



Caledonian

Waterproof

Fire Retardant

Low Smoke and Halogen Free

Fire Resistant

Fiber Optic Cables

www.caledonian-cables.co.uk

www.addison-cables.com

 **ADDISON**

COMPANY PROFILE

Caledonian & Addison, established in 1978, produces a wide range of copper and fiber optic cables for communication, power and electronics in its primary plants in UK, Italy and Spain. To stay in front, we continually keep expanding our manufacturing capabilities in more low cost region such as China, Romania, Taiwan and Malaysia etc. This low-cost manufacturing facilities enables us provide execute a flexible, scalable global system that delivers superior operational performance and optimal results for our customers.

Our extensive global network of manufacturing facilities gives us significant scale and the flexibility to fulfill our customer requirements. This global presence provides design and consultancy solutions that are combined with core cable manufacturing and logistics services, and vertically integrated with our E commerce technologies, to optimize customer operations by lowering costs and reducing time to market.

Caledonian & Addison has been respected for its high standards of quality, excellent service level, competitive pricing and a unique and innovative spirit. With our latest technologies, we are both inspired and well-positioned to meet the changing needs of our customers. We have the resources to diversify and to enhance our product lines and services. We understand the need for change and with our accurate planning we are ready for the future and the promise of new marketing opportunities. Our tradition of growth through excellence is assured.

Our Design Centers work closely with customers to constantly improve its standard range of products and technologies and to develop customized, country and industry-specific solutions. Caledonian has established an extensive network of design, manufacturing, and logistics facilities in the world's major markets to serve the growing outsourcing needs of both multinational and regional customers.



Caledonian

ADDISON



Registration Certificate

**This document certifies that the administration systems of
Caledonian Cables Limited/Addison Technology Limited
Pheonix Works, North Street, Lewes, E. Sussex, BN7 2QJ**

**have been assessed and approved by QAS-International
to the following management systems, standards, and guidelines:**

ISO 9001 : 2000

With the permitted exclusion of clauses 7.3 Design and Development, 7.5.2 Validation of Processes for Production and Service Provision and 7.5.4 Customer Property

The approved administration systems apply to the following:

The manufacture and supply of electrical cables and ancillary power equipment to customers internationally.

| | |
|---------------------|--------------------------------------|
| Original Approval | <u>6th September 1997</u> |
| Current Certificate | <u>7th February 2008</u> |
| Certificate Expiry | <u>7th February 2009</u> |
| Certificate Number | <u>A6211</u> |

On behalf of QAS-International
www.qas-international.com

This certificate remains valid while the holder maintains their administration systems in accordance with the standards and guidelines stated above, which will be audited annually by QAS-International. The holder is entitled to display the above registration mark for the duration of this certificate. This certificate must be returned to QAS-International on reasonable request.

Issuing Office: QAS International Ltd, The Gigg House, Malmesbury, Wilts, SN16 9AX, UK.



◀ **TABLE OF CONTENTS**

| | |
|-------|--|
| 01-03 | TIGHT BUFFER PVC/LSZH JACKETED SIMPLEX / DUPLEX CORD |
| 04-05 | TIGHT BUFFER DISTRIBUTION PVC/LSZH JACKETED CABLE |
| 06-07 | TIGHT BUFFER BREAKOUT PVC/LSZH JACKETED CABLE |
| 08-10 | CENTRAL LOOSE TUBE CABLE |
| 11-14 | MULTI LOOSE TUBE CABLE |
| 15-16 | CENTRAL LOOSE TUBE UNDER WATER CABLE |
| 17-18 | MULTI LOOSE TUBE UNDER WATER CABLE |
| 19-21 | FIG8 SELF-SUPPORTING CABLE |
| 22-24 | CENTRAL LOOSE TUBE RIBBON FIBER CABLE |
| 25-27 | MULTI LOOSE TUBE RIBBON FIBER CABLE |
| 28-29 | ALL DIELECTRIC SELF-SUPPORTING (ADSS) CABLE |
| 30-32 | OVERHEAD POWER GROUND WIRE (OPGW) FIBER CABLE |
| 33-38 | ORDERING INFORMATION |
| 39-44 | ORDERING OPTIONS |
| 45 | OPTICAL & GEOMETRICAL PROPERTIES FOR SINGLE MODE FIBERS |
| 46 | OPTICAL & GEOMETRICAL PROPERTIES FOR MULTIMODE FIBERS |
| 47-49 | TESTING METHOD FOR OPTICAL & GEOMETRICAL PROPERTIES OF FIBER |
| 50 | MECHANICAL & ENVIRONMENTAL PROPERTIES FOR SINGLE MODE FIBER |
| 50 | MECHANICAL & ENVIRONMENTAL PROPERTIES FOR MULTI MODE FIBER |
| 51 | TESTING METHOD FOR MECHANICAL & ENVIRONMENTAL PROPERTIES OF FIBER |

▶ TIGHT BUFFER PVC/LSZH JACKETED SIMPLEX / DUPLEX CORD



▶ Application

This cable is mainly used for interconnecting cable for jumpers, patch cords or pigtails.

▶ Description

Simplex

Simplex cable consists of single tight buffered fiber with aramid yarns as tensile strength members with jacket of either Flame Retardant PVC or LSZH compound. The cable is unconnectorized.

Duplex Flat

Duplex Flat Cable consists of two simplex units. Two simplex cords are placed side by side and jacketed with either Flame Retardant PVC or LSZH compound. The cable is unconnectorized.

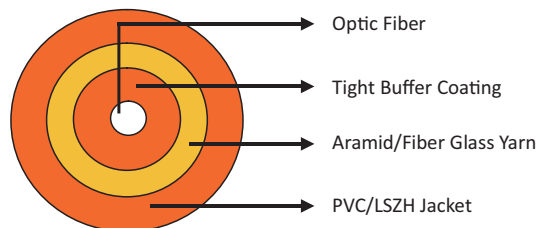
Duplex Round

Duplex Round Cable consists of two single fibers, each with a color-coded PVC tight buffer. They are reinforced with aramid yarn to provide physical and tensile strength. The fibers are jacketed with either Flame Retardant PVC or LSZH compound. The cable is unconnectorized.

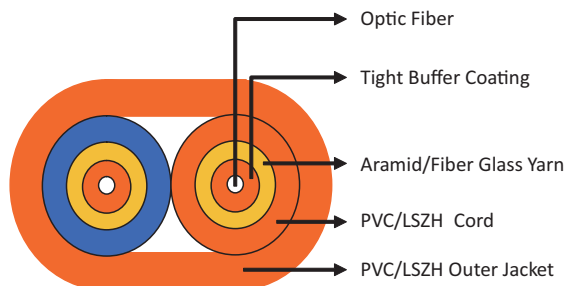
Duplex Zip

Duplex Zipcord Cable consists of two single fibers, each with a color-coded PVC tight buffer. They are reinforced with aramid yarn to provide physical and tensile strength. The fibers have either Flame Retardant PVC or LSZH compound jackets connected by a web to form a “zipcord” construction. The cable is unconnectorized.

▶ Construction



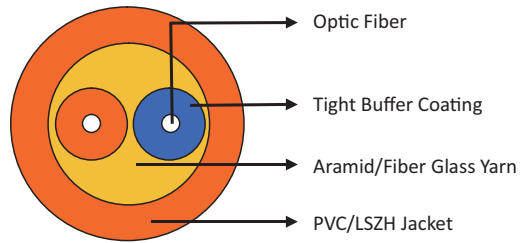
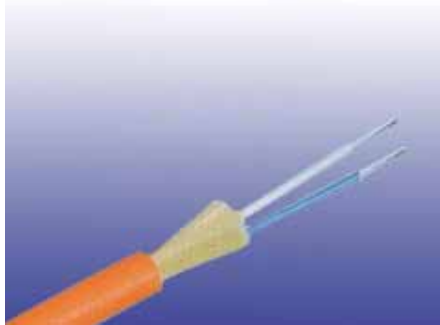
Simplex –PVC/LSZH Cable



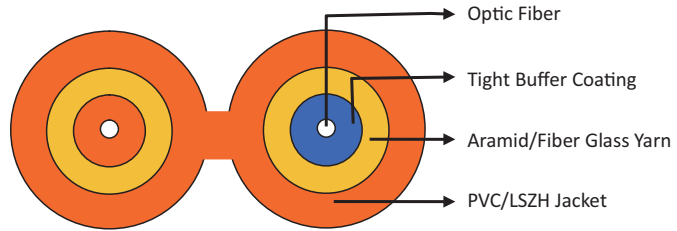
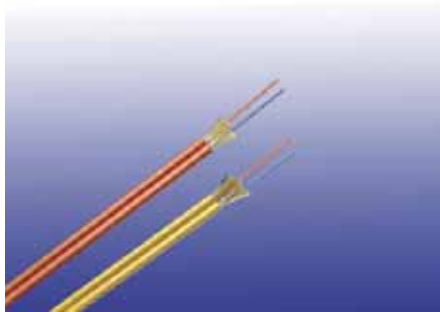
Duplex Flat-PVC/LSZH Cable



TIGHT BUFFER PVC/LSZH JACKETED SIMPLEX / DUPLEX CORD



Duplex Round-PVC/LSZH Cable



Duplex Zip-PVC/LSZH Cable

Physical Properties

| Fiber Count | Cable Type | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling Load | |
|-------------|----------------|------------------------|-------------------------|-----------------------------|-----------------------------|----------------------|-------------------|
| | | | | | | Installation (N/lb) | In Service (N/lb) |
| 1 | Simplex 2.0mm | 7.6 | 5.10 | 2.0 | 0.079 | 490/110 | 290/65 |
| 1 | Simplex 2.5mm | 7.8 | 5.23 | 2.5 | 0.098 | 490/110 | 290/65 |
| 1 | Simplex 2.8mm | 8.0 | 5.37 | 2.8 | 0.110 | 490/110 | 290/65 |
| 1 | Simplex 3.0 mm | 8.2 | 5.50 | 3.0 | 0.118 | 490/110 | 290/65 |
| 2 | Duplex Flat | 28.0 | 18.79 | 4.0×6.8 | 0.157×0.267 | 980/220 | 580/130 |
| 2 | Duplex Round | 18.4 | 12.35 | 4.2 | 0.165 | 980/220 | 580/130 |
| 2 | Duplex Zip | 15.0 | 10.07 | 2.4×4.8 | 0.094×0.188 | 980/220 | 580/130 |

▶ TIGHT BUFFER PVC/LSZH JACKETED SIMPLEX / DUPLEX CORD



▶ Mechanical Properties

| | | |
|--------------------------------|-------------------------------|---|
| Minimum Bending Radius: | | Maximum Compressive Load: 2000N |
| Under installation: | 20×OD | Repeated Impact: 2.9 N.m (J) 3×2 impacts |
| During operation: | 10×OD | Twist (Torsion): 180×10 times, 125×OD |
| Temperature Range: | | Cyclic Flexing: 25 cycles for armoured cables.; 100 cycles for unarmoured cables. |
| Operating Temperature Range: | -40°C(-40°F) to +70°C(+158°F) | Crush Resistance: 875N/cm (500lb/in) |
| Storage Temperature Range: | -50°C(-58°F) to +70°C(+158°F) | |

▶ Fiber Compliance

| | | | |
|----------------------------|------------------|-------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 | Repeated Bending | IEC60794-1-2-E6 |
| Tensile Strength | IEC60794-1-2-E1A | Torsion | IEC60794-1-2-E7 |
| Crush | IEC60794-1-2-E3 | Kink | IEC60794-1-2-E10 |
| Impact | IEC60794-1-2-E4 | Cable Bend | IEC60794-1-2-E11 |
| | | Cool Bend | IEC60794-1-2-E11 |

▶ Safety Compliance

| | |
|------------------------------|---|
| General Purpose Grade | Flammability Test: OFN (UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6 (UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 Flammability Test: IEC60332-1 & IEC 60332-3C/A |
| FR Grade | Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

▶ Standard Compliance

| | | |
|------------|----------------|---------------|
| GR409-CORE | TIA/EIA 568B.3 | ICEA-S-83-596 |
|------------|----------------|---------------|

▶ Features

- Suitable for indoor use, such as routing connections in patching systems
- Short "patch cord" cables ideal for links between electronic equipment and fiber panels
- Compatible with wide variety of fiber optic connectors
- High quality tight-buffer coating on fiber for environmental and mechanical protection
- Customized jacket colors available for matching connectors.
- Private labeling on the cable outer jacket is also available.



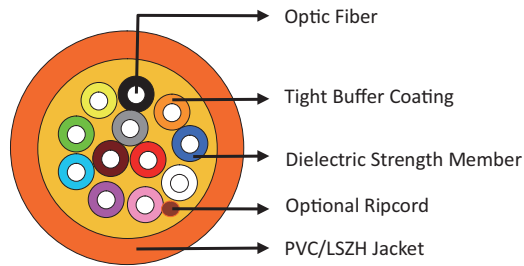
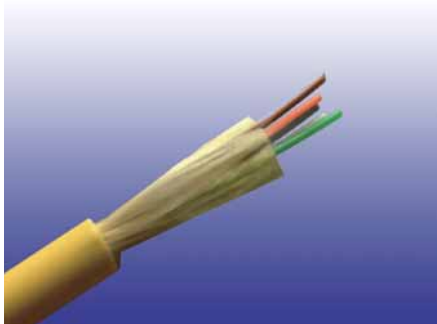
TIGHT BUFFER DISTRIBUTION PVC/LSZH JACKETED CABLE

► Application

This cable is used for interconnection of the distribution boxes and end devices. The cable is very suitable for various indoor and outdoor applications, including routing between buildings within ducts and inside building up to riser shafts.

► Description

The Distribution Cable consists of color-coded PVC tight buffered fibers. The fibers are reinforced with aramid yarn for superior strength and contains no metallic elements. The fibers are jacketed with Flame Retardant PVC or LSZH compound.



► Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|----------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-6 | 26.0 | 17.45 | 5.0 | 0.197 | 1000/225 | 290/65 |
| 8-12 | 50.0 | 33.56 | 7.5 | 0.296 | 1425/320 | 500/112 |
| 14-24 | 140.0 | 93.96 | 13.0 | 0.512 | 2670/600 | 890/200 |
| 26-36 | 200.0 | 134.23 | 16.5 | 0.650 | 4448/1000 | 1490/335 |
| 38-48 | 300.0 | 201.34 | 18.0 | 0.709 | 4448/1000 | 1490/335 |

► Mechanical Properties

Minimum Bending Radius:

Under installation: 20 × OD
 During operation: 10 × OD

Temperature Range:

Operating Temperature Range: -40°C (-40°F) to +70°C (+158°F)
 Storage Temperature Range: -50°C (-58°F) to +70°C (+158°F)

Maximum Compressive Load: 2000N

Repeated Impact: 2.9 N.m (J) 3 × 2 impacts

Twist (Torsion): 180 × 10 times, 125 × OD

Cyclic Flexing: 25 cycles for armoured cables.;
 100 cycles for unarmoured cables.

Crush Resistance: 1485N/cm (850lb/in)

▶ TIGHT BUFFER DISTRIBUTION PVC/LSZH JACKETED CABLE



▶ Fiber Compliance

| | |
|---------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 |
| Tensile Strength | IEC60794-1-2-E1A |
| Crush | IEC60794-1-2-E3 |
| Impact | IEC60794-1-2-E4 |
| Repeated Bending | IEC60794-1-2-E6 |
| Torsion | IEC60794-1-2-E7 |
| Kink | IEC60794-1-2-E10 |
| Cable Bend | IEC60794-1-2-E11 |
| Cool Bend | IEC60794-1-2-E11 |

▶ Safety Compliance

| | |
|-----------------------|---|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 Flammability Test: IEC60332-1 & IEC 60332-3C/A |
| FR Grade | Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

▶ Standard Compliance

| | | |
|------------|----------------|---------------|
| GR409-CORE | TIA/EIA 568B.3 | ICEA-S-83-596 |
|------------|----------------|---------------|

▶ Features

- Used in LAN and distribution applications where compact size and lightweight are required
- Suitable for both indoor and outdoor use - no need for splicing at the building entrance
- Flame-retardant or LSZH version for indoor installations
- Fungus-resistant, water-resistant, and UV-resistant for outdoor installations
- Cable can be armoured for additional protection in direct burial and aerial installations
- Highest specific strength-to-weight ratio for limited conduit space
- Economical for longer distance runs where cable cost is significant
- High quality tight-buffered coating on fiber for environmental and mechanical protection



TIGHT BUFFER DISTRIBUTION PVC/LSZH JACKETED CABLE

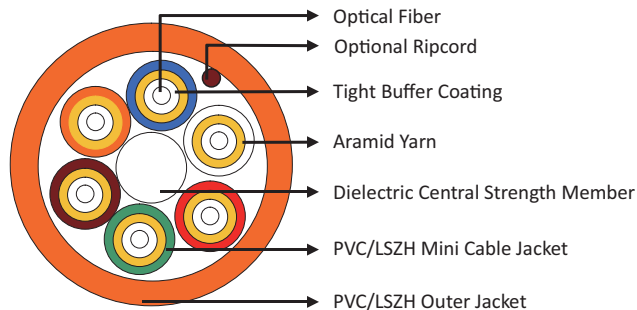
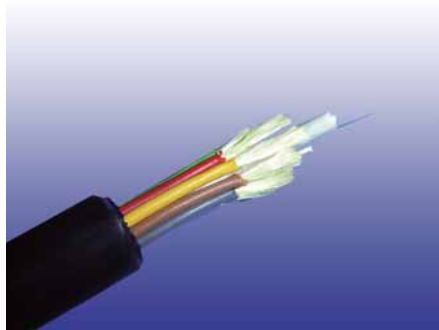
► Application

Breakout Cable is designed for routing to different locations and direct termination of fibers in the field. The cable is mostly suitable for pre-terminated cable assemblies.

► Description

The cable contains 2 to 36 fibers which are individually buffered tight or semi-tight construction. Each fiber is individually protected in a mini cable. Aramid yarn will be applied either inside the mini cable or within the inner jacket of the cable. The color coded mini cable may be stranded around a central strength member which can be either FRP or flexible all-dielectric. Outer Jacket may be PVC or LSZH.

► Construction



► Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|----------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2 | 50.0 | 33.56 | 5.5 | 0.217 | 1200/270 | 490/110 |
| 6 | 110.0 | 73.83 | 12.5 | 0.493 | 2000/450 | 800/180 |
| 12 | 160.0 | 107.38 | 13.0 | 0.512 | 3515/790 | 1200/270 |
| 24 | 230.0 | 154.36 | 15.5 | 0.611 | 5470/1230 | 2000/450 |

► Mechanical Properties

Minimum Bending Radius:

Under installation: 20×OD
 During operation: 10×OD for unarmoured cables
 20×OD for armoured cables

Maximum Compressive Load: 3000N for unarmoured

5000N for armoured

Repeated Impact: 2.9 N.m (J) 3×2 impacts

Twist (Torsion): 180×10 times, 125×OD

Temperature Range:

Operating Temperature Range: -40°C(-40°F) to +70°C(+158°F)

Storage Temperature Range: -50°C(-58°F) to +70°C(+158°F)

Cyclic Flexing: 25 cycles for armoured cables.

100 cycles for unarmoured cables.

Crush Resistance: 1750N/cm (1000lb/in)

▶ TIGHT BUFFER DISTRIBUTION PVC/LSZH JACKETED CABLE

▶ Fiber Compliance

| | |
|---------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 |
| Tensile Strength | IEC60794-1-2-E1A |
| Crush | IEC60794-1-2-E3 |
| Impact | IEC60794-1-2-E4 |
| Repeated Bending | IEC60794-1-2-E6 |
| Torsion | IEC60794-1-2-E7 |
| Kink | IEC60794-1-2-E10 |
| Cable Bend | IEC60794-1-2-E11 |
| Cool Bend | IEC60794-1-2-E11 |

▶ Safety Compliance

| | |
|-----------------------|---|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 Flammability Test: IEC60332-1 & IEC 60332-3C/A |
| FR Grade | Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

▶ Standard Compliance

| | | |
|-------------|----------------|---------------|
| GR-409-CORE | TIA/EIA 568B.3 | ICEA-S-83-596 |
|-------------|----------------|---------------|

▶ Features

- Most rugged and "user friendly" cable design for Local Area Networks
- For installations where ease of termination and termination costs are important factors
- Short and moderate distance links between buildings or within a building, where multiple termination points are needed
- Breakout cables are designed for direct termination with standard connectors
- Cable ideal for direct pulling with wire mesh grips
- Suitable for both indoor and outdoor use -- no need to for splicing at the building entrance
- Flame-retardant or LSZH version for indoor installations
- Fungus-resistant, water-resistant, and UV-resistant for outdoor use
- High quality tight-buffered coating on each fiber for environmental and mechanical protection





CENTRAL LOOSE TUBE CABLE

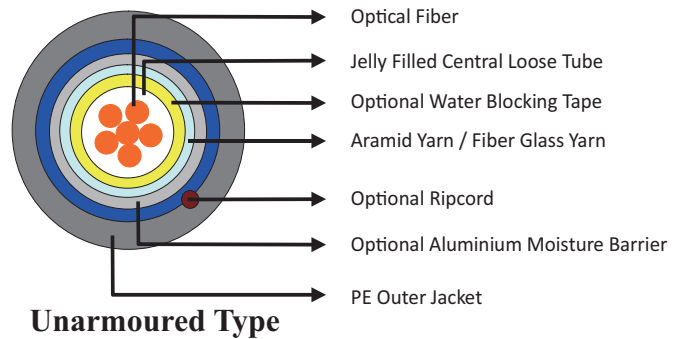
► Application

This cable is characterized by light weight and small diameter, suitable for both aerial and duct installation. The cable can also be used for direct burial for armoured option.

► Description

Central loose tube cable contains one tube with 2 - 24 fibers, which is filled with water blocking gel. Either aramid yarn or fiber glass is wound around the tube to provide physical protection and tensile strength. The cable can be jacketed with either PE or LSZH. PE is the preferred option in outdoor environment for water protection purpose. For direct burial, either steel wire armour or corrugated steel tape armour is applied with an optional inner jacket of either PVC, PE or LSZH. An Aluminium moisture tape can be incorporated under the jacket for water blocking and shielding purpose. A ripcord is located under the jacket to facilitate jacket removal.

► Construction

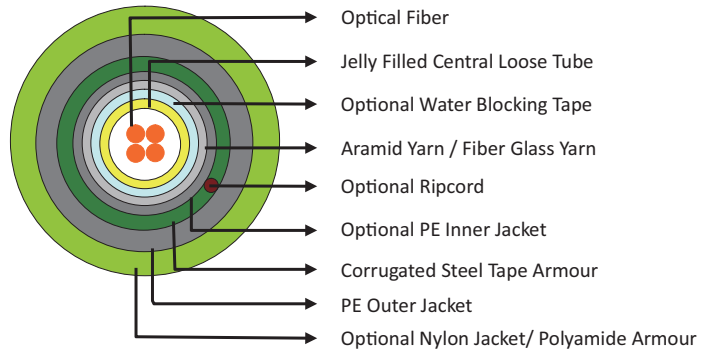


► Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-12 | 60.0 | 40.27 | 7.5 | 0.296 | 1500/337 | 445/100 |
| 14-24 | 65.0 | 43.62 | 8.5 | 0.335 | 1500/337 | 445/100 |

▶ CENTRAL LOOSE TUBE CABLE

▶ Construction

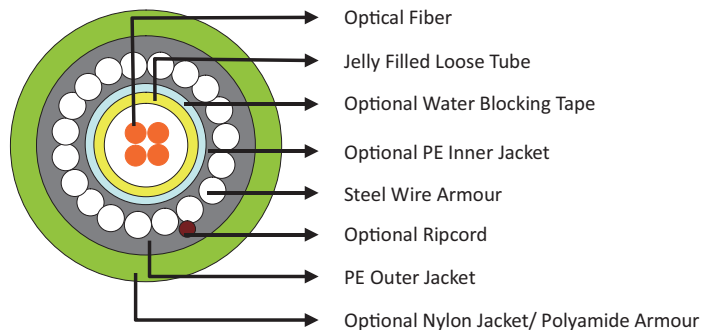


Corrugated Steel Tape Armoured Type

▶ Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-12 | 125.0 | 83.89 | 10.5 | 0.414 | 2670/600 | 890/200 |
| 14-24 | 145.0 | 97.32 | 12.0 | 0.473 | 2670/600 | 890/200 |

▶ Construction



Steel Wire Armoured Type

▶ Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-12 | 170.0 | 114.09 | 10.5 | 0.414 | 8000/1800 | 2650/595 |
| 14-24 | 245.0 | 164.43 | 12.0 | 0.473 | 8000/1800 | 2650/595 |





CENTRAL LOOSE TUBE CABLE

► Mechanical Properties

| | | |
|--------------------------------|--|--|
| Minimum Bending Radius: | | Maximum Compressive Load: 3000N |
| Under installation: | 20×OD | Repeated Impact: 4.4 N.m (J) |
| During operation: | 10×OD for unarmoured cables; 20×OD for armoured cables. | Twist (Torsion): 180×10 times, 125×OD |
| Temperature Range: | | Cyclic Flexing: 25 cycles for armoured cables; 100 cycles for unarmoured cables. |
| Operating Temperature Range: | -40°C(-40°F) to +70°C(+158°F) | Crush Resistance: 263N/cm (150lb/in) |
| Storage Temperature Range: | -50°C(-58°F) to +70°C(+158°F) | |

► Fiber Compliance

| | |
|----------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 |
| Tensile Strength | IEC60794-1-2-E1A |
| Crush | IEC60794-1-2-E3 |
| Impact | IEC60794-1-2-E4 |
| Repeated Bending | IEC60794-1-2-E6 |
| Torsion | IEC60794-1-2-E7 |
| Kink | IEC60794-1-2-E10 |
| Cable Bend | IEC60794-1-2-E11 |
| Cool Bend | IEC60794-1-2-E11 |

► Safety Compliance

| | |
|------------------------------|---|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 Flammability Test: IEC60332-1 & IEC 60332-3C/A |
| FR Grade | Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

► Standard Compliance

| | | |
|-----------------|--------------------------------|---------------|
| Telcordia GR-20 | RUS 7 CFR 1755.900 (REA PE-90) | ICEA S 87-640 |
|-----------------|--------------------------------|---------------|

► Features

- Loose Tube construction provides environmental protection
- Loose tube jelly filled for superior fiber protection
- Colored coded fibers and binders for quick and easy identification during installation.
- Very lightweight and flexible design allows for easy installation
- UV or moisture resistant for outdoor application
- Compact design with small cable diameter
- All Dielectric strength member
- Anti-termite and rodent protection as options
- Optional Aluminium moisture barrier for EMI protection

▶ MULTI LOOSE TUBE CABLE

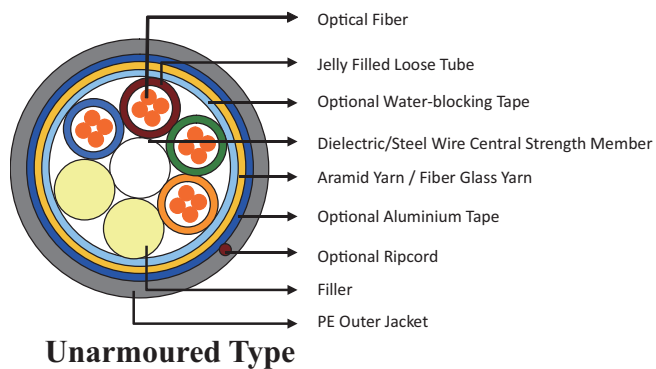
▶ Application

The multi loose tube non metallic cable is designed for outside plant, which is prone to electrical interference.

▶ Description

The cable consists of 5 to 36 fibers containing tubes or fillers stranded in up to 3 layers around a central strength member and bound under a PE jacket. Each tube contains 4 -12 fibers. Solid or stranded steel wire coated with polyethylene is usually used as central strength member. Fiber glass reinforced plastics (FRP) will be used as central strength member if non metallic construction is required. Either aramid yarn or fiber glass is wound around the tube to provide physical protection and tensile strength. The cable can be jacketed with either PE, PVC or LSZH though PE is the preferred option for water protection purpose. For direct burial, steel wire armour or corrugated steel tape armour is applied with an optional inner jacket of either PVC or PE. An Aluminium moisture tape can be incorporated under the jacket for water blocking and shielding purpose. A ripcord is located under the jacket to facilitate jacket removal.

▶ Construction



▶ Physical Properties

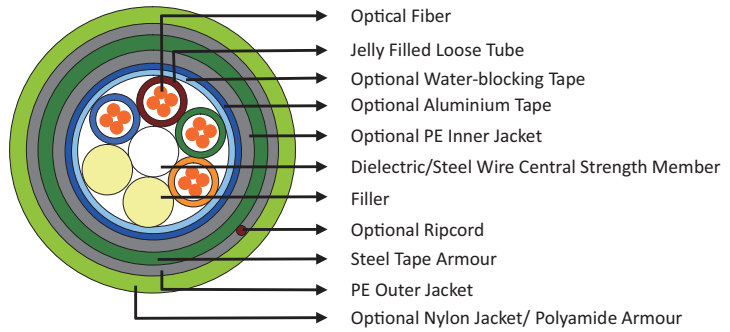
| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-36 | 110.0 | 73.83 | 12.0 | 0.472 | 2670/600 | 800/180 |
| 38-72 | 120.0 | 80.54 | 12.6 | 0.496 | 2670/600 | 800/180 |
| 74-84 | 135.0 | 90.60 | 13.5 | 0.531 | 2670/600 | 800/180 |
| 76-96 | 150.0 | 100.67 | 14.0 | 0.551 | 2670/600 | 800/180 |
| 98-108 | 170.0 | 114.09 | 15.0 | 0.590 | 2670/600 | 800/180 |
| 110-120 | 190.0 | 127.52 | 15.5 | 0.610 | 2670/600 | 800/180 |
| 122-132 | 210.0 | 140.94 | 16.5 | 0.649 | 2670/600 | 800/180 |
| 134-144 | 230.0 | 154.36 | 17.5 | 0.688 | 2670/600 | 800/180 |
| 146-216 | 250.0 | 167.79 | 18.0 | 0.708 | 2670/600 | 800/180 |
| 218-264 | 300.0 | 201.34 | 19.5 | 0.767 | 2670/600 | 800/180 |
| 266-312 | 350.0 | 234.90 | 21.0 | 0.826 | 2670/600 | 800/180 |
| 314-360 | 400.0 | 268.46 | 22.5 | 0.885 | 2670/600 | 800/180 |





MULTI LOOSE TUBE CABLE

Construction



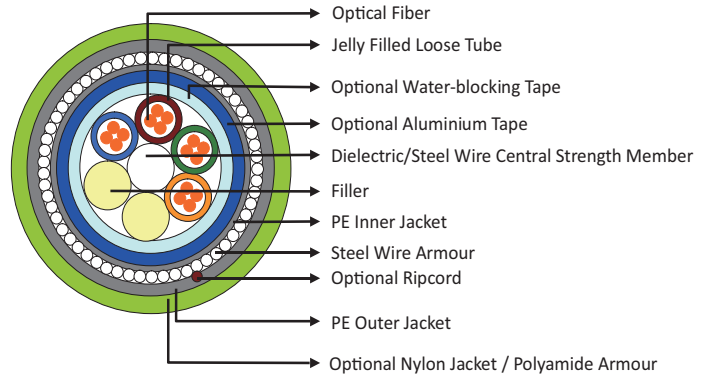
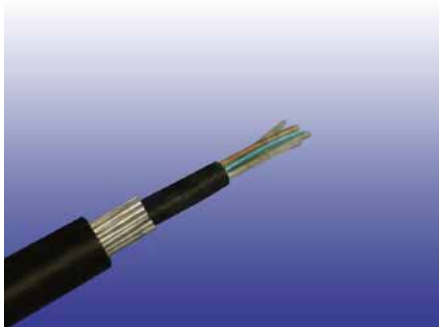
Corrugated Steel Tape Armoured Type

Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-36 | 210.0 | 140.94 | 15.0 | 0.590 | 2670/600 | 800/180 |
| 38-72 | 230.0 | 154.36 | 15.5 | 0.610 | 2670/600 | 800/180 |
| 74-84 | 250.0 | 167.79 | 16.5 | 0.649 | 2670/600 | 800/180 |
| 76-96 | 270.0 | 181.21 | 17.0 | 0.669 | 2670/600 | 800/180 |
| 98-108 | 295.0 | 197.98 | 17.5 | 0.688 | 2670/600 | 800/180 |
| 110-120 | 320.0 | 214.77 | 18.5 | 0.728 | 2670/600 | 800/180 |
| 122-132 | 355.0 | 238.26 | 19.0 | 0.748 | 2670/600 | 800/180 |
| 134-144 | 370.0 | 248.32 | 20.0 | 0.787 | 2670/600 | 800/180 |
| 146-216 | 390.0 | 261.74 | 21.0 | 0.826 | 2670/600 | 800/180 |
| 218-264 | 455.0 | 305.37 | 22.5 | 0.885 | 2670/600 | 800/180 |
| 266-312 | 515.0 | 345.64 | 24.0 | 0.944 | 2670/600 | 800/180 |
| 314-360 | 580.0 | 389.26 | 26.0 | 1.023 | 2670/600 | 800/180 |

MULTI LOOSE TUBE CABLE

Construction



Steel Wire Armoured Type

Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-36 | 700.0 | 469.80 | 21.0 | 0.826 | 8000/1800 | 2650/595 |
| 38-72 | 830.0 | 557.05 | 23.5 | 0.925 | 8000/1800 | 2650/595 |
| 74-84 | 870.0 | 583.89 | 24.0 | 0.944 | 8000/1800 | 2650/595 |
| 76-96 | 900.0 | 604.03 | 24.5 | 0.964 | 8000/1800 | 2650/595 |
| 98-108 | 950.0 | 637.58 | 26.0 | 1.023 | 8000/1800 | 2650/595 |
| 110-120 | 1000.0 | 671.14 | 27.0 | 1.062 | 8000/1800 | 2650/595 |
| 122-132 | 1050.0 | 704.70 | 28.0 | 1.102 | 8000/1800 | 2650/595 |
| 134-144 | 1100.0 | 738.26 | 29.0 | 1.141 | 8000/1800 | 2650/595 |
| 146-216 | 1300.0 | 872.48 | 31.0 | 1.220 | 8000/1800 | 2650/595 |
| 218-264 | 1400.0 | 939.60 | 33.0 | 1.299 | 8000/1800 | 2650/595 |
| 266-312 | 1500.0 | 1006.71 | 35.0 | 1.377 | 8000/1800 | 2650/595 |
| 314-360 | 1600.0 | 1073.83 | 37.0 | 1.456 | 8000/1800 | 2650/595 |





MULTI LOOSE TUBE CABLE

► Mechanical Properties

| | | |
|--------------------------------|-------------------------------|---|
| Minimum Bending Radius: | | Maximum Compressive Load: 4000N for unarmoured cables; |
| Under installation: | 20×OD | 6000N for armoured cables |
| During operation: | 10×OD for unarmoured cables; | Repeated Impact: 4.4 N.m (J) |
| | 20×OD for armoured cables. | Twist (Torsion): 180×10 times, 125×OD |
| Temperature Range: | | Cyclic Flexing: 25 cycles for armoured cables.; |
| Operating Temperature Range: | -40°C(-40°F) to +70°C(+158°F) | 100 cycles for unarmoured cables. |
| Storage Temperature Range: | -50°C(-58°F) to +70°C(+158°F) | Crush Resistance: 220N/cm(125lb/in) |

► Fiber Compliance

| | |
|----------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 |
| Tensile Strength | IEC60794-1-2-E1A |
| Crush | IEC60794-1-2-E3 |
| Impact | IEC60794-1-2-E4 |
| Repeated Bending | IEC60794-1-2-E6 |
| Torsion | IEC60794-1-2-E7 |
| Kink | IEC60794-1-2-E10 |
| Cable Bend | IEC60794-1-2-E11 |
| Cool Bend | IEC60794-1-2-E11 |

► Safety Compliance

| | |
|------------------------------|---|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| FR Grade | Flammability Test: IEC60332-1 & IEC 60332-3C/A Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

► Standard Compliance

| | | |
|-----------------|--------------------------------|---------------|
| Telcordia GR-20 | RUS 7 CFR 1755.900 (REA PE-90) | ICEA S 87-640 |
|-----------------|--------------------------------|---------------|

► Features

- Loose Tube construction provides environmental protection
- Loose tube jelly filled for superior fiber protection
- Colored coded fibers and binders for quick and easy identification during installation.
- UV resistant for outdoor application
- Dry water blocking core design for ease of handling
- Anti-termite and rodent protection as options
- Optional Aluminium moisture barrier for EMI protection and water protection

▶ CENTRAL LOOSE TUBE UNDER WATER CABLE

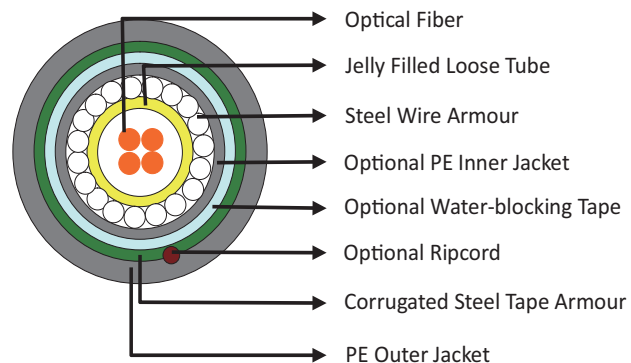
▶ Application

This cable exhibits excellent tensile strength and side press retardancy, having excellent mechanical and environmental performance. Featured by its thin diameter and light weight, it is best suited for underwater condition, junction communication system and long haul communication system.

▶ Description

Central loose tube cable contains one tube with 2 - 24 fibers, which is filled with water blocking gel. A water swelling tape is helically wrapped around the cable core. Either aramid yarn or fiber glass is wound around the tube to provide physical protection and tensile strength. The cable is jacketed with PE for water protection purpose. For direct burial, steel wire armour and corrugated steel tape armour are applied with an optional PE inner jacket. An optional Aluminium moisture tape can be incorporated under the jacket for water blocking and shielding purpose. An optional ripcord can be put under the jacket to facilitate jacket removal.

▶ Construction



▶ Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-12 | 352.0 | 236.24 | 14.0 | 0.553 | 8000/1800 | 2650/595 |





CENTRAL LOOSE TUBE UNDER WATER CABLE

► Mechanical Properties

| | | |
|--------------------------------|-------------------------------|--|
| Minimum Bending Radius: | | Maximum Compressive Load: 3000N |
| Under installation: | 20×OD | Repeated Impact: 4.4 N.m (J) |
| During operation: | 10×OD for unarmoured cables; | Twist (Torsion): 180×10 times, 125×OD |
| | 20×OD for armoured cables. | Cyclic Flexing: 25 cycles for armoured cables.; 100cycles for unarmoured cables. |
| Temperature Range: | | Crush Resistance: 263N/cm(150lb/in) |
| Operating Temperature Range: | -40°C(-40°F) to +70°C(+158°F) | |
| Storage Temperature Range: | -50°C(-58°F) to +70°C(+158°F) | |

► Fiber Compliance

| | |
|----------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 |
| Tensile Strength | IEC60794-1-2-E1A |
| Crush | IEC60794-1-2-E3 |
| Impact | IEC60794-1-2-E4 |
| Repeated Bending | IEC60794-1-2-E6 |
| Torsion | IEC60794-1-2-E7 |
| Kink | IEC60794-1-2-E10 |
| Cable Bend | IEC60794-1-2-E11 |
| Cool Bend | IEC60794-1-2-E11 |

► Safety Compliance

| | |
|------------------------------|---|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 Flammability Test: IEC60332-1 & IEC 60332-3C/A |
| FR Grade | Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

► Standard Compliance

| | | |
|-----------------|--------------------------------|---------------|
| Telcordia GR-20 | RUS 7 CFR 1755.900 (REA PE-90) | ICEA S 87-640 |
|-----------------|--------------------------------|---------------|

► Features

- Loose tube jelly filled for superior fiber protection
- Colored coded fibers and binders for quick and easy identification during installation.
- High tensile strength design
- Superior mechanical and environmental performance
- Rugged and lightweight design
- Durable construction to withstand high water pressure
- Sufficient waterproof to withstand water penetration

▶ MULTI LOOSE TUBE UNDER WATER CABLE

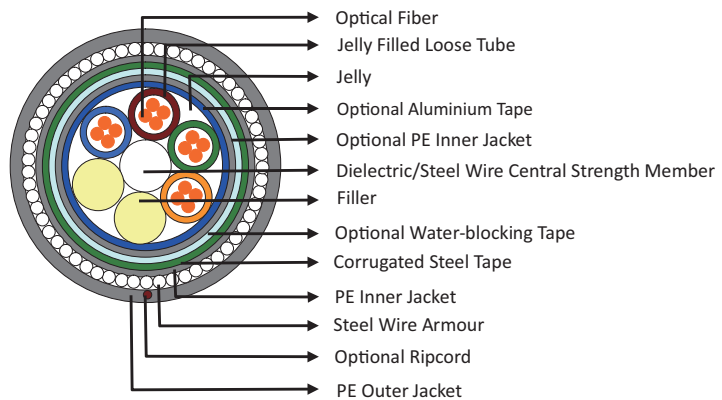
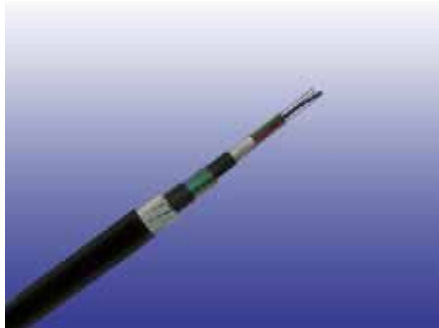
▶ Application

This cable exhibits excellent tensile strength and side press retardancy, having excellent mechanical and environmental performance. Featured by its thin diameter and light weight, it is best suited for underwater condition, junction communication system and long haul communication system.

▶ Description

The cable consists of 5 to 36 fibers containing tubes or fillers stranded in up to 3 layers around a central strength member and bound under a PE jacket. Each tube contains 4 -12 fibers. Solid or stranded steel wire coated with polyethylene is usually used as central strength member. Fiber glass reinforced plastics (FRP) will be used as central strength member if non metallic construction is required. Either aramid yarn or fiber glass is wound around the tube to provide physical protection and tensile strength. The cable incorporates the first layer of PE inner jacket, a layer of corrugated steel tape armour, the second layer of PE inner jacket, a layer of steel wire armour and PE outer jacket. An optional Aluminium moisture tape can be incorporated under the jacket for water blocking and shielding purpose. An optional ripcord is located under the jacket to facilitate jacket removal.

▶ Construction



▶ Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|-------------------|
| | | | | | Installation (N/lb) | In Service (N/lb) |
| 2-24 | 650.0 | 436.24 | 20.3 | 0.798 | 8000/1800 | 2650/595 |
| 26-36 | 716.0 | 480.54 | 21.6 | 0.849 | 8000/1800 | 2650/595 |
| 38-72 | 1008.0 | 676.51 | 25.2 | 0.991 | 8000/1800 | 2650/595 |





MULTI LOOSE TUBE UNDER WATER CABLE

► Mechanical Properties

| | | |
|--------------------------------|-------------------------------|---|
| Minimum Bending Radius: | | Maximum Compressive Load: 4000N for unarmoured cables; |
| Under installation: | 20×OD | 6000N for armoured cables |
| During operation: | 0×OD for unarmoured cables; | Repeated Impact: 4.4 N.m (J) |
| | 20×OD for armoured cables. | Twist (Torsion): 180×10 times, 125×OD |
| Temperature Range: | | Cyclic Flexing: 25 cycles for armoured cables.; |
| Operating Temperature Range: | -40°C(-40°F) to +70°C(+158°F) | 100 cycles for unarmoured cables. |
| Storage Temperature Range: | -50°C(-58°F) to +70°C(+158°F) | Crush Resistance: 220N/cm(125lb/in) |

► Fiber Compliance

| | | | |
|----------------------------|------------------|-------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 | Repeated Bending | IEC60794-1-2-E6 |
| Tensile Strength | IEC60794-1-2-E1A | Torsion | IEC60794-1-2-E7 |
| Crush | IEC60794-1-2-E3 | Kink | IEC60794-1-2-E10 |
| Impact | IEC60794-1-2-E4 | Cable Bend | IEC60794-1-2-E11 |
| | | Cool Bend | IEC60794-1-2-E11 |

► Safety Compliance

| | |
|------------------------------|--|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 |
| | Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 |
| | Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| | Flammability Test: IEC60332-1 & IEC 60332-3C/A |
| FR Grade | Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

► Standard Compliance

| | | |
|-----------------|--------------------------------|---------------|
| Telcordia GR-20 | RUS 7 CFR 1755.900 (REA PE-90) | ICEA S 87-640 |
|-----------------|--------------------------------|---------------|

► Features

- Loose tube jelly filled for superior fiber protection
- Colored coded fibers and binders for quick and easy identification during installation.
- High tensile strength design
- Superior mechanical and environmental performance
- Rugged and lightweight design
- Durable construction to withstand high water pressure
- Sufficient waterproof to withstand water penetration

► FIG8 SELF-SUPPORTING CABLE

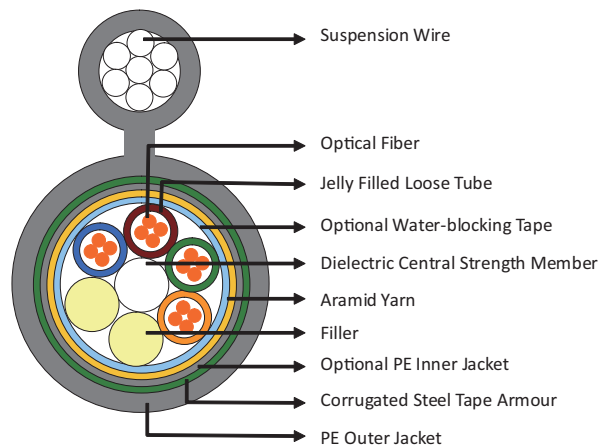
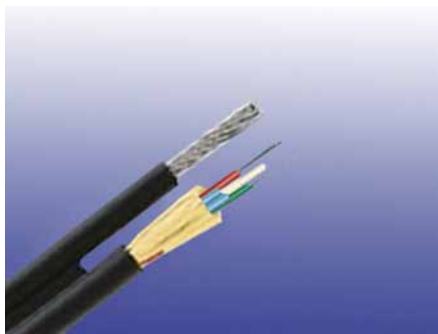
► Application

This cable is ideal for in long distance and interoffice communication in strong current zone, as well as power transmission system. The built in suspension stranded rope provides high tensile strength, enabling the cable suited for large span installation, resulting in time and installation cost savings. The suspension wire, being an integral part of the cable, is easily available for gripping, fastening and pulling. This cable is featured of its lightness, low dispersion and high tensile strength.

► Description

The cable consists of 5 to 36 fibers containing tubes or fillers stranded in up to 3 layers around a central strength member and bound under a PE jacket. Each jelly filled tube contains 4 -12 fibers. Solid or stranded steel wire coated with polyethylene is usually used as central strength member. Fiber glass reinforced plastics (FRP) will be used as central strength member if non metallic construction is required. Either aramid yarn or fiber glass is wound around the tube to provide physical protection and tensile strength. Water blocking materials are filled in the interstice of the cable core, core wrapping layer/water blocking tape. The cable can be jacketed with either PE, PVC or LSZH though PE is the preferred option for water protection purpose. For direct burial, steel wire armour or corrugated steel tape armour is applied with an optional inner jacket of either PVC or PE. An optional Aluminium moisture tape can be incorporated under the jacket for water blocking and shielding purpose. Cable cores are connected with the suspension wires by PE sheath to form a figure “8” shape. An optional ripcord is located under the jacket to facilitate jacket removal.

► Construction



Armoured Type

► Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|------------------|
| | | | | | Installation (N/lb) | Operating (N/lb) |
| 2-24 | 389.0 | 261.07 | 12.6*25.1 | 0.50*0.99 | 2670/600 | 890/200 |
| 36-72 | 429.0 | 287.92 | 14.7*27.1 | 0.58*1.07 | 2670/600 | 890/200 |
| 96-144 | 571.0 | 383.22 | 20.2*32.6 | 0.80*1.29 | 2670/600 | 890/200 |



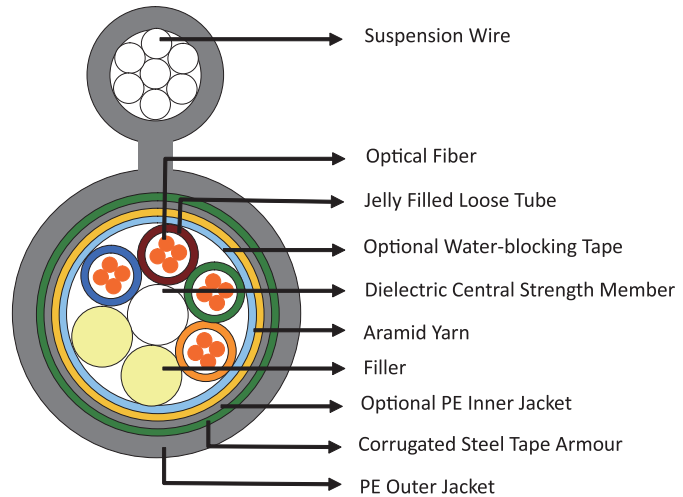
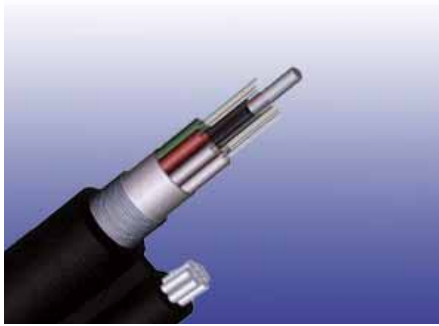


FIG8 SELF-SUPPORTING CABLE

Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|------------------|
| | | | | | Installation (N/lb) | Operating (N/lb) |
| 2-24 | 303.0 | 203.36 | 9.1*21.5 | 0.36*0.85 | 2670/600 | 890/200 |
| 36-72 | 332.0 | 222.82 | 11.1*23.5 | 0.44*0.93 | 2670/600 | 890/200 |
| 96-144 | 417.0 | 279.87 | 15.9*28.3 | 0.63*1.12 | 2670/600 | 890/200 |

Construction



Armoured Type

Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|------------------|
| | | | | | Installation (N/lb) | Operating (N/lb) |
| 2-24 | 389.0 | 261.07 | 12.6*25.1 | 0.50*0.99 | 2670/600 | 890/200 |
| 36-72 | 429.0 | 287.92 | 14.7*27.1 | 0.58*1.07 | 2670/600 | 890/200 |
| 96-144 | 571.0 | 383.22 | 20.2*32.6 | 0.80*1.29 | 2670/600 | 890/200 |

▶ FIG8 SELF-SUPPORTING CABLE



▶ Mechanical Properties

| | | | |
|--------------------------------|---|--------------------------|-----------------------------------|
| Minimum Bending Radius: | Maximum Compressive Load: 4000N for unarmoured cables; | | |
| Under installation: | 20×OD | | 6000N for armoured cables |
| During operation: | 10×OD for unarmoured cables; | Repeated Impact: | 4.4 N.m (J) |
| | 20×OD for armoured cables. | Twist (Torsion): | 180×10 times, 125×OD |
| Temperature Range: | | Cyclic Flexing: | 25 cycles for armoured cables.; |
| Operating Temperature Range: | -40°C (-40°F) to +70°C (+158°F) | | 100 cycles for unarmoured cables. |
| Storage Temperature Range: | -50°C (-58°F) to +50°C (+158°F) | Crush Resistance: | 220N/cm (125lb/in) |

▶ Fiber Compliance

| | | | |
|----------------------------|------------------|-------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 | Repeated Bending | IEC60794-1-2-E6 |
| Tensile Strength | IEC60794-1-2-E1A | Torsion | IEC60794-1-2-E7 |
| Crush | IEC60794-1-2-E3 | Kink | IEC60794-1-2-E10 |
| Impact | IEC60794-1-2-E4 | Cable Bend | IEC60794-1-2-E11 |
| | | Cool Bend | IEC60794-1-2-E11 |

▶ Safety Compliance

| | |
|------------------------------|--|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 |
| | Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 |
| | Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| | Flammability Test: IEC60332-1 & IEC 60332-3C/A |
| FR Grade | Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

▶ Standard Compliances

| | | |
|-----------------|--------------------------------|---------------|
| Telcordia GR-20 | RUS 7 CFR 1755.900 (REA PE-90) | ICEA S 87-640 |
|-----------------|--------------------------------|---------------|

▶ Features

- Suitable for self supporting aerial, duct and direct burial installation
- Tear away messenger simplifies grounding
- Ripcord allows easy cable entry and jacket removal
- Compatible with existing Fig 8 hardware
- Flexible buffer tube simplifies routing and splicing.
- Loose tube jelly filled for superior fiber protection
- UV or moisture resistant for outdoor application



CENTRAL LOOSE TUBE RIBBON FIBER CABLE

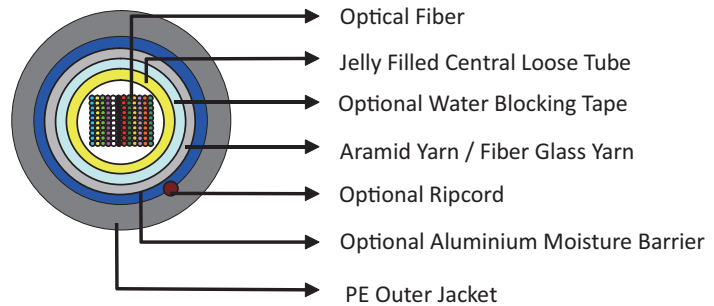
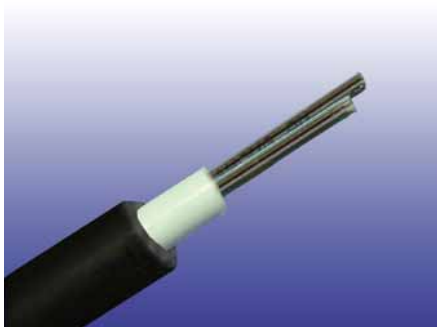
► Application

This cable can provide excellent transmission performance and protection of fibers in a variety of field environments. It is usually used in long haul communication system, subscriber network system, distribution, feeder network system and local area network system.

► Description

Central loose tube cable contains one tube with 12 fiber ribbons, which is filled with water blocking gel. The fiber ribbon can be easily separated by hand tool. Either aramid yarn or fiber glass is wound around the tube to provide physical protection and tensile strength. The cable can be jacketed with either PE, PVC or LSZH though PE is the preferred option for water protection purpose. For direct burial, steel wire armour or corrugated steel tape armour is applied with an optional inner jacket of either PVC or PE. An optional Aluminium moisture tape can be incorporated under the jacket for water blocking and shielding purpose. An optional ripcord can be put under the jacket to facilitate jacket removal.

► Construction



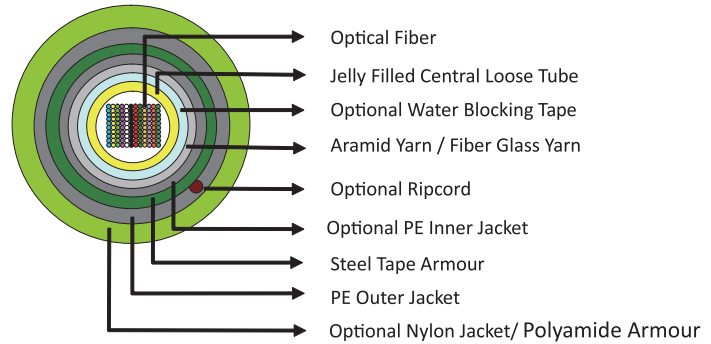
Unarmoured Type

► Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|------------------|
| | | | | | Installation (N/lb) | Operating (N/lb) |
| 12-96 | 166.0 | 111.41 | 16.2 | 0.637 | 2670/600 | 890/200 |
| 108-144 | 208.0 | 139.60 | 18.5 | 0.727 | 2670/600 | 890/200 |
| 156-216 | 244.0 | 163.76 | 20.5 | 0.806 | 2670/600 | 890/200 |

▶ CENTRAL LOOSE TUBE RIBBON FIBER CABLE

▶ Construction



Armoured Type

▶ Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|------------------------------|------------------|
| | | | | Installation (N/lb) | Operating (N/lb) |
| 12-96 | 233.0 | 156.38 | 14.8 | 2670/600 | 890/200 |
| 108-144 | 276.0 | 185.23 | 16.1 | 2670/600 | 890/200 |
| 156-216 | 316.0 | 212.08 | 17.1 | 2670/600 | 890/200 |

▶ Mechanical Properties

Minimum Bending Radius:

Under installation: 20×OD
 During operation: 10×OD for unarmoured cables
 20×OD for armoured cables.

Temperature Range:

Operating Temperature Range: -40°C(-40°F) to +70°C(+158°F)
 Storage Temperature Range: -50°C(-58°F) to +70°C(+158°F)

Maximum Compressive Load:3000N

Repeated Impact: 4.4 N.m (J)
Twist (Torsion): 180×10 times, 125×OD
Cyclic Flexing: 25 cycles for armoured cables.;
 100 cycles for unarmoured cables.

Crush Resistance: 263N/cm(150lb/in)





CENTRAL LOOSE TUBE RIBBON FIBER CABLE

► Fiber Compliance

| | |
|---------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 |
| Tensile Strength | IEC60794-1-2-E1A |
| Crush | IEC60794-1-2-E3 |
| Impact | IEC60794-1-2-E4 |
| Repeated Bending | IEC60794-1-2-E6 |
| Torsion | IEC60794-1-2-E7 |
| Kink | IEC60794-1-2-E10 |
| Cable Bend | IEC60794-1-2-E11 |
| Cool Bend | IEC60794-1-2-E11 |

► Safety Compliance

| | |
|-----------------------|---|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 Flammability Test: IEC60332-1 & IEC 60332-3C/A |
| FR Grade | Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

► Compliance

| | | |
|-----------------|--------------------------------|---------------|
| Telcordia GR-20 | RUS 7 CFR 1755.900 (REA PE-90) | ICEA S 87-640 |
|-----------------|--------------------------------|---------------|

► Features

- Large fiber counts with small cable diameter
- Highly adaptable to mass splicing
- Suitable for installation in pipeline
- High quality jelly filled loose tube provides the ribbon fiber satisfactory mechanical and environmental protection.
- Ripcord allows easy jacket removal
- UV or moisture resistant for outdoor application
- Dry water blocking core design for ease of handling

▶ MULTI LOOSE TUBE RIBBON FIBER CABLE

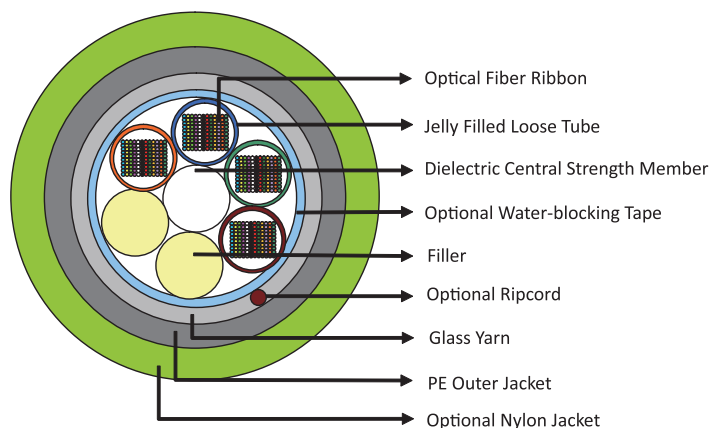
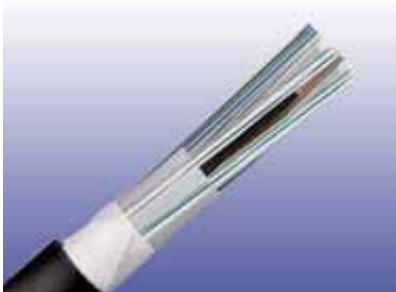
▶ Application

This cable can provide excellent transmission performance and protection of fibers in a variety of field environments. It is usually used in long haul communication system, subscriber network system, distribution, feeder network system and local area network system.

▶ Description

The cable consists of 12 to 648 fibers containing tubes or fillers stranded in up to 3 layers around a central strength member and bound under a PE jacket. Each tube contains 4 -12 ribbon fibers. Solid or stranded steel wire coated with polyethylene is usually used as central strength member. Fiber glass reinforced plastics (FRP) will be used as central strength member if non metallic construction is required. Either aramid yarn or fiber glass is wound around the tube to provide physical protection and tensile strength. The cable can be jacketed with either PE, PVC or LSZH though PE is the preferred option for water protection purpose. For direct burial, steel wire armour or corrugated steel tape armour is applied with an optional inner jacket of either PVC or PE. An optional Aluminium moisture tape can be incorporated under the jacket for water blocking and shielding purpose. An optional ripcord is located under the jacket to facilitate jacket removal.

▶ Construction



Unarmoured Type



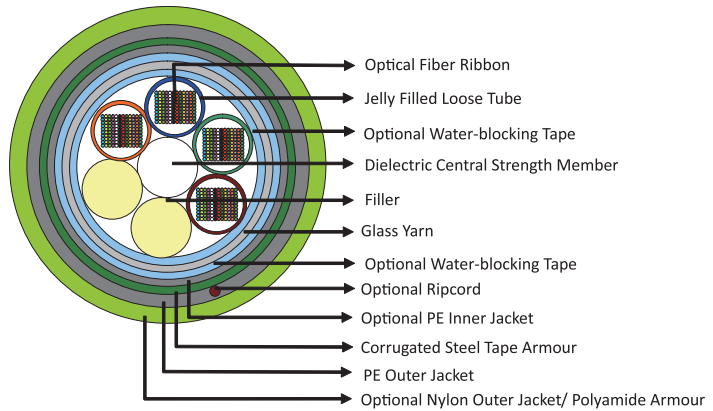


MULTI LOOSE TUBE RIBBON FIBER CABLE

Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|------------------|
| | | | | | Installation (N/lb) | Operating (N/lb) |
| 12-96 | 195.0 | 130.87 | 18.5 | 0.727 | 2670/600 | 890/200 |
| 108-288 | 320.0 | 214.77 | 22.0 | 0.865 | 2670/600 | 890/200 |
| 288-648 | 400.0 | 268.46 | 24.5 | 0.963 | 2670/600 | 890/200 |

Construction



Armoured Type

Physical Properties

| Fiber Count | Nominal Weight (kg/km) | Nominal Weight (lb/kft) | Nominal Outer Diameter (mm) | Nominal Outer Diameter (in) | Maximum Pulling/Tensile Load | |
|-------------|------------------------|-------------------------|-----------------------------|-----------------------------|------------------------------|------------------|
| | | | | | Installation (N/lb) | Operating (N/lb) |
| 12-96 | 280.0 | 187.92 | 22.5 | 0.885 | 2670/600 | 890/200 |
| 108-288 | 400.0 | 268.46 | 25.0 | 0.983 | 2670/600 | 890/200 |
| 288-648 | 500.0 | 335.57 | 29.0 | 1.141 | 2670/600 | 890/200 |

MULTI LOOSE TUBE RIBBON FIBER CABLE



Mechanical Properties

| | |
|--|---|
| Minimum Bending Radius: | Maximum Compressive Load: 4000N for unarmoured cables; |
| Under installation: 20×OD | 6000N for armoured cables |
| During operation: 10×OD for unarmoured cables; | Repeated Impact: 4.4 N.m (J) |
| 20×OD for armoured cables | Twist (Torsion): 180×10 times, 125×OD |
| Temperature Range: | Cyclic Flexing: 25 cycles for armoured cables.; |
| Operating Temperature Range: -40°C(-40°F) to +70°C(+158°F) | 100 cycles for unarmoured cables. |
| Storage Temperature Range: -50°C(-58°F) to +70°C(+158°F) | Crush Resistance: 220N/cm(125lb/in) |

Fiber Compliance

| | |
|----------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 |
| Tensile Strength | IEC60794-1-2-E1A |
| Crush | IEC60794-1-2-E3 |
| Impact | IEC60794-1-2-E4 |
| Repeated Bending | IEC60794-1-2-E6 |
| Torsion | IEC60794-1-2-E7 |
| Kink | IEC60794-1-2-E10 |
| Cable Bend | IEC60794-1-2-E11 |
| Cool Bend | IEC60794-1-2-E11 |

Safety Compliance

| | |
|------------------------------|---|
| General Purpose Grade | Flammability Test: OFN(UL1581) |
| Riser Grade | Flammability Test: OFNR/FT4 (UL1666) |
| Plenum Grade | Flammability Test: OFNP/FT6(UL 910) |
| FRPVC Grade | Flammability Test: IEC60332-1 |
| LSZH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| LSFROH Grade | Halogen Content Test: IEC 60754-1 Acidity Test: IEC 60754; Smoke Emission Test: IEC61034-1/2 |
| FR Grade | Flammability Test: IEC60332-1 & IEC 60332-3C/A Fire Resistance Test: IEC 60331 / BS 6387 CWZ |

Standard Compliance

| | | |
|-----------------|--------------------------------|--------------|
| Telcordia GR-20 | RUS 7 CFR 1755.900 (REA PE-90) | CEA S 87-640 |
|-----------------|--------------------------------|--------------|

Features

- Large fiber counts with small cable diameter
- Highly adaptable to mass splicing
- Suitable for installation in pipeline
- High quality jelly filled loose tube provides the ribbon fiber satisfactory mechanical and environmental protection.
- Ripcord allows easy jacket removal
- UV or moisture resistant for outdoor application
- Dry water blocking core design for ease of handling



ALL DIELECTRIC SELF-SUPPORTING (ADSS) CABLE

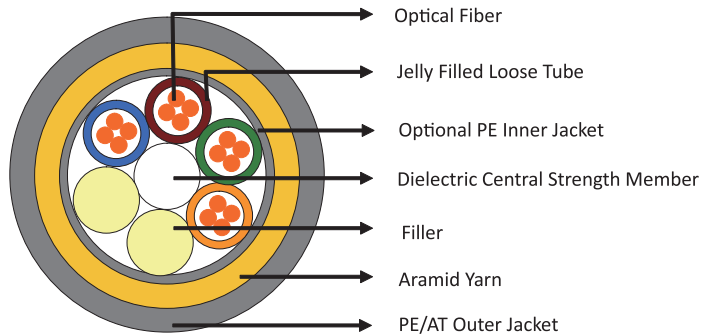
► Application

The “All Dielectric Self-supporting (ADSS)” cable is designed for aerial self supporting application at short, medium and long span distances. ADSS cable offers a rapid and economical means for deployment by cable television operators, telephone companies and power utilities. It is adopted for high voltage, middle, small span conditions in Power Transmission System or mazy terrain such as river spanning, mountains.

► Description

The cable consists of 5 to 36 fibers containing tubes or fillers stranded in up to 3 layers around a central strength member and bound under a PE jacket. Each tube contains 6 -12 fibers. All the fibers in the cores are filled with water blocking gel. Fillers may be used to preserve the cable geometry. A water swelling tape is helically wrapped around the cable core. Aramid yarns are helically laid to supply peripheral strengthening of the cable. The outer jacket is tightly bounded over the aramid yarn layer. The cable jacket incorporates an optional inner polyethylene jacket and an outer polyethylene or AT (anti-tracking) jacket. When the induction on cable surface is above 12KV, anti-tracking sheath material (AT) will be applied. With AT outer jacket, the maximum electric field strength at operating point can reach 35KV. For long span application, a double jacket design can be considered. An optional ripcord can be put under the jacket layer to facilitate its removal.

► Construction



► Physical Properties

| Span (m) | Ice + Wind: 0mm + 35m/sec | | | | Ice + Wind: 12mm + 30m/sec | | | |
|----------|---------------------------|-------------------------------|-----------------------------|--------------|----------------------------|-------------------------------|-----------------------------|--------------|
| | Cable O.D. (mm/in) | Cable Weight (kg/km)/(lb/kft) | Max. Working Tension (N/lb) | Max. Sag (%) | Cable O.D. (mm/in) | Cable Weight (kg/km)/(lb/kft) | Max. Working Tension (N/lb) | Max. Sag (%) |
| 100 | 13.9/0.5472 | 152/102.01 | 7578/1704 | 2 | 13.8/0.543 | 150.0/100.67 | 6621/1489 | 2 |
| 200 | 14.3/0.562 | 161/108.05 | 10430/2346 | 3 | 14.1/0.555 | 157.0/105.37 | 9000/2024 | 3 |
| 400 | 15.9/0.625 | 199/133.56 | 23221/5223 | 3 | 15.4/0.606 | 187.0/125.50 | 19255/4331 | 3 |
| 500 | 16.7/0.657 | 220/147.65 | 30590/6881 | 3 | 16.1/0.633 | 204.0/136.91 | 24885/5598 | 3 |
| 600 | 16.3/0.641 | 209/140.27 | 26952/6063 | 4 | 15.7/0.618 | 196.0/131.54 | 22154/4983 | 4 |
| 800 | 16.5/0.649 | 216/144.97 | 29452/6625 | 5 | 15.9/0.625 | 201.0/134.90 | 24042/5408 | 6 |
| 1000 | 16.7/0.657 | 221/148.32 | 31271/7034 | 6 | 16.1/0.633 | 204.0/136.91 | 24407/5490 | 6 |

* Above table do not cover all of available types. Other ADSS cables can be manufactured upon customer's request according to different span and sag environment.

▶ ALL DIELECTRIC SELF-SUPPORTING (ADSS) CABLE



▶ Mechanical Properties

| | | |
|------------------------------|---|--|
| Minimum Bend Radius: | | Maximum Compressive Load: 4000N |
| Under installation: | 20×OD | Repeated Impact: 4.4 N.m (J) |
| During operation: | 10×OD for unarmoured cables; 20×OD for armoured cables | Twist (Torsion): 180×10 times, 125×OD |
| Temperature Range: | | Cyclic Flexing: 100 cycles . |
| Operating Temperature Range: | -40°C(-40°F) to +70°C(+158°F) | Crush Resistance: 220N/cm(125lb/in) |
| Storage Temperature Range: | -50°C(-58°F) to +70°C(+158°F) | |

▶ Fiber Compliance

| | |
|----------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 |
| Tensile Strength | IEC60794-1-2-E1A |
| Crush | IEC60794-1-2-E3 |
| Impact | IEC60794-1-2-E4 |
| Repeated Bending | IEC60794-1-2-E6 |
| Torsion | IEC60794-1-2-E7 |
| Kink | IEC60794-1-2-E10 |
| Cable Bend | IEC60794-1-2-E11 |
| Cool Bend | IEC60794-1-2-E11 |

▶ Standard Compliance

| | | | |
|-----------------|--------------------------------|---------------|-----------|
| Telcordia GR-20 | RUS 7 CFR 1755.900 (REA PE-90) | ICEA S 87-640 | IEEE 1222 |
|-----------------|--------------------------------|---------------|-----------|

▶ Features

- High capacity cable offer great flexibility for placement on overhead transmission towers, eliminating the need for a support messenger.
- Dry core design and high tension strength capability suitable for toughest environmental and electrical conditions.
- Fit for extra high voltage power lines without interruption of power service to the customers.
- Typical spans with 1%-1.5% installation sag



Overhead Power Ground Wire (OPGW) FIBER CABLE

► Application

OPGW is a dual functioning cable performing the duties of a ground wire and also providing a path for the transmission of voice, video or data signals . The fibers are protected from environmental conditions (lightning, short circuit, loading) to ensure reliability and longevity. The cable is designed to be installed on transmission and distribution lines to carry voice, data and video communications, especially in lighting waveform monitoring system, an observation system for overhead test line, maintenance data information system, power line protection system, power line operation system, and unmanned substation monitoring.

► Description

OPGW cable has two constructions:

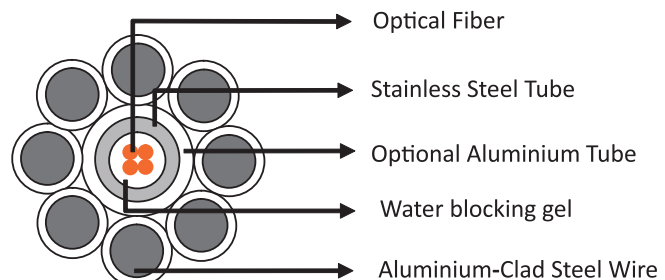
Central loose tube type---The fibers is placed loosely in a sealed and water resistant stainless steel tube filled with water blocking gel. This tube provides protection to the fibers during installation and operation under severe environmental conditions. Aluminium layer over the tube is optional. The stainless optical tube is located at the center of the cable protected by single or multiple layers of aluminium clad steel and aluminium alloy wires. The Aluminium-clad steel wires are shaped trapezoidally around the optical unit to provide compact construction. The metallic wires provide mechanical strength to withstand severe installation and operating conditions, while achieving conductivity to control temperature rise during short circuit conditions.

This type can accommodate up to 48 fibers in a cable. Despite such a high fiber count in a single tube, each optical fiber is clearly distinguishable utilizing a fiber identification system consisting of coloring and the number of ring marks on it. This compact design features high mechanical strength and fault current rating within a smaller diameter. The smaller diameter also results in excellent sag tension performance.

Multi loose tube type--- The fibers is placed loosely in a sealed and water resistant stainless steel tube filled with water blocking gel. Two or three stainless steel optical tubes are helically stranded in the inner layer of a multiple-layer cable.

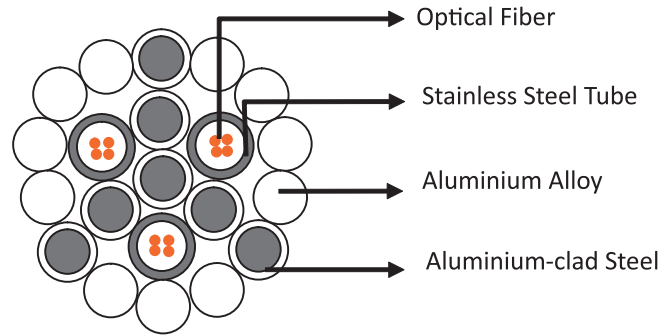
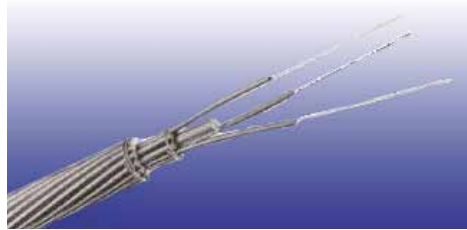
The multi loose tube type is designed mostly for very high fiber count requirement over 48 with the maximum fiber count reaching 144. The multi loose tube type can meet the requirement of huge cross and large current capacity.

► Construction



Central Loose Tube Type

► Overhead Power Ground Wire (OPGW) FIBER CABLE



Multi Loose Tube Type

► Physical Properties

| Cable section (mm ²) | Nominal Outer Diameter (mm/in) | Nominal Weight (kg/km)/(lb/kft) | Max working tension (kN) | Modulus of elasticity (kN/mm ²) | Heat expansion coefficient (10 ⁻⁶ /°C) | DC Resistance (Ω/km) | Short-circuit current capacity (kA ² s) |
|----------------------------------|--------------------------------|---------------------------------|--------------------------|---|---|----------------------|--|
| 35 | 8.1/0.318 | 250/167.79 | 45.2 | 162.0 | 13.0 | 2.433 | 8.9 |
| 50 | 9.6/0.378 | 343/230.20 | 63.0 | 162.0 | 13.0 | 1.743 | 16.5 |
| 70 | 11.4/0.448 | 487/326.85 | 89.3 | 162.0 | 13.0 | 1.237 | 3.04 |
| 90 | 12.5/0.492 | 368/246.98 | 58.2 | 94.1 | 17.3 | 0.473 | 72.7 |
| 105 | 13.5/0.531 | 428/287.25 | 67.9 | 94.1 | 17.3 | 0.403 | 98.8 |
| 130 | 15.0/0.590 | 527/353.69 | 83.8 | 94.1 | 17.3 | 0.329 | 149.9 |

- * The effective sectional area of the single-layer design ranges from 50mm² to 83mm², suitable for rated voltages of 66kV, 115kV, 150kV, 250kV and 275kV.
- * The effective sectional area of the double-layer design ranges from 90mm² to 200mm², suitable for rated voltages of 150kV, 250kV, 275kV, 380kV and 500kV.
- * The effective sectional area of the three-layer design ranges from 200mm² to 400mm², suitable for rated voltages of 380kV, 420kV and 500kV in European markets.





Overhead Power Ground Wire (OPGW) FIBER CABLE

► Mechanical Properties

| | | |
|------------------------------|-------------------------------|---|
| Minimum Bend Radius: | | Maximum Compressive Load: 4000N for unarmoured cables; |
| Under installation: | 20×OD | 6000N for armoured cables |
| During operation: | 10×OD for unarmoured cables | Repeated Impact: 4.4 N.m (J) |
| | 20×OD for armoured cables. | Twist (Torsion): 180×10 times, 125×OD |
| Temperature Range: | | Cyclic Flexing: 25 cycles for armoured cables.; |
| Operating Temperature Range: | -40°C(-40°F) to +70°C(+158°F) | 100 cycles for unarmoured cables. |
| Storage Temperature Range: | -50°C(-58°F) to +70°C(+158°F) | Crush Resistance: 220N/cm (125lb/in) |

► Fiber Compliance

| | | | |
|----------------------------|------------------|-------------------------|------------------|
| Temperature Cycling | IEC60794-1-2-F2 | Repeated Bending | IEC60794-1-2-E6 |
| Tensile Strength | IEC60794-1-2-E1A | Torsion | IEC60794-1-2-E7 |
| Crush | IEC60794-1-2-E3 | Kink | IEC60794-1-2-E10 |
| Impact | IEC60794-1-2-E4 | Cable Bend | IEC60794-1-2-E11 |
| | | Cool Bend | IEC60794-1-2-E11 |

► Standard Compliance

IEEE 1138-1994

► Features

- Colored coded fibers and binders for quick and easy identification during installation.
- Compact design results in excellent sag tension performance of the cable
- Aluminium-clad steel wires and Aluminium alloy wires provides mechanical strength to withstand the installation and operating conditions, while achieving conductivity required to control temperature rise, during the short circuit fault condition
- Optical unit placed inside the Aluminium tube provides exceptional mechanical and thermal protection for the fiber against severe environments and external lateral force.
- Thick walled Aluminium tubes provide hermetic seal for optical units, providing excellent crush resistance and low resistivity.
- Unique design has maximum allowable tension to control fiber strain
- Stranded wires used for optimizing the mechanical and electrical properties of the cables
- High load, long span capability.

► Ordering Information

► Central Member Options

| | | |
|--------------|--------------------------------|---|
| Blank | No central strength member | |
| S | Solid steel | Solid steel is used as an anti bucking element in the cable for providing very high tensile strength in outdoor cables where the cable has to be pulled or blown into ducts. The steel is hot rolled with anticorrosion treatment, Steel is chosen when extreme cold temperature performance is required since it exhibits good temperature stability. |
| SR | Stranded steel | Stranded steel is used as an anti bucking element for providing both flexibility and high strength. |
| F | Fiber reinforced plastic (FRP) | FRP Rods combine the high performance properties of glass reinforcements with unique resin formulation to produce a strong and cost effective non-metallic cable strength member. The dielectric nature of glass fibers renders them immune to electromagnetic interference and lightning. In addition to being dielectric, FRP has high young modulus and exhibits high tensile strength and low weight. FRP is used when all dielectric construction is required. |
| A | Aramid yarn | High strength aramid yarn strength member ensures tension resistance and long term stability. Aramid yarn is a dielectric with high modulus and low specific weight. It is mostly employed as a central strength member for indoor tight buffered cables. |

► Inner Jacket Options

| | | |
|--------------|------------------------------------|--|
| Blank | No inner jacket | |
| 2Y | Polyethylene (PE) | PE is used mostly for outdoor applications. PE sheath acts as a moisture barrier as well as a protection to the core. PE will not crack or become brittle at low temperatures and will retain its mechanical properties and stability at high temperatures. PE is very resistant to water, chemical and solvents and thus used as sheath for outdoor installation. PE can be UV resistant if carbon black additive is added. It will exhibit extremely good aging properties and high UV and weather resistance. |
| Y | Polyvinyl Chloride (PVC) | PVC is mostly used mostly for indoor applications. It is most widely used because of its good mechanical and electrical properties combined with cheap cost. The PVC material may include special carbon black additives for being UV and weather resistant. |
| Yu | Fire retardant PVC (FRPVC) | Fire retardant PVC will not allow fire to propagate along the cable when ignited. Fire retardant PVC jacketed cables will usually meet the flammability requirements of UL 1581(VW-1) and IEC 60332-1. With special design, the cables can meet IEC 60332-3A/C or UL 1666 (OFNR riser grade or UL 910 (OFNP plenum grade). |
| H | Low smoke and Halogen-free, (LSZH) | LSZH material is used mostly for indoor applications. When exposed to fire it will retard fire propagation while emitting non toxic corrosive halogen gases (halogen free as per IEC 60754-1 and IEC 60754-2) and low amounts of smoke emission as per IEC 61034-2. LSZH cables can usually meet the flammability requirement of UL 1581(VW-1) and IEC 60332-1. With special design, the cables can meet IEC 60332-3A/C. |





Ordering Information

Strength Member Options

| | | |
|-----------|---------------------------------|---|
| G | Fiber Glass yarn | Fiber glass is a dielectric with high compressive strength high modulus and light weight. It is characterized by its great abrasion resistance. Fiber glass yarn is usually used in a form of thin fiber bundles or roving. Compared to aramid yarn, fiber glass yarn is much easier to cut. Fiber glass yarn has similar impact resistance as steel. |
| A | Aramid yarn | Aramid yarn is a dielectric with high strength, high modulus and light weight. Aramid yarn is usually produced in its natural yellow color. Because of its toughness, aramid yarn is difficult to cut and requires a high quality scissor dedicated for cutting aramid. Aramid yarn is 5 times stronger than steel. |
| AG | Fiber Glass yarn + Aramid yarn | The weakest aspect of aramid yarn is its compressive strength and that is one of the strong points of fiberglass yarn. Putting the two together combines the tensile strength, toughness, and light weight of aramid yarn with the compressive strength and rigidity of fiberglass yarn. |
| FG | Fire Resisting Fiber Glass yarn | Fiber glass is characterized by its hazard proof and soft nature. Special fiber glass yarn can be used as both a strength member and fire barrier for meeting IEC 60331 |

Armour Options

| | | |
|--------------|--|--|
| Blank | No armouring | |
| T | Corrugated steel tape armour | Steel tape is corrugated to enhance the flexibility of the cable. Steel tape armour is used to provide mechanical protection and rodent resistance. The steel tape armour is usually offered with either PE, PVC or LSZH inner jacket. It is not recommended to use PVC for outer jacket. Compared with steel wire armour, it has the advantage of lower cost, increased torsional stiffness and reduced cable diameter |
| J | Fiberglass armour | Flexible dielectric armour is made of a thick layer of fiber glass roving, It is a dielectric with high modulus and low weight glass. Fiberglass armour is used when there is a need for dielectric and high flexibility. Fiberglass armour is a fraction of weight of the steel wire armour for identical performance level. |
| W | Steel wire armour | Helical wrap of galvanized steel wire armour provides the best protection against rodent attack and mechanical damage, also offering high tensile strength and crush resistance. |
| TW | Corrugated steel tape armour + Steel wire armour | The double armour is designed for underwater application. The double armour wires provide the necessary tensile stiffness needed during installation to prevent excessive strain of the optical fibers, mechanical protection from outside disturbances, as well as the structural strength needed for underwater cables as relatively long lengths of cable must be lifted to bring the cable to the water's surface for servicing. Without the strength provided by the double armour, the weight of the cable could break the optical fibers at the point of lifting the cable. |
| B | Bronze armour | The braided bronze armour is used for increased mechanical protection for offshore and shipboard cables. With this design, the cable can pass IEC60332-3A. The bronze armour layer may also be used to assist in locating buried cables. This is accomplished by imparting a signal to the bronze armour and detecting the signal by suitable above-ground apparatus. |

► Ordering Information

► Outer Jacket Options

| | | |
|--------------|-------------------------------------|--|
| Blank | No inner jacket | |
| 2Y | Polyethylene (PE) | PE is used mostly for outdoor applications. PE sheath acts as a moisture barrier as well as a protection to the core. PE will not crack or become brittle at low temperatures and will retain its mechanical properties and stability at high temperatures. PE is very resistant to water, chemical and solvents and thus used as sheath for outdoor installation. PE can be UV resistant if carbon black additive is added. It will exhibit extremely good aging properties and high UV and weather resistance. |
| Y | Polyvinyl Chloride (PVC) | PVC is mostly used mostly for indoor applications. It is most widely used because of its good mechanical and electrical properties combined with cheap cost. The PVC material may include special carbon black additives for being UV and weather resistant |
| Yu | Fire retardant PVC (FRPVC) | Fire retardant PVC will not allow fire to propagate along the cable when ignited. Fire retardant PVC jacketed cables will usually meet the flammability requirements of UL 1581(VW-1) and IEC 60332-1. With special design, the cables can meet IEC 60332-3A/C or UL 1666 (OFNR riser grade or UL 910 (OFNP plenum grade). |
| H | Halogen-free, Fire-retardant (LSFH) | LSZH material is used mostly for indoor applications. When exposed to fire it will retard fire propagation while emitting non toxic corrosive halogen gases (halogen free as per IEC 60754-1 and IEC 60754-2) and low amounts of smoke emission as per IEC 61034-2. LSZH cables can usually meet the flammability requirement of UL 1581(VW-1) and IEC 60332-1. With special design, the cables can meet IEC 60332-3A/C. |
| 4Y | Polyamide/Nylon (PA) | The nylon sheath provides necessary protection against rodents and termites and the smooth surface of nylon makes laying of cables in duct much easier. This material does not degrade the cable mechanical properties or causes environmental damage. |
| 11Y | Polyurethane (PU) | PU is used for harsh environments requiring very high flexibility. This cable material is characterized by its good resistance to humidity, moisture and weather, high flexibility, stable electrical characteristics, and excellent resistance to abrasion or chemicals PU provides good tear strength, providing cut-resistance in many rugged environment. With special design, the cables may include a flame retarding additive. |





Ordering Information

Fiber Options

| | | |
|---|--|---|
| 9 | 9.3/125um standard single mode fiber per ITU-T G.652D (SMF) | This most employed fiber has a simple step index structure. It is optimized for operation at the 1300 nm band and can also operate in the 1550 nm, but it is not optimized for this region. The typical chromatic dispersion at 1550nm is high at 17ps/nm-km. Dispersion compensation must be employed for high-bit-rate applications. The attenuation is typically 0.2dB/km at 1550nm and the PMD is less than 0.1ps/km. This fiber is designed for use in long distance, high bandwidth systems such as telecommunication and CATV. |
| 2 | 9.3/125um low water peak non dispersion shifted single mode fiber per ITU-T G.652C | The ITU-T G.652 standard SMFs are not optimized for WDM applications due to the high attenuation around the water peak region. ITU G.652.C-compliant fibers offer extremely low attenuation around the OH peaks. The G.652.C fiber is optimized for networks where transmission occurs across a broad range of wavelengths from 1285 nm to 1625 nm. Although G.652.C-compliant fibers offer excellent capabilities for shorter, unamplified metro and access networks, they do not fully address the needs for 1550-nm transmission. The attenuation parameter for G.652 fiber is typically 0.2 dB/km at 1550 nm, and the PMD parameter is less than 0.1 ps/km. |
| 3 | Dispersion Shifted single mode fiber per G.653 (DSF) | Conventional SMF has a zero-dispersion wavelength that falls near the 1310-nm window band. SMF shows high dispersion values over the range between 1500 nm and 1600 nm (third window band). The trend of shifting the operating transmission wavelength from 1310 nm to 1550 nm initiated the development of a fiber type called dispersion-shifted fiber (DSF). DSF exhibits a zero-dispersion value around the 1550-nm wavelength where the attenuation is minimum. The DSFs are optimized for operating in the region between 1500 to 1600 nm. With the introduction of WDM systems, however, channels allocated near 1550 nm in DSF are seriously affected by noise induced as a result of nonlinear effects caused by FWM. This initiated the development of NZDSF. G.653 fiber is rarely deployed any more and has been superseded by G.655. |
| 8 | Non-Zero Dispersion Shifted single mode fiber per G.655 (NZDSF) | Using nonzero dispersion-shifted fiber (NZDSF) can mitigate nonlinear characteristics. NZDSF fiber overcomes these effects by moving the zero-dispersion wavelength outside the 1550-nm operating window. The practical effect of this is to have a small but finite amount of chromatic dispersion at 1550 nm, which minimizes nonlinear effects, such as FWM, SPM, and XPM, which are seen in the dense wavelength-division multiplexed (DWDM) systems without the need for costly dispersion compensation. There are two fiber families called nonzero dispersion (NZD+ and NZD-), in which the zero-dispersion value falls before and after the 1550-nm wavelength, respectively. The typical chromatic dispersion for G.655 fiber at 1550 nm is 4.5 ps/nm-km. The attenuation for G.655 fiber is typically 0.2 dB/km at 1550 nm, and the PMD is less than 0.1 ps/km. |

Ordering Information

| | | |
|---|--|---|
| 7 | Non-Zero Dispersion Shifted single mode fiber per G.656 (NZDSF) | In order to overcome the defects of G652 and G655 optical fibers, G656 fiber is developed. G656 fibers are designed for use in long haul transmission system and metro network. CWDM and DWDM can also be applied on S+C+L bands with these types fiber. These fibers are manufactured by PCVD process. The minimum dispersion value from 1460nm to 1625nm is greater than 2ps/nm km; the maximum value is less than 14ps/nm km. The effective area at 1550nm is around 52 to 66 μ m. The excellent polarization mode dispersion properties help the fiber to meet the requirement of high bit rate transmission. The PMD co efficiency of these fibers is less 0.05 ps/km. By use of improved PCVD process, excellent attenuation of these fibers was obtained, the water peak around 1385nm is almost removed; attenuation from 1310nm to 1650nm is less than 0.4 dB/km, attenuation at 1550nm is less than 0.22dB/km. Excellent attenuation performance will help the fiber to utilize the bandwidth more effectively. |
| 4 | Laser optimized 50/125um multi mode fiber. OM3 grade per ISO/IEC 11801 | OM3 MMF has a 50-um nominal core diameter and a 125-um nominal cladding diameter with a graded refractive index. The attenuation parameter for OM3 fiber is typically 0.9 dB/km at 1300 nm. The main application for OM3 fiber is for 10G Ethernet network where very long transmission distance is required. This fiber is optimized for use in the 850-nm band. |
| 5 | 50/125um multi mode fiber per G.651. OM2 grade per ISO/IEC 11801(MMF) | MMF has a 50-um nominal core diameter and a 125-um nominal cladding diameter with a graded refractive index. The attenuation parameter for G.651 fiber is typically 0.9 dB/km at 1300 nm. The main application for ITU-T G.651 fiber is for local area network. This fiber is optimized for use in the 1300-nm band. It can also operate in the 850-nm band. |
| 6 | 62.5/125um multi mode fiber per ITU-T G651, OM1 grade per ISO/IEC 11801. | MMF has a 62.5-um nominal core diameter and a 125-um nominal cladding diameter with a graded refractive index. The attenuation parameter for G.651 fiber is typically 0.9 dB/km at 1300 nm. The main application for ITU-T G.651 fiber is for local area networks.. This fiber is optimized for use in the 1300-nm band. It can also operate in the 850-nm band |
| 1 | 9/125um or 50/125um or 62.5/125um fiber. | Composite Cables containing two or more fiber types within the same cables. |
| 0 | 9/125um or 50/125um or 62.5/125um fiber plus copper cable. | Hybrid Cables containing two or more fibers and copper conductors within the same cables. |





Ordering Information

General Options

| | | |
|-------------|---|---|
| J | Water-blocking gel in tubes only | For moderate protection of the fibers against water penetration. |
| JJ | Water-blocking gel in tubes and in cable core interstices | For better protection of the fibers against water penetration. |
| JD | Water-blocking gel in tubes and dry water blocking elements in cable core interstices | For better protection of the fibers against water penetration. |
| VT | Tight buffer | The fibers are tightly buffered by a plastic material. Buffer diameter is 0.9mm. |
| CG | Semi-tight buffer | A semi-tight buffer, 0.9 outer diameter, gel filled. |
| AT | Anti-termite coating | This is a special coating applied over the cable jacket to reduce the damage of the cable by repelling insects and the termites. The anti termite coating does not degrade the cable mechanical properties or causes environmental damage. |
| AL | Aluminium moisture barrier tape | The aluminium moisture barrier tape offers extra protection against water ingress. The tape is applied around the cable cores to form a moisture barrier along the entire cable length. |
| OPGW | Overhead Power Ground Wire | Used in lightning waveform monitoring system, an observation system for overhead test line, maintenance data information system, power line protection system, power line operation system, and unmanned substation monitoring. |
| ADSS | All Dielectric Self Supporting | For aerial self supporting aerial installation at short, medium and long span distances. Adapted for high voltage, middle, small span conditions in Power Transmission System or mazy terrain such as river spanning, mountains. |
| SS | Figure-8-self-supporting cable | For self-supporting aerial installation, with steel messenger wire. The Fig 8 cable is recommended for spans up to 150m. The messenger wire is made of 7 stranded galvanized steel elements having a diameter and tensile strength to match the cable weight. |
| R | Ribbon Fiber | For use in long haul communication system, subscriber network system, distribution, feeder network system and local area network system. |

▶ ORDERING OPTIONS

▶ Cable Type Family

| | |
|-------------|--------------------------------|
| S | Simplex Cord |
| D | Duplex Cord |
| MT | Tight Buffer Distribution |
| BT | Tight Buffer Breakout |
| CL | Central Loose Tube |
| ML | Multi Loose Tube |
| ADSS | All Dielectric Self Supporting |
| OPGW | Overhead Power Ground Wire |

▶ Simplex/Duplex Cord

Simplex: CCL-FC-SA-B-C-D

Duplex: CCL-FC-DA-B-C-D-E

A: Cord Diameter

20=2.0mm; 25=2.5mm; 28=2.8mm; 30=3.0mm

B: Fiber Type

0=Fiber and copper conductors in cable

4=50/125 multi-mode fiber (OM3) per ITU-T G.651

5=50/125 multi-mode fiber (OM2) per ITU-T G.651

6=62.5/125 multi-mode fiber (OM1) per ITU-T G.651

7=NZDS SM fiber per ITU-T G.656.

8=NZDS SM fiber per ITU-T G.655.

9=Standard SM fiber per ITU-T G.652.D

C: Tight Buffer Type:

VT=Standard tight buffer (Default), YT=Tactical grade,

CG=Semi-tight buffer, jelly filled, CD-D=Semi-tight buffer, dry

D: Jacket Type

2Y=PVC, H=LSZH, ONR-OFNR PVC; ONP-OFNP FEP; Yu-FRPVC

E: Cable Shape

FT= Flat Cord; RD= Round Cord; ZIP= Zip Cord





ORDERING OPTIONS

► Tight Buffered Cable

Distribution: CCL-FC-MTA-B-C-D-E-F-G-H-I-J-K-L

Breakout: CCL-FC-BTA-B-C-D-E-F-G-H-I-J-K-L

- A: Distribution: Sub Unit Diameter
 - A=0.9mm (up to 12 fibers)
 - B=3.6mm (12-36 fibers)
 - C=4.2mm (24-72 fibers)
- Breakout Mini Cable Jacket Diameter
 - A- 1.8mm; B-2.0mm ; C-2.5mm; D-2.8mm; E-3.0mm
- B: Fiber Type
 - 0=Fiber and copper conductors in cable
 - 4=50/125 multi-mode fiber(OM3)
 - 5=50/125 multi-mode fiber(OM2)
 - 6=50/125 multi-mode fiber(OM1)
 - 7=NZDS SM fiber per G.656.
 - 8=NZDS SM fiber per G.655.
 - 9=Standard SM fiber per G.652.D
- C: No. of fibers:
 - 4 to 72
- D: Sub-unit Jacket Options
 - 0=No sub-unit (for up to 12 fibers), Y=PVC, H=LSZH
- E: Central member Options
 - Blank=No central member; A=Aramid yarn, F=Fiber Reinforced Plastic (FRP)
- F: Inner Jacket Options
 - 2Y=PE, Y=PVC, H=LSZH; ONR-OFNR PVC; ONP-OFNP FEP; Yu-FRPVC
- G: Armour options
 - Blank=No armour, T=Corrugated steel tape armour, W=Steel wire armour
 - B=Bronze armour, D=Fiber glass armour; TW= Steel tape + Steel wire armour
- H: Outer Jacket Options
 - Y=PVC, H=LSZH; ONR-OFNR PVC; ONP-OFNP FEP; Yu-FRPVC
- I: Water-Blocking Options for cable core
 - X=No water-blocking; J= Water blocking gel in tubes;
 - JD=Water-blocking gel in tubes + dry water blocking in cable core interstices;
 - JJ= Water-blocking gel in tubes and cable core interstices.
- J: Water-Blocking Options for cables with more than one jacket
 - X=No water-blocking, J= Water blocking gel between jackets;
 - D=Dry water-blocking between cable jackets;
- K: Tight Buffer Type
 - VT=Standard tight buffer, YT=Tactical grade, CG=Semi-tight buffer, gel-jelly,
 - CD=Semi-tight buffer, dry
- L: Strength Member Options
 - A=Aramid yarn, AG=Aramid yarn and fiberglass yarn, G=Fiberglass yarn

▶ Central Loose Tube Cable

CCL-FC-CLA-B-C-D-E-F-G-H-I-J

A: Loose tube diameter

A=2.1mm, B=2.5mm

B: Fiber type

0=Fiber and copper conductors in cable

4=50/125 multi-mode fiber (OM3) per ITU-T G.651

5=50/125 multi-mode fiber (OM2) per ITU-T G.651

6=62.5/125 multi-mode fiber (OM1) per ITU-T G.651

7=NZDS SM fiber per ITU-T G.656.

8=NZDS SM fiber per ITU-T G.655.

9=Standard SM fiber per ITU-T G.652.D

Ended with R=Ribbon type fiber (Ex: 9R= SM fiber per G.652.D ribbon type)

C: No. of fibers:

1 to 24

D: Inner jacket options

2Y=PE, Y=PVC, H=LSZH

E: Armour options

Blank=No armour, T=Corrugated steel tape armour, W=Steel wire armour

B=Bronze armour, D=Fiber glass armour; TW= Steel tape + Steel wire armour

F: Jacket material options

2Y=PE, Y=PVC, H=LSZH, 11Y=PU, A=Aluminium moisture barrier,

T=Anti-termite protection

G: Water-blocking options for cable core

X=No water-blocking; J= Water blocking gel in tubes;

JD=Water-blocking gel in tubes + dry water blocking in cable core interstices;

JJ= Water-blocking gel in tubes and cable core interstices.

H: Water-blocking options for cables with more than one jacket

X=No water-blocking, J= Water blocking gel between jackets;

D=Dry water-blocking between cable jackets;

I: Strength member options

A=Aramid yarn, AG=Aramid yarn and fiberglass yarn, G=Fiberglass yarn

J: General options

SS=Fig-8 self-supporting

UW=Under Water



ORDERING OPTIONS

► Multi Loose Tube Cable

CCL-FC-MLA-B-C×D-E-F-G-H×I-J-K-L

A: Loose tube diameter

B=2.1mm, C=2.5mm, D=2.8mm, E=3.0mm, F=3.2mm

B: Fiber type

0=Fiber and copper conductors in cable

4=50/125 multi-mode fiber (OM3) per ITU-T G.651

5=50/125 multi-mode fiber (OM2) per ITU-T G.651

6=62.5/125 multi-mode fiber (OM1) per ITU-T G.651

7=NZDS SM fiber per ITU-T G.656.

8=NZDS SM fiber per ITU-T G.655.

9=Standard SM fiber per ITU-T G.652.D

Ended with R=Ribbon type fiber (Ex: 9R= SM fiber per G.652.D ribbon type)

C: No. of tubes:

1 to 36

D: No. of fibers per tubes:

2 to 12

E: Central member

S=Solid steel, SR=Stranded steel, F=Fiber Reinforced Plastic (FRP)

F: Inner jacket options

2Y=PE, Y=PVC, H=LSZH

G: Armour options

Blank=No armour, T=Corrugated steel tape armour, W=Steel wire armour

B=Bronze armour, D=Fiber glass armour; TW= Steel tape + Steel wire armour

H: Jacket material options

2Y=PE, Y=PVC, H=LSZH,

11Y=PU, A=Aluminium moisture barrier, T=Anti-termite protection

I: Water-blocking options for cable core

X=No water-blocking; J= Water blocking gel in tubes;

JD=Water-blocking gel in tubes + dry water blocking in cable core interstices;

JJ= Water-blocking gel in tubes and cable core interstices.

J: Water-blocking options for cables with more than one jacket

X=No water-blocking, J= Water blocking gel between jackets;

D=Dry water-blocking between cable jackets;

K: Strength member options

A=Aramid yarn, AG=Aramid yarn and fiberglass yarn, G=Fiberlass yarn

L: General options

SS=Fig-8 self-supporting

UW=Under Water

▶ ADSS Multi Loose Tube Cable

CCL-FC-MLA-B-C-D-E-F-G-H-I-J-K-L-M- ADSS

A: Loose tube diameter

B=2.1mm, C=2.5mm, D=2.8mm,
E=3.0mm, F=3.2mm

B: Fiber type

0=Fiber and copper conductors in cable
4=50/125 multi-mode fiber(OM3)
5=50/125 multi-mode fiber(OM2)
6=50/125 multi-mode fiber(OM1)
7=NZDS SM fiber per G.656.
8=NZDS SM fiber per G.655.
9=Standard SM fiber per G.652.D
Ended with R=Ribbon type fiber (Ex: 9R= SM fiber per G.652.D ribbon type)

C: No. of tubes:

01 to 36

D: No. of fibers per tubes:

02 to 12

E: Central member

S=Solid steel, SR=Stranded steel, F=Dielectric(FRP)

F: Inner jacket options

2Y=PE, Y=PVC, H=LSZH

G: Armour options

T=Corrugated steel tape armour, B=Bronze, W=Steel wire Armour, WB= Steel Wire

Braid

H: Jacket material options

2Y=PE, AT= Anti-tracking

I: Water-blocking options for cable core

X=No water-blocking; J= Water blocking gel in tubes;
JD=Water-blocking gel in tubes + dry water blocking in cable core interstices;
JJ= Water-blocking gel in tubes and cable core interstices.

J: Water-blocking options for cables with more than one jacket

X=No water-blocking, J= Water blocking gel between jackets;

K: Strength member options

A=Aramid yarn, AG=Aramid yarn and glass yarn, G=Glass yarn

L: Span Length

M: Voltage Rating



ORDERING OPTIONS

▶ OPGW Type Cable

CCL-FC-A-B-C-D-E-OPGW

A: Fiber type

0=Fiber and copper conductors in cable

4=50/125 multi-mode fiber(OM3)

5=50/125 multi-mode fiber(OM2)

6=50/125 multi-mode fiber(OM1)

7=NZDS SM fiber per G.656.

8=NZDS SM fiber per G.655.

9=Standard SM fiber per G.652.D

B: No. of steel tubes:

01 to 3

C: No. of fibers per tubes:

02 to 12

D: Cross Sectional Area

35=35mm²; 50=50mm²; 70=70mm²; 90=90 mm²; 130=130mm²

E: Rated Voltage

66=66KV; 115=115kV; 150=150kV;

250=250kV; 275=275kV; 380=380kV; 500=500kV



► Optical & Geometrical Properties for Single Mode Fibers

► Optical & Geometrical Properties for Single Mode Fibers

| Parameter | | Standard Single Mode Fiber per ITU-T G.652D | Non-zero Dispersion Shifted fiber per ITU-T G.655 | Non-zero Dispersion Shifted fiber per ITU-T G.656 | Units |
|--|----------------------------------|---|---|---|--------------------------|
| | | 9 | 8 | 7 | |
| Attenuation, Loose Tube Cables | | Standard | Metro Area | Long Haul | |
| | @1310nm | ≤0.35 | - | - | dB/km |
| | @1550nm | ≤0.22 | ≤0.22 | ≤0.22 | dB/km |
| | @1625nm | ≤0.25 | ≤0.26 | ≤0.26 | dB/km |
| Attenuation, Tight Buffer or Semi-Tight Cables | | | | | |
| | @1310nm | ≤0.38 | - | - | dB/km |
| | @1550nm | ≤0.28 | - | - | dB/km |
| Chromatic Dispersion | between 1260 and 1360nm (O Band) | ≤3.5 | NA- | - | ps/(nm*km) |
| | between 1460 and 1530nm (S Band) | - | - | 2.0-7.0 | ps/(nm*km) |
| | between 1530 and 1565nm (C Band) | ≤18 | 1.0-10.0 | 7.0-10.0 | ps/(nm*km) |
| | between 1565 and 1625nm (L Band) | ≤22 | 7.0-12.0 | 10.0-14.0 | ps/(nm*km) |
| Zero Dispersion Wavelength | | 1310±11 | ≤1520 | ≤1420 | nm |
| Zero Dispersion Slope | | 0.093 | 0.093 | 0.093 | ps/(nm ² .km) |
| Point Discontinuity at 1300nm & 1550nm | | 0.1 | 0.1 | 0.1 | dB |
| Mode Field Diameter | @1300nm | 9.3±0.5 | - | - | um |
| | @1550nm | 10.4±0.8 | 8.5±0.6 | 9.0±0.5 | um |
| Cable Cut-off Wavelength | | ≤1260 | ≤1450 | ≤1310 | nm |
| PMD (Individual fiber) | | ≤0.2 | ≤0.2 | ≤0.2 | ps/km ^{1/2} |
| Cladding Diameter | | 125±1 | 125±1 | 125±1 | um |
| Core/Cladding Concentricity Error | | ≤0.5 | ≤0.5 | ≤0.6 | um |
| Cladding Non-Circularity | | ≤1.0 | ≤1.0 | ≤1.0 | % |
| Coating Non-Circularity | | ≤6.0 | ≤6.0 | ≤6.0 | % |
| Primary Coating Diameter | | 245±10 | 245±10 | 245±10 | um |
| Proof-Test Level | | 100 (0.7) | 100 (0.7) | 100 (0.7) | Kpsi/GN/m ² |
| Fatigue Coefficient | | ≥20 | ≥20 | ≥20 | |
| Temperature Dependence between 0°C ~ +70°C @ 1310 & 1550nm | | 0.1 | 0.1 | 0.1 | Db/km |





► Optical & Geometrical Properties for Multimode Fibers

► Optical & Geometrical Properties for Multimode Fibers

| Parameter | | 50/125 | | 62.5/125 | Units |
|---|---------|------------|-------|-------------|---------------------------|
| Fiber Code | | 5 | 4 | 6 | - |
| ISO/IEC 11801 Classification(2) | | | | | - |
| Attenuation, Loose Tube Cables | | | | | |
| @850nm | | ≤3.0 | | ≤3.0 | dB/km |
| @1300nm | | ≤0.8 | | ≤0.8 | dB/km |
| Attenuation, Tight Buffer and Semi-tight Cables | | | | | |
| @850nm | | ≤3.0 | | ≤3.5 | dB/km |
| @1300nm | | ≤1.0 | | ≤1.0 | dB/km |
| Bandwidth * | @850nm | ≥500 | ≥2000 | ≥200 | MHz*km |
| | @1300nm | ≥800/500 | ≥500 | ≥500/600 | MHz*km |
| Numerical Aperture | | 0.20±0.015 | | 0.275±0.015 | - |
| Core Diameter | | 50±3 | | 62.5±3 | um |
| Cladding Diameter | | 125±2 | | 125±2 | um |
| Core/Cladding Concentricity | | ≤1.5 | | ≤1.5 | um |
| Core Non-Circularity | | ≤6 | | ≤6 | % |
| Cladding Non-Circularity | | ≤2 1 | | ≤2 1 | % |
| Core/Cladding Offset | | ≤3 | | ≤3 | um |
| Coating Diameter | | 245±10 | | 245±10 | um |
| Proof-Test Level | | 100 (0.7) | | 100 (0.7) | Kpsi (GN/m ²) |
| Fatigue Coefficient | | ≥20 | | ≥20 | |
| Temperature Dependence between 0°C - 70°C | | 0.1 | | 0.1 | dB |

► Testing Method for Optical & Geometrical Properties of Fiber



► Testing Method for Optical & Geometrical Properties of Fiber

| Testing Parameters | Parameter & Test Method Description | EIA/ TIA-455 FOTP | IEC- 607931 | ITU-T |
|--|---|---|----------------|--|
| Fiber Geometry | <p>Fiber geometry is important where two fibers cores are to be joined together. Fiber geometry is measured to identify fiber mismatches which occur when manufacturer fails to maintain the optical and structural tolerances during the fiber fabrication process. Fiber mismatches will lead to fiber attenuation and intrinsic coupling loss.</p> <p>EIA/TIA 455-176 introduces method to measure all key parameters of fiber cross sectional geometry except core diameter.</p> <p>IEC-60793-1-20 describes four methods for measuring fiber geometry (namely refractive near field, transverse interference, near-field light distribution and mechanical diameter). The following parameters are measured: cladding diameter, cladding non circularity, core diameter, core non circularity and core cladding concentricity error and theoretical numerical aperture.</p> <p>IEC 60793-1-21 describes four methods for coating geometry of the fiber. The following parameters are measured: coating diameter, coating non-circularity and coating cladding concentricity error.</p> | 176 | 20,21 | <p>SM: G.650 Method 5.2.1</p> <p>MM: G.651,Sec.1, Method B.3</p> |
| Spectral Attenuation | <p>The reduction in signal strength is measured as attenuation. Attenuation is function of wavelength. TIA 455-78 describes a method for measuring the spectral attenuation of single mode fiber. TIA 455-46 describes a method for measuring the spectral attenuation of long length grade index multimode fiber. IEC 60793-1-40 describes four methods for measuring attenuation: (a) cut-back, (b) insertion loss, (c) backscattering (d) modelling spectral attenuation.</p> | <p>SM Fibers:78</p> <p>MM Fibers:46</p> | 40 | <p>SM: G.650 Method 5.4.1</p> <p>MM: G.651,Sec.2,1, Method B.2</p> |
| Attenuation Uniformity (Point discontinuity) | <p>The backscattering method adopted in IEC 60793-1-40 covers the location, loss and characterization of point discontinuity. This test is to monitor the change in optical transmittance of the fiber and cables arising from optical discontinuity.</p> | 78 | 40 | <p>SM: G.650 Method 5.4.2</p> <p>MM: G.651,Sec.2, Method B.4</p> |
| Numerical Aperture (MMF) | <p>The numerical aperture (NA) is a measurement of the ability of an optical fiber to capture light.</p> <p>TIA 455-177 is to determine the NA of near parabolic profile, graded index, glass core and glass clad optic fibers. NA is determined either from the fiber far field radiation pattern (Method A) or the fiber refractive index profile (Method B). IEC 60793-1-43 establishes requirement for measuring A1 graded index multimode fiber and its light gathering ability.</p> <p>The test is used to predict launching efficiency, joint loss at splices, and micro/macrobending performance</p> | 177 | 43 | G.651,Sec.1, Method B.4 |



Testing Method for Optical & Geometrical Properties of Fiber

| Testing Parameters | Parameter & Test Method Description | EIA/ TIA-455 FOTP | IEC- 607931 | ITU-T |
|---------------------------|--|-------------------------|----------------|--|
| Cutoff Wavelength (SMF) | The wavelength at which a mode stops to propagate is called cutoff wavelength for that mode; However, an optical fiber is always able to propagate at least one mode, the fundamental mode. The fundamental mode can never be cut off. The cutoff wavelength of a single mode fiber is the wavelength above which the fiber propagates only the fundamental mode. Measuring the cutoff length involves comparing the transmitted Power from the test fiber with that of a reference fiber at different wavelength. TIA 455-80 & IEC 60793-1-44 provides methods for measuring the cut-off wavelength of single-mode optical fibers. The test method applies to sample fiber in either an uncabled condition or in a cable or as a jumper cable. | 80 | 44 | G.650, Methods 5.3.1, 5.3.3 |
| Mode Field Diameter (SMF) | Not all light travels through the core of the fiber, but is distributed through both the core and the cladding. The "mode field" is the distribution of light through the core and cladding of a particular fiber. Mode-Field Diameter (MFD) defines the size of the power distribution. TIA/EIA 455-191 establishes uniform requirement for measuring MFD of fiber. Four methods are described in IEC 60793-1-45: a) direct far field scan b) variable aperture in the far field c) near field scan d) bidirectional backscattering using an ODTR. Mode field diameter is a key parameter because the radial extent of the mode can be used to predict losses at joints and microbends. In addition, if its spectral variation is known, it can be used to measure cut off wavelength. Other parameters which can be predicted using MFD data include waveguide dispersion and refractive index profile. | 191 | 45 | G.650, Methods 5.1.2 |
| Bandwidth (MMF) | Bandwidth is generally the amount of data that can be carried from one point to another in a given time period. Bandwidth is measured by launching light into fiber from LED. With this type of light, all modes are filled and which is called overfilled launch. TIA/EIA 455-204 describes two methods for determining the transmission capacity for multimode fiber. IEC 60793-1-41 describes two methods for measuring the modal bandwidth of multimode fiber. a) optical time domain measurement (pulse distortion) b) frequency domain measurement. Each method can be performed using one of the two launches: an overfilled launch (OFL) condition or a restricted mode launch (RML) condition. | 204 | 41 | G.651, Sec.3 Methods B2 G650 Method 5.5.1 |

▶ Testing Method for Optical & Geometrical Properties of Fiber

| | | | | |
|-----------------------------------|--|------------|-----------|----------------------------|
| <p>Chromatic Dispersion (SMF)</p> | <p>Chromatic dispersion occurs because different colors of light travels through the fiber at different speed. Some colors arrive at the fiber end before the others. This differential delay difference is called group delay which leads to pulse broadening. Chromatic dispersion is obtained by measuring this fiber group delay in the time domain. TIA455-175 use the differential phase shift method to determine the dispersion coefficient at a particular wavelength from the differential group delay between two closely spaced wavelength. IEC 60793-1 describes four methods for measuring chromatic dispersion: (a) phase shift, (b) spectral group delay in the time domain, (c) differential phase shift, and (d) interferometry.</p> | <p>175</p> | <p>42</p> | <p>G.650, Method 5.5.1</p> |
| <p>Polarization Mode (PMD)</p> | <p>Polarization mode dispersion (PMD) is the average differential group delay (DGD) which is the time delay between two principle polarization modes of the transmission link at the receiver. PMD occurs when different planes of light inside a fiber travel at slightly different speeds, making it impossible to transmit data reliably at high speeds. PMD is the biggest challenge for high speed optic system. IEC 60793-1 describes three methods of measuring PMD of single mode fiber. TIA455-124 describes methods for measuring average PMD of SMF and cable assemblies over the measurement wavelength range of the selected source from 1210 nm and/or 1550 nm region.</p> | <p>124</p> | <p>48</p> | <p>G.650 Method 5.7.3</p> |





Mechanical & Environmental Properties for Single Mode Fiber
Mechanical & Environmental Properties for Multi Mode Fiber

► **Mechanical & Environmental Properties for Single Mode Fiber**

| Testing Parameters | EIA/TIA-455 FOTP Number | IEC-794-1 Test Method | EN 187000 Test Method | Maximum Increased loss |
|-----------------------------------|-------------------------|-----------------------|-----------------------|---|
| Tensile Load & Bending | 33 | E1 | 501 | <0.05dB (90%); <0.15dB (100%) |
| Low & High Temperature Bend | 37 | E11 | | <0.05dB (90%); <0.15dB (100%) |
| Compression loading (Crush) | 41 | E3 | 504 | <0.05dB (90%); <0.15dB (100%) 440N/km(250lb/in) load |
| Impact Resistance | 25 | E4 | 505 | <0.05dB (90%); <0.15dB (100%) |
| Twist (Torson) | 85 | E7 | 508 | <0.05dB (90%); <0.15dB (100%) |
| Cyclic Flexing (Repeated Bending) | 104 | E6 | 509 | <0.05dB (90%); <0.15dB (100%) |
| External freezing | 98 | F6 | | <0.05dB (90%); <0.15dB (100%) |
| Temperature Cycling | 3 | F1 | 601 | <0.05dB (90%); <0.15dB (100%) |
| Fiber Stripability | 178 | B6 | | <8.9N(2lbf) on unaged and aged fiber; >1.3N(0.3lbf) on unaged and aged fiber |
| Cable Aging | 82 | F5 | | <0.1dB (90%); <0.25dB (100%) |
| Water Penetration | 82 | F5 | | No flow after 24 hours from 1 meter length of cable |
| Compound Flow (Drip) | 81 | E14 | | 80 C 24 hrs duration, no drip |

► **Mechanical & Environmental Properties for Multi Mode Fiber**

| Testing Parameters | EIA/TIA-455 FOTP Number | IEC-794-1 Test Method | EN 187000 Test Method | Maximum Increased loss |
|-----------------------------------|-------------------------|-----------------------|-----------------------|---|
| Tensile Load & Bending | 33 | E1 | 501 | <0.2dB |
| Low & High Temperature Bend | 37 | E11 | | <0.4dB |
| Compression loading (Crush) | 41 | E3 | 504 | <0.2dB 440N/km(250lb/in) load |
| Cyclic Impact | 25 | E4 | 505 | <0.4dB |
| Twist (Torsion) | 85 | E7 | 508 | <0.2dB |
| Cyclic Flexing (Repeated Bending) | 104 | E6 | 509 | <0.2dB |
| External freezing | 98 | F6 | | <0.2dB |
| Temperature Cycling | 3 | F1 | 601 | <0.05dB (90%); <0.15dB (100%) |
| Fiber Stripability | 178 | B6 | | <13.4N(3lbf) on unaged fiber |
| Cable Aging | 82 | F5 | | <0.1dB (90%); <0.25dB (100%) |
| Water Penetration | 82 | F5 | | No flow after 24 hours from 1 meter length of cable |
| Compound Flow (Drip) | 81 | E14 | | 80 C 24 hrs duration, no drip |

► Testing Method for Optical & Geometrical Properties of Fiber

► Testing Method for Mechanical & Environmental Properties of Fiber

| Testing Parameters | Test Method Description | EIA/TIA-455 FOTP Number | IEC-794-1 |
|-----------------------------------|---|-------------------------|-----------|
| Tensile Load & Bending | Cable installed outside will be exposed to tensile load during installation and service. The cable should be able to withstand this force without fiber strain and attenuation change over its limit. | 33 | E1 |
| Low & High Temperature Bend | This test measures the ability of the cable to retain its mechanical and optical properties in spite of wide and rapid changes in temperature. | 37 | E11 |
| Compression loading (Crush) | The purpose of this test is to test the ability of the fiber to withstand transverse pressure. | 41 | E3 |
| Cyclic Impact | The fall of a heavy device is simulated in this test. The weight is allowed to fall vertically onto an intermediate steel piece that transmits the force to the cable sample. No damage to the cable sheath may occur. | 25 | E4 |
| Twist (Torsion) | During feeding, the fiber must withstand torsion forces in addition to tension, transverse pressure and bending load. Thus a cable sample is turned around its own axis and attenuation is measured during the test. Nether fiber or sheath material may be damaged during the test. | 85 | E7 |
| Cyclic Flexing (Repeated Bending) | The resistance of a fiber optic cable to repeated bending is determined by a cable sample bent forwards and backward 180 degree over a specific radius. | 104 | E6 |
| External freezing | This freezing test evaluates the ability of the fiber cable to withstand the freezing of the water that may immediately surround the cable. The test evaluates the physical appearance and mechanical properties of the jacket after test, monitoring the attenuation change during/after freezing. | 98 | F6 |
| Temperature Cycling | This test measures the effect of wide swing in temperature and humidity on the optical and mechanical performance of the cables.. Since the thermal coefficient of expansion of the plastic coating and buffer are different from the fibers themselves, microbending may occur with the temperature changes, and which may bring changes in attenuation. | 3 | F1 |
| Fiber Stripability | This test measures the forces required to remove the fiber coating. | 178 | B6 |
| Cable Aging | This test measures the effect of prolonged heat aging on the fiber. The accelerated oxygen test simulates the result of long term aging on the cable jacket. After test, the cable is examined for color changes, embrittlement, softening and surface damages etc. | 82 | F5 |
| Water Penetration | This test is to determine whether the interstices within the cable is continuously filled with jelly compound or water blocking to prevent water to enter the cable | 82 | F5 |
| Compound Flow (Drip) | This test is to determine whether the flooding compound will remain stable for ambient temperature up to 70deg and will not drip, flow or leak with age or at the change of temperature. No drip of the jelly compound may be observed during and after the test. | 81 | E14 |



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