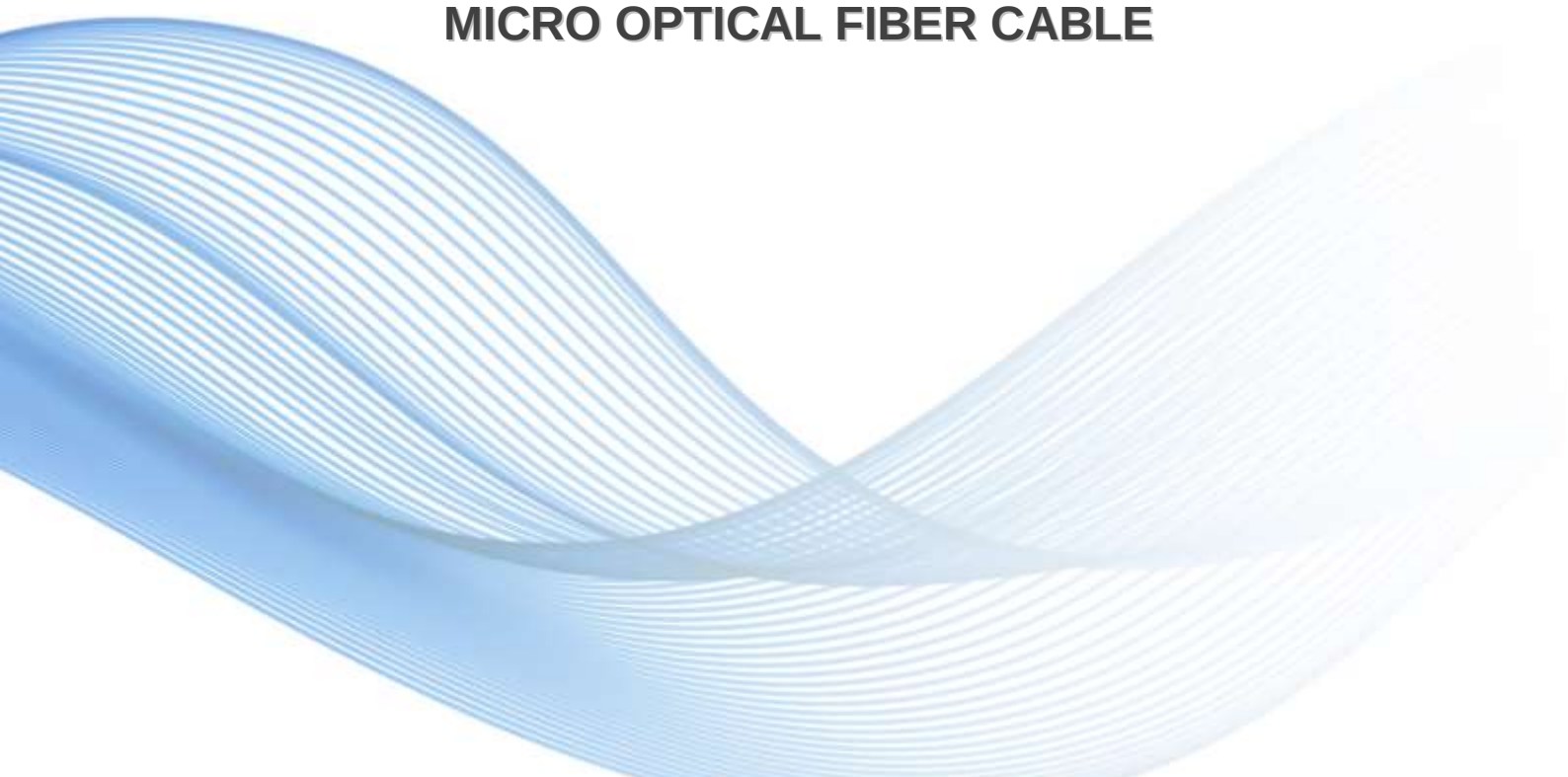


# TECHNICAL SPECIFICATION

## MICRO OPTICAL FIBER CABLE



|                |               |                 |                 |                 |
|----------------|---------------|-----------------|-----------------|-----------------|
| F              | June 20, 2018 | Kuck            | Erica           | Felix           |
| E              | Jan 23, 2018  | Kuck            | Erica           | Felix           |
| D              | Dec 9, 2017   | Kuck            | Erica           | Felix           |
| C              | Nov 6, 2017   | Kuck            | Erica           | Felix           |
| B              | Nov 3, 2017   | Kuck            | Erica           | Felix           |
| A              | Oct 12, 2017  | Kuck            | Erica           | Felix           |
| <b>Version</b> | <b>Date</b>   | <b>Prepared</b> | <b>Reviewed</b> | <b>Approved</b> |

## 1. General

### 1.1 Scope

This listed specification covers the design requirements and performance standard for the supply of optical fiber cable in the industry. It also includes ZTT premium designed cable with optical, mechanical and geometrical characteristics.

| Cable type                           | Application                      |
|--------------------------------------|----------------------------------|
| OFC-4/8/12 G.657A1/G.657A2-MD-S3     | Blowing installation micro cable |
| OFC-12/24/48/72/96/144 G.652D-FMD-S1 | Blowing installation micro cable |

### 1.2 Cable Description

ZTT cable possesses high tensile strength and flexibility in compact cable sizes. At the same time, it provides excellent optical transmission and physical performance.

### 1.3 Quality

Excellent quality control is achieved through intense in-house quality check and stringent audit acceptance by ISO 9001.

### 1.4 Reliability

Initial and periodic product qualification tests for performance and durability are performed rigorously to ensure product reliability.

### 1.5 Reference

The cable which ZTT offered are designed, manufactured and tested according to international standards as follows:

|             |                                                                                                      |
|-------------|------------------------------------------------------------------------------------------------------|
| IEC 60793-1 | Optical fiber Part 1: Generic specifications                                                         |
| IEC 60793-2 | Optical fiber Part 2: Product specifications                                                         |
| IEC 60794-5 | Optical fiber cables- Part 5: sectional specification -Microduct cabling for installation by blowing |
| 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 and cable                                             |
| ITU-T G.657 | Characteristics of a bending loss insensitive single-mode optical fiber cable                        |
| EIA/TIA 598 | Color code of fiber optic cables                                                                     |

## 2. Optical Fiber

The optical fiber is made of high pure silica and germanium doped silica. UV curable acrylate material is applied over fiber cladding as optical fiber primary protective coating. The detail data of optical fiber performance are shown in the following table.

**G.652D Fiber**

| Category                   | Description                                                                        | Specifications                 |               |
|----------------------------|------------------------------------------------------------------------------------|--------------------------------|---------------|
|                            |                                                                                    | Before cabling                 | After cabling |
| Optical Specifications     | Attenuation @1310 nm                                                               | ≤0.34 dB/km                    | ≤0.35 dB/km   |
|                            | Attenuation @1550 nm                                                               | ≤0.20 dB/km                    | ≤0.22 dB/km   |
|                            | Zero Dispersion Wavelength                                                         | 1300~1324 nm                   |               |
|                            | Zero Dispersion Slope                                                              | ≤ 0.092 ps/nm <sup>2</sup> ·km |               |
|                            | Max. PMD Value                                                                     | ≤0.2 ps/√km                    |               |
|                            | Cable Cutoff Wavelength (λ <sub>cc</sub> )                                         | ≤1260 nm                       |               |
|                            | Macro bending Loss<br>(100 turns; Φ50 mm) @1550 nm<br>(100 turns; Φ50 mm) @1625 nm | ≤ 0.05 dB<br>≤ 0.10 dB         |               |
|                            | Mode Field Diameter @1310 nm                                                       | 9.2±0.4μm                      |               |
| Dimensional Specifications | Cladding Diameter                                                                  | 125 ±1μm                       |               |
|                            | Cladding non circularity                                                           | ≤0.6μm                         |               |
|                            | Core/clad concentricity error                                                      | ≤1.0%                          |               |
|                            | Coating diameter(colored)                                                          | 250±15μm                       |               |
| Mechanical Specifications  | Proof stress                                                                       | ≥0.69 GPa                      |               |

### G.657A1 Fiber

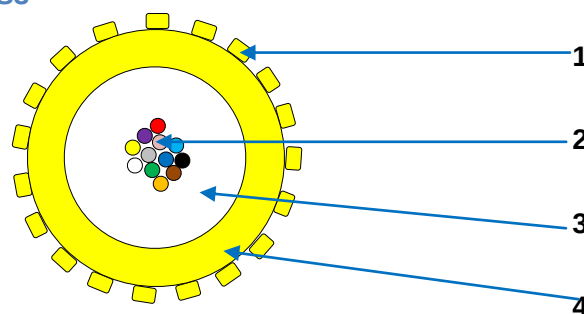
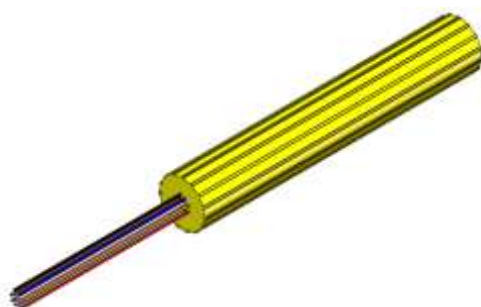
| Category                   | Description                                       | Specifications                 |             |
|----------------------------|---------------------------------------------------|--------------------------------|-------------|
|                            |                                                   | Before cable                   | After cable |
| Optical Specifications     | Attenuation @1310 nm                              | ≤0.34 dB/km                    | ≤0.36 dB/km |
|                            | Attenuation @1550 nm                              | ≤0.21 dB/km                    | ≤0.22 dB/km |
|                            | Zero Dispersion Wavelength                        | 1300~1324 nm                   |             |
|                            | Zero Dispersion Slope                             | ≤ 0.092 ps/nm <sup>2</sup> ·km |             |
|                            | Macro bending Loss<br>(10 turns; Φ30 mm) @1550 nm | ≤ 0.25 dB                      |             |
|                            | (10 turns; Φ30 mm) @1625 nm                       | ≤ 1.0 dB                       |             |
|                            | (1 turns; Φ20 mm) @1550 nm                        | ≤ 0.75 dB                      |             |
| Dimensional Specifications | (1 turns; Φ20 mm) @1625 nm                        | ≤ 1.5 dB                       |             |
|                            | Mode Field Diameter @1310 nm                      | (8.6~9.2) ±0.4μm               |             |
|                            | Cladding Diameter                                 | 125±1.0μm                      |             |
|                            | Cladding non circularity                          | ≤1.0%                          |             |
| Mechanical Specifications  | Core/clad concentricity error                     | ≤0.5μm                         |             |
|                            | Proof stress                                      | ≥1.05%                         |             |

## G.657A2 Fiber

| Category                   | Description                                                                                                                                                                                              | Specifications                                                             |               |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------|
|                            |                                                                                                                                                                                                          | Before cabling                                                             | After cabling |
| Optical Specifications     | Attenuation @1310 nm                                                                                                                                                                                     | ≤0.34 dB/km                                                                | ≤0.36 dB/km   |
|                            | Attenuation @1550 nm                                                                                                                                                                                     | ≤0.21 dB/km                                                                | ≤0.22 dB/km   |
|                            | Zero Dispersion Wavelength                                                                                                                                                                               | 1300~1324 nm                                                               |               |
|                            | Zero Dispersion Slope                                                                                                                                                                                    | ≤ 0.092 ps/nm <sup>2</sup> ·km                                             |               |
|                            | Macro bending Loss<br>(10 turns; Φ30 mm) @1550 nm<br>(10 turns; Φ30 mm) @1625 nm<br>(1 turns; Φ20 mm) @1550 nm<br>(1 turns; Φ20 mm) @1625 nm<br>(1 turns; Φ15 mm) @1550 nm<br>(1 turns; Φ15 mm) @1625 nm | ≤ 0.03 dB<br>≤ 0.10 dB<br>≤ 0.10 dB<br>≤ 0.20 dB<br>≤ 0.50 dB<br>≤ 1.00 dB |               |
|                            | Mode Field Diameter @1310 nm                                                                                                                                                                             | (8.6~9.2)±0.4μm                                                            |               |
|                            |                                                                                                                                                                                                          |                                                                            |               |
| Dimensional Specifications | Cladding Diameter                                                                                                                                                                                        | 125±1.0μm                                                                  |               |
|                            | Cladding non circularity                                                                                                                                                                                 | ≤1.0%                                                                      |               |
|                            | Core/clad concentricity error                                                                                                                                                                            | ≤0.5μm                                                                     |               |
| Mechanical Specifications  | Proof stress                                                                                                                                                                                             | ≥1.05%                                                                     |               |

### 3. Cable Structure

#### 3.1 Cable Type: OFC-4/8/12 G.657A1/G.657A2-MD-S3



Picture is only for reference

#### Technical Characteristics

- Air blown fibers, outer surface promoting low-friction
- Light weight, small size, easy for blowing
- Saving the source of duct

#### Construction:

1. Trough
2. Colored fiber
3. 1<sup>st</sup> UV curable resin
4. Outer sheath (LSZH, Yellow)

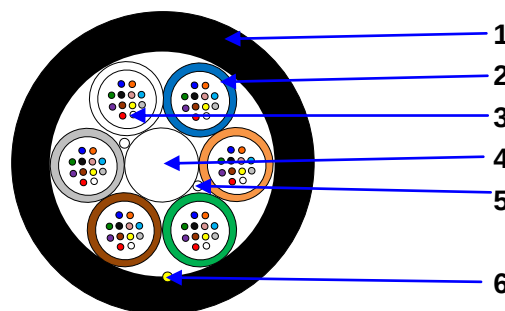
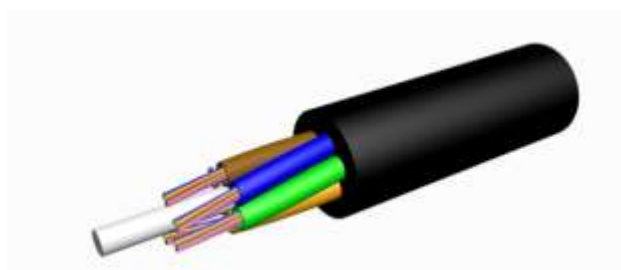
### Dimension and Properties

| Physical   | Fiber count (G.657A1/G.657A2)           | 4                       | 8         | 12        |
|------------|-----------------------------------------|-------------------------|-----------|-----------|
|            | Cable OD                                | 1.2±0.2mm               | 1.6±0.2mm | 1.8±0.2mm |
|            | Cable weight                            | 2±0.5kg/km              | 3±1kg/km  | 4±1kg/km  |
|            | Operation temperature range             | -40 deg C to + 60 deg C |           |           |
|            | Installation temperature range          | -30 deg C to + 60 deg C |           |           |
|            | Transport and storage temperature range | -40 deg C to + 70 deg C |           |           |
| Mechanical | Max. tensile load                       | 15N                     |           |           |
|            | Crush resistance                        | 200 N/10cm              |           |           |
|            | Minimal installation bending radius     | 20D                     |           |           |
|            | Minimal operation bending radius        | 15D                     |           |           |

#### Color code scheme:

| Fiber color | blue | orange | green | brown | gray | white | red | black | yellow | violet | pink | turquoise |
|-------------|------|--------|-------|-------|------|-------|-----|-------|--------|--------|------|-----------|
|-------------|------|--------|-------|-------|------|-------|-----|-------|--------|--------|------|-----------|

### 3.2 Cable Type: OFC-12/24/48/72 G.652D-FMD-S1



Picture is only for reference

#### Technical Characteristics

- The unique extruding technology provides the fibers in the tube with good flexibility and bending endurance
- The unique fiber excess length control method provides the cable with excellent mechanical and environmental properties
- Multiple water blocking material filling provides dual water blocking function

#### Construction:

1. Outer sheath (**HDPE, Black**)
2. Loose tube
3. Fiber and jelly
4. Central strength member (**FRP**)
5. Water blocking yarn
6. Ripcord

### Dimension and Properties

|            |                                         |                         |     |     |     |
|------------|-----------------------------------------|-------------------------|-----|-----|-----|
| Physical   | Fiber count (G.652D)                    | 12                      | 24  | 48  | 72  |
|            | No of loose tube / filler               | 1/5                     | 2/4 | 4/2 | 6/0 |
|            | Fiber No. per tube                      | 12                      |     |     |     |
|            | Cable OD                                | 5.7±0.2mm               |     |     |     |
|            | Cable weight                            | 27kg/km±10%             |     |     |     |
|            | Operation temperature range             | -40 deg C to + 60 deg C |     |     |     |
|            | Installation temperature range          | -30 deg C to + 60 deg C |     |     |     |
|            | Transport and storage temperature range | -40 deg C to + 70 deg C |     |     |     |
| Mechanical | Max. tensile load                       | 700N                    |     |     |     |
|            | Crush resistance                        | 500 N/10cm              |     |     |     |
|            | Minimal installation bending radius     | 20D                     |     |     |     |
|            | Minimal operation bending radius        | 15D                     |     |     |     |

#### Color code scheme:

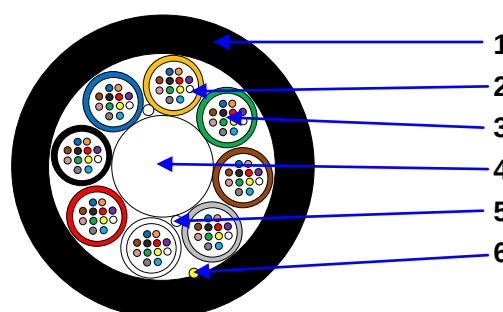
|             |      |        |       |       |      |       |     |       |        |        |      |           |
|-------------|------|--------|-------|-------|------|-------|-----|-------|--------|--------|------|-----------|
| Fiber color | blue | orange | green | brown | gray | white | red | black | yellow | violet | pink | turquoise |
| Tube color  | blue | orange | green | brown | gray | white | /   | /     | /      | /      | /    | /         |

**Note:** sheath thickness not consider ripcord portion

### 3.3 Cable Type: OFC-96 G.652D-FMD-S1



Picture is only for reference



#### Technical Characteristics

- The unique extruding technology provides the fibers in the tube with good flexibility and bending endurance
- The unique fiber excess length control method provides the cable with excellent mechanical and environmental properties
- Multiple water blocking material filling provides dual water blocking function

#### Construction:

1. Outer sheath (**HDPE, Black**)
2. Loose tube
3. Fiber and jelly
4. Central strength member (**FRP**)
5. Water blocking yarn
6. Ripcord

### Dimension and Properties

|                   |                                         |                         |
|-------------------|-----------------------------------------|-------------------------|
| <b>Physical</b>   | Fiber count                             | 96 G.652D               |
|                   | No of loose tube / filler               | 8/0                     |
|                   | Fiber No. per tube                      | 12                      |
|                   | Cable OD                                | Max. 6.5mm              |
|                   | Cable weight                            | 42kg/km±10%             |
|                   | Operation temperature range             | -40 deg C to + 60 deg C |
|                   | Installation temperature range          | -30 deg C to + 60 deg C |
|                   | Transport and storage temperature range | -40 deg C to + 70 deg C |
| <b>Mechanical</b> | Max. tensile load                       | 1000N                   |
|                   | Crush resistance                        | 500 N/10cm              |
|                   | Minimal installation bending radius     | 20D                     |
|                   | Minimal operation bending radius        | 15D                     |

#### Color code scheme:

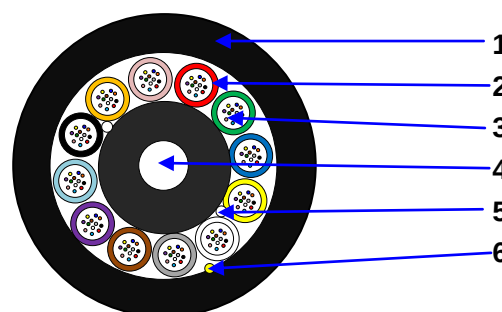
|                    |      |        |       |       |      |       |     |       |        |        |      |           |
|--------------------|------|--------|-------|-------|------|-------|-----|-------|--------|--------|------|-----------|
| <b>Fiber color</b> | blue | orange | green | brown | gray | white | red | black | yellow | violet | pink | turquoise |
| <b>Tube color</b>  | blue | orange | green | brown | gray | white | red | black | /      | /      | /    | /         |

**Note:** sheath thickness not consider ripcord portion

### 3.4 Cable Type: OFC-144 G.652D-FMD-S1



Picture is only for reference



#### Technical Characteristics

- The unique extruding technology provides the fibers in the tube with good flexibility and bending endurance
- The unique fiber excess length control method provides the cable with excellent mechanical and environmental properties
- Multiple water blocking material filling provides dual water blocking function

#### Construction:

1. Outer sheath (**HDPE, Black**)
2. Loose tube
3. Fiber and jelly
4. Central strength member (**Coated FRP**)
5. Water blocking yarn
6. Ripcord

### Dimension and Properties

|                   |                                         |                         |
|-------------------|-----------------------------------------|-------------------------|
| <b>Physical</b>   | Fiber count                             | 144 G.652D              |
|                   | No of loose tube / filler               | 12/0                    |
|                   | Fiber No. per tube                      | 12                      |
|                   | Cable OD                                | 8.7±0.2mm               |
|                   | Cable weight                            | 70kg/km±15%             |
|                   | Operation temperature range             | -25 deg C to + 70 deg C |
|                   | Installation temperature range          | -5 deg C to + 55 deg C  |
|                   | Transport and storage temperature range | -30 deg C to + 70 deg C |
| <b>Mechanical</b> | Max. tensile load                       | 1000N                   |
|                   | Crush resistance                        | 500 N/10cm              |
|                   | Minimal installation bending radius     | 20D                     |
|                   | Minimal operation bending radius        | 15D                     |

#### Color code scheme:

|                    |      |        |       |       |      |       |     |       |        |        |      |           |
|--------------------|------|--------|-------|-------|------|-------|-----|-------|--------|--------|------|-----------|
| <b>Fiber color</b> | blue | orange | green | brown | gray | white | red | black | yellow | violet | pink | turquoise |
| <b>Tube color</b>  | blue | orange | green | brown | gray | white | red | black | yellow | violet | pink | turquoise |

**Note:** sheath thickness not consider ripcord portion

## 4. Test Requirements

Approved by various professional optical and communication product institution, ZTT also conduct various in-house testing in its own Laboratory and Test Center. ZTT also conduct test with special arrangement with the Chinese Government Ministry of Quality Supervision & Inspection Center of Optical Communication Products (QSICO). ZTT possess the technology to keep its fiber attenuation loss within Industry Standards.

The cable is in accordance with applicable standard of cable and requirement of customer. The following test items are carried out according to corresponding reference.

### Routine tests of optical fiber

|                          |                |
|--------------------------|----------------|
| Mode field diameter      | IEC 60793-1-45 |
| Core/clad concentricity  | IEC 60793-1-20 |
| Cladding diameter        | IEC 60793-1-20 |
| Cladding non-circularity | IEC 60793-1-20 |
| Attenuation coefficient  | IEC 60793-1-40 |
| Chromatic dispersion     | IEC 60793-1-42 |
| Cable cut-off wavelength | IEC 60793-1-44 |

## Test list

### 4.1 Tension Loading Test

|               |                                              |
|---------------|----------------------------------------------|
| Test Standard | IEC 60794-1-2 E1                             |
| Sample length | No less than 50 meters                       |
| Load          | Max. tension load                            |
| Duration time | 1 minute                                     |
| Test results  | $\Delta\alpha\leq 0.05\text{dB/km}$          |
|               | No damage to outer jacket and inner elements |

### 4.2 Crush/Compression Test

|               |                                              |
|---------------|----------------------------------------------|
| Test Standard | IEC 60794-1-2 E3                             |
| Load          | 3.1 structure: 200N/10cm, others: 500N/10cm  |
| Duration time | 1 minute                                     |
| Test number   | 3                                            |
| Test results  | $\Delta\alpha\leq 0.05\text{dB/km}$          |
|               | No damage to outer jacket and inner elements |

### 4.3 Impact Resistance Test

|               |                                              |
|---------------|----------------------------------------------|
| Test Standard | IEC 60794-1-2 E4                             |
| Impact energy | 1J for 3.1 structure, others: 10J            |
| Radius        | 300mm                                        |
| Impact points | 3                                            |
| Impact number | 1                                            |
| Test result   | $\Delta\alpha\leq 0.05\text{dB/km}$          |
|               | No damage to outer jacket and inner elements |

### 4.4 Torsion/Twist Test

|               |                                     |
|---------------|-------------------------------------|
| Test Standard | IEC 60794-1-2 E7                    |
| Sample length | 2m                                  |
| Angles        | $\pm 180$ degree                    |
| cycles        | 5                                   |
| Test result   | $\Delta\alpha\leq 0.05\text{dB/km}$ |
|               | No damage to cable elements         |

#### 4.5 Bend Test

|                  |                                              |
|------------------|----------------------------------------------|
| Test Standard    | IEC 60794-1-2 E11A                           |
| Mandrel diameter | 20D                                          |
| Turn number      | 4                                            |
| Number of cycles | 3                                            |
| Test result      | $\Delta\alpha \leq 0.05\text{dB/km}$         |
|                  | No damage to outer jacket and inner elements |

#### 4.6 Temperature cycling Test

|                    |                                                 |
|--------------------|-------------------------------------------------|
| Test Standard      | IEC 60794-1-2 F1                                |
| Temperature step   | +20°C → -40°C → +70°C                           |
| Time per each step | 12 hrs                                          |
| Cycles             | 2                                               |
| Test result        | $\Delta\alpha \leq 0.05\text{dB/km}$ after test |

#### 4.7 Water penetration Test

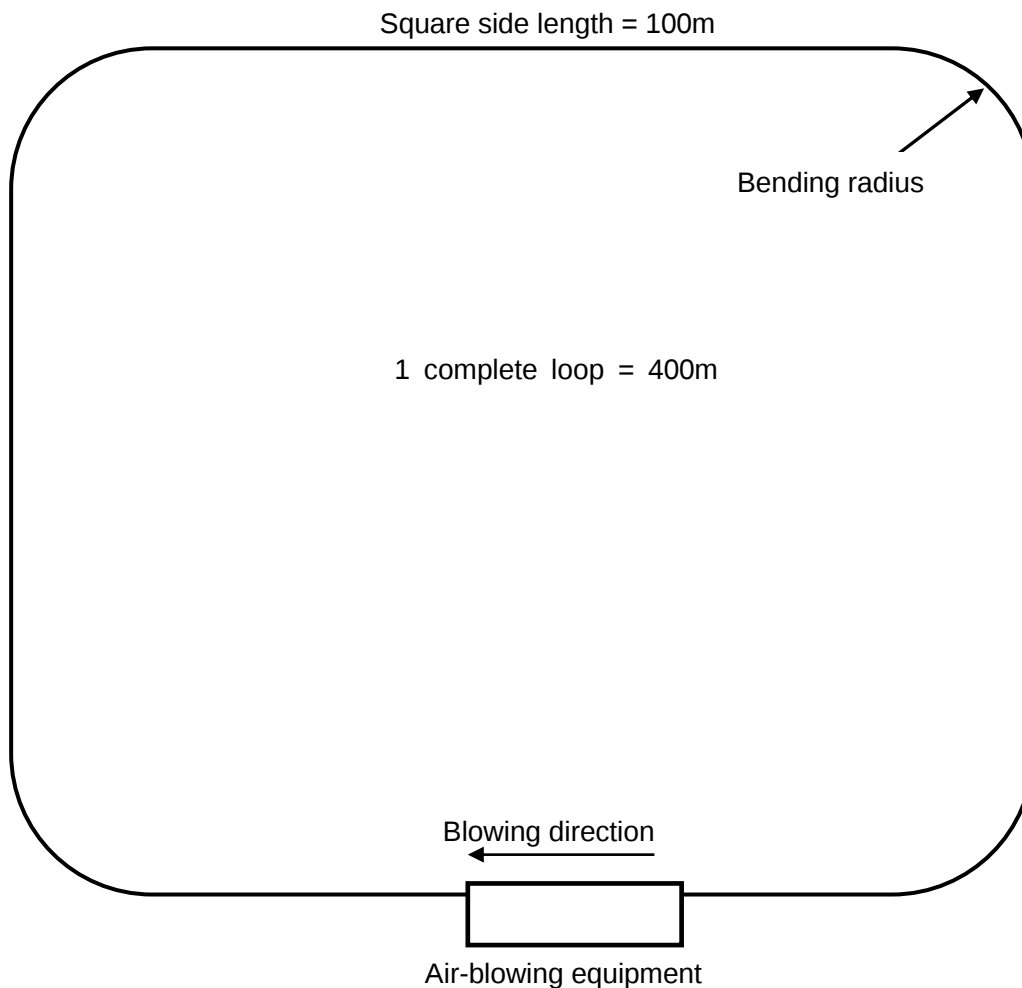
|                        |                                                  |
|------------------------|--------------------------------------------------|
| Test Standard          | IEC 60794-1-2 F5                                 |
| Height of water column | 1m                                               |
| Sample length          | 3m                                               |
| Test time              | 24 hrs                                           |
| Test result            | No water leakage from the opposite of the sample |

#### 4.8 Drip Test

|               |                                           |
|---------------|-------------------------------------------|
| Test Standard | IEC 60794-1-2 E14                         |
| Sample length | 0.3m                                      |
| Temperature   | 70°C                                      |
| Duration      | 24 hrs                                    |
| Test result   | No filling compound shall drip from tubes |

## 5. Air-Blowing Route Program

### 5.1 Air-blowing route



### 5.2 Air-blowing route parameters

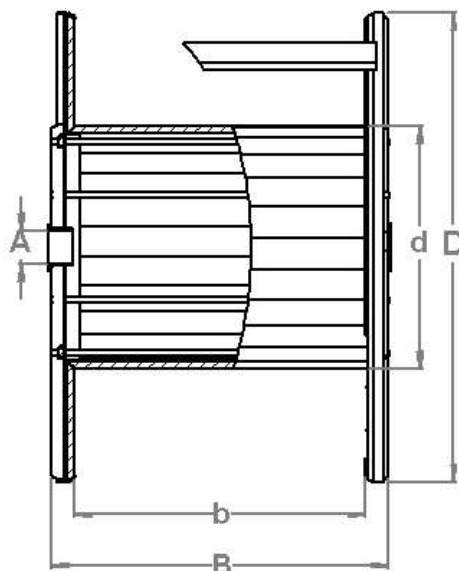
|                             |                                    |               |    |    |    |         |     |
|-----------------------------|------------------------------------|---------------|----|----|----|---------|-----|
| Fiber count                 | 12                                 | 12            | 24 | 48 | 72 | 96      | 144 |
| Standard duct (OD/ID)       | 5/3.5mm                            | 10/8mm        |    |    |    | 14/12mm |     |
| Length of one complete loop | Approx. 400m                       |               |    |    |    |         |     |
| Square side length          | Approx. 100m                       |               |    |    |    |         |     |
| Bending radius              | ≥ 40 x outer diameter of microduct |               |    |    |    |         |     |
| Min accepted blowing speed  | Min 5m/min                         |               |    |    |    |         |     |
| Air pressure                | 15 bar                             |               |    |    |    |         |     |
| Air-blowing distance        | Up to 2km                          | Approx. 1000m |    |    |    |         |     |
| Air-blowing equipment       | CBS                                |               |    |    |    |         |     |

## 6. Packing and Drum

6.1 ZTT cables are coiled on bakelite, wooden or ironwood drum. During transportation, right tools should be used to avoid damaging the package and to handle with ease. Cables should be protected from moisture; kept away from high temperature and fire sparks; protected from over bending and crushing; protected from mechanical stress and damage.



**Wooden Drum**



| ZTT Cable                        | D*d*B cm ( weights kg )<br>D: including seal plate thickness |  |
|----------------------------------|--------------------------------------------------------------|--|
| Type \ Length                    | 4Km/reel                                                     |  |
| OFC-4<br>G.657A1/G.657A2-MD-S1   | Plywood<br>62*40*45(11)                                      |  |
| OFC-8<br>G.657A1/G.657A2-MD-S1   | Plywood<br>62*40*45(15)                                      |  |
| OFC-12<br>G.657A1/G.657A2-MD-S1  | Plywood<br>62*40*45(19)                                      |  |
| OFC-12/24/48/72<br>G.652D-FMD-S1 | Wooden<br>105*60*50(200)                                     |  |
| OFC-96 G.652D-FMD-S1             | Wooden<br>115*60*50(268)                                     |  |
| OFC-144 G.652D-FMD-S1            | Wooden<br>125*70*50(405)                                     |  |

**Note:** The drum size & cable weight as above is estimated and final size & weight shall be confirmed before shipment.

6.2 The color of cable marking is black. (The printing shall be carried out at interval of 1 meter on the outer sheath of cable) The inner end of cable is then sealed with heat shrinkable end cap to prevent ingress of water and is made available for testing. The outer end of cable is equipped with heat shrinkable end cap. Outer sheath marking legend can be changed according to user's requests.

### 6.3 Outdoor cable packing

Bakelite, wooden or ironwood drum

Strong wooden batten protection