FIBER OPTIC CABLES

OPTICAL CABLE CORPORATION

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FIBER OPTIC CABLE PRODUCT CATALOG
VOLUME 2

VERSION 2.1

ISO 9001:2000 GMI REGISTERED QUALITY SYSTEM
Certificate No. 007038

Introduction

Optical Cable Corporation pioneered the design and production of special tight-buffered cables for the most demanding military field applications in the early 1980s. At its ISO 9001:2000 registered facility in Roanoke, Virginia, the company manufactures a broad range of fiber optic cables for high bandwidth transmission of data, video, and audio communications over short to moderate distances. Optical Cable Corporation's cables can be used both indoors and outdoors and utilize a unique tight-buffered coating process that provides excellent mechanical and environmental protection for the optical fiber. The current product portfolio is built on the evolution and refinement of the original fundamental technology into a comprehensive and versatile product line to provide end-users with significant value.

Table Of Contents

The purpose of this condensed catalog is to provide our valued customers with a summary of our most popular fiber optic cable products. For requirements not addressed in this summary catalog, please contact Optical Cable Corporation. Some of the product information contained in this catalog can also be found on our web site at: www.occfiber.com.

Fiber optic cables for all applications including monitors, security cameras and communications systems for airports, highways and railways.

Optical Cable Corporation is driven by a tradition of leadership — in technology, product performance and customer service.

Optical Cable Corporation was founded in 1983. The founders were responsible for performing the government-funded fiber optic cable development work at ITT Electro-Optical Products Division (EOPD) during the late 1970s and early 1980s. During that time, ITT captured nearly all of the government-funded R&D programs for development of fiber optic components and systems. Key among these programs was the creation of extremely strong, lightweight, rugged, and survivable fiber optic cable for military tactical field use.

Millions of dollars of engineering, prototype development and testing produced the tight-buffered, tightbound cable technology. Optical Cable Corporation has applied the results of these programs, the technology, the manufacturing methods and the thorough understanding of the capabilities of the tight-buffered cable process to designs for fiber optic cable for commercial applications.

Several of the company's key personnel worked at ITT EOPD during the same time frame. They provide combined experience of greater than 100 years in optical fiber development, cable engineering, quality control, production, sales and marketing.

From its inception, Optical Cable Corporation pioneered the use of military tactical cable technology with advanced manufacturing techniques to offer new cable designs specifically optimized for the requirements of moderate-distance local area network (LAN) installation environments.

Optical Cable Corporation office and manufacturing facility in Roanoke, Virginia.

Today, the company manufactures a comprehensive, state-of-the-art line of tight-buffered fiber optic cable products, which address nearly all communications applications including data communications, LANs, telecommunications, video transmission, cable TV, traffic signaling, and military tactical communications. Gigabit Ethernet, 10

Gigabit Ethernet, ATM and Fibre Channel are all placing new and different demands on communications systems. Optical Cable Corporation meets today's challenge with the industry's widest array of optical fiber types and performance characteristics available.

Publicly held since 1996, the company has about one-quarter of its sales with international customers in over 70 countries. The company has constantly worked on expanding its product line to become the most diverse manufacturer in the industry. Products are available for almost every application in government, military and commercial markets worldwide.

Fiber optic cables for all applications including interbuilding and intra-building communications, office automation and local area networks (LANs).

QMI
A DIVISION OF CSA GROUP

CERTIFICATE OF REGISTRATION

QMI issues this certificate to:

OPTICAL CABLE CORPORATION
5290 Concourse Drive
Roanoke, Virginia
24019 USA

which has demonstrated that its Quality Management System is in compliance with:

ISO 9001:2000

The following scope of registration applies:

Design, development, distribution, and production of fiber optic cables.

Certificate Number: 007038
SIC Number: 3357
Date of Original Registration: March 18, 1994
Date of Current Registration: March 26, 2003
Date Registration Expires: Continuous

Wendy J. Tilford
President

Fiber optic cables for all harsh environments including mining.

Optical Cable Corporation's tight-buffered fiber optic cable products are widely selected for installation by:

- Aerospace Prime Contractors
- Industrial/Manufacturing Facilities
- CATV
- Insurance Companies
- Fiber-To-The-Home (FTTH)
- Colleges and Universities
- Military
- Financial Institutions
- Petrochemical/Oil/Gas Facilities
- Governments - Federal/State/Local
- Telco
- Hospitals and Healthcare Facilities
- Utilities
- Mining
- Security
- Transportation
- Broadcast

For more information call our Sales Department at 1-800-622-7711 or (540) 265-0690 or send a fax to (540) 265-0724.

Tight-Buffered Cables vs. Loose-Tube Gel-Filled Cables

Tight-Buffered Fiber Optic Cable. Fast, easy, economical termination with no chemical cleaning required.

Optical Cable Corporation's Tight-Buffered Fiber Optic Cables Are the Answer

Optical Cable Corporation is committed to tight-buffered construction as the best proven state-of-the-art design for nearly all commercial communications applications demanding the high performance of optical fibers. Such applications include moderate distance transmission for telco local loop, LANs, SANs ,COLOs, and point-to-point links in cities, buildings, factories, office parks and on campuses. Tight-buffered cables offer the flexibility, direct connectability and design versatility necessary to satisfy the diverse requirements existing in high performance fiber optic applications.

Loose-Tube Gel-Filled Construction Falls Short

In loose-tube gel-filled cable construction, the fibers are contained in small, rigid tubes, generally flooded with gel, stranded together, again flooded with gel and covered in an outer cable jacket. Even in the relatively long straight runs for which they were designed, these cable types may experience problems in water penetration and chemical interaction of gel with fiber buffers — causing weakening and brittling of the fibers with time.

Although loose-tube gel-filled fiber optic cables are used for high-fiber-count, long-distance telco applications, they are an inferior design for the Local Area (Private) Network applications where reliability, attenuation stability over a wide temperature range and low installed cost are the priorities. With the loose-tube gel-filled cables, terminations and any required splices demand extensive cleaning of the messy gel. Also, being relatively inflexible, loose-tube gel-filled cables can develop stress cracks and pinholes, which can allow water penetration and damage to the optical fiber.

Tight-Buffered Construction is the Clear Advantage

Tight-buffered fiber optic cables from Optical Cable Corporation incorporate the following attributes most important in networking applications:

- Excellent fiber protection: maximum moisture and mechanical protection provided by multiple fiber buffers and advanced jacket design
- Easy handling: dense fiber packaging for smaller cable diameter, tight bend radius and easier pulling with Core-Locked™ jacket
- No messy gel
- Ease of termination: direct termination of fibers reduces mess and expense of installation by eliminating steps and materials required
- A built-in ripcord speeds the stripping process

Tight-Buffered Construction is the Clear Advantage (cont.)

- Flame-retardant and UL-listed
- Indoor/outdoor versatility: exceptional moisture resistance, UV resistance, material durability and extended temperature range make the cables suitable for outdoor runs
- Water-blocking available to meet relevant standards without the use of messy gel filling compound
- Higher survivability standards: based on military technology for survival under mechanical and environmental stress

Cable Construction Comparison

Optical Cable Corporation's Tight-Buffered Cable	Loose-Tube Gel-Filled Cable
One fiber per buffer–excellent mechanical and environmental protection	Multiple fibers per buffer
No gel filling needed–exceptional tight-buffered cable construction and aramid strength members provide excellent protection for every inch of the cable	Gel filling needed to prevent moisture collection in tubes
No cleaning needed–no gel, easy to handle, install and terminate, saving time and costs, and improving reliability	Gel filling must be chemically cleaned–messy, costly and time consuming
No stiff strength member needed, more flexible cable–easier to handle	Requires stiff cable strength member–more difficult to handle and install
Cable is "tightbound" and can be pulled around multiple bends or hung vertically (no fiber axial migration)	Should not be pulled around multiple bends or hung vertically (fiber axial migration)–installation limitations
Easy to terminate, no breakout kits or splicing required	Difficult to terminate, breakout kits or splicing required–time consuming, requires expensive equipment and skills
Lower total installed costs	Cable purchase cost may be slightly lower
This tight-buffered cable is the CLEAR ADVANTAGE	

Optical Cable Corporation - A Heritage of Industry "Firsts"

- **First** used 100 kpsi proof-tested fibers in commercial fiber optic cables many years before industry standard was established
- **First** gel-free fiber optic cable for outdoor commercial applications
- **First** dry water-blocked fiber optic cable designs
- **First** indoor/outdoor fiber optic cables to eliminate transition from outdoor to indoor rated cables
- **First** Core-Locked™ outer cable jacket technology
- **First** outdoor fiber optic cables not requiring fanout/breakout kits to terminate
- **First** easy to dispense box with decreasing cable length markings, OptiReel™

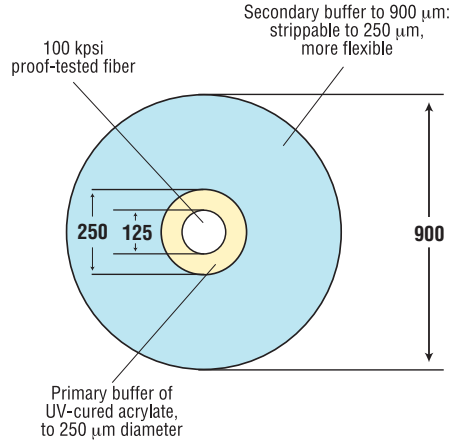
Tight-Buffered Cables vs. Loose-Tube Gel-Filled Cables

Fiber Buffer Options

Optical Cable Corporation offers three distinct buffering systems, each carefully engineered and manufactured to be the best available for its respective installation/application.

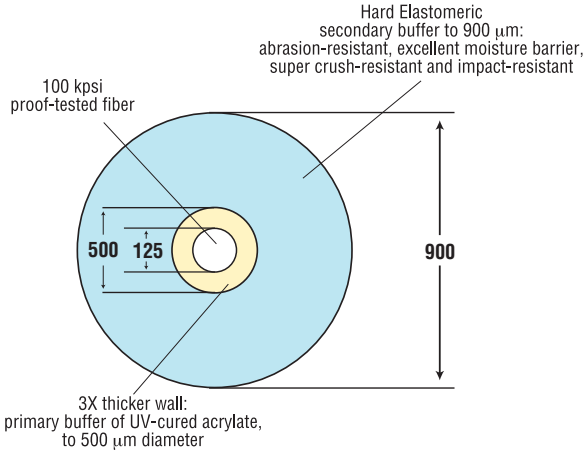
Ultra-Fox™

Our Ultra-Fox™ cable features 100 kpsi proof-tested fiber, a primary coating of UV-cured acrylate material to a diameter of 250 µm, and a secondary buffer to 900 µm. The composite primary coating and secondary buffer may be mechanically removed to the 125 µm glass diameter in one step. This is typically done for direct termination with connectors. The versatile buffer system permits mechanical stripping in short lengths (about 1 cm) to remove the secondary buffer and leave the 250 µm primary coating intact. This 250 µm buffered fiber is, therefore, available for splicing to similar buffered fibers from loose-tube gel-filled cables. The 250 µm coating may then be further mechanically stripped to the 125 µm glass diameter.



Ultra-Fox™ Plus

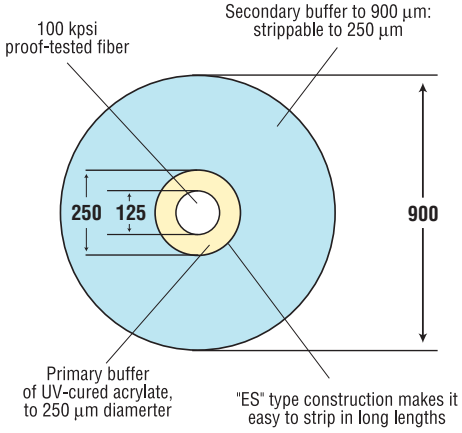
Our Ultra-Fox™ Plus cable features 100 kpsi proof-tested fiber, a primary buffer of UV-cured acrylate material to a diameter of 500 µm and a secondary hard elastomeric buffer to 900 µm diameter. This provides the ultimate environmental and mechanical protection and is identical to the buffering on our military tactical cables. This buffering system can be easily mechanically stripped directly to the glass for termination with connectors or for splicing.



Easy Strip (ES) Buffer Options

Our Easy Strip options permit easily removing long lengths (20-30 cm) of the 900 µm buffer and leaving the 250 µm acrylate coating. This is well suited when the 900 µm buffer must be removed to allow for splicing or ribbonizing.

- ES1 features a 900 µm primary buffer of hard elastomeric material that is semi-loose-fitting over the 250 µm acrylate coating.
- ES2 features a 900 µm PVC primary buffer with a release agent placed between the primary buffer and the 250 µm acrylate coating.



Laser Ultra-Fox™ Cables and Laser Ultra-Fox™ DE Cables

Laser Ultra-Fox™ Cables

For the laser-based high-speed networks of today and tomorrow, Optical Cable Corporation's Laser Ultra-Fox™ multimode fiber optic cables offer the best performance and longest operational distances available.

Laser Ultra-Fox™ multimode cables are optimized for use with high-speed laser-based systems, such as Gigabit Ethernet. Laser Ultra-Fox™ cables are also fully compliant with all LED-based standards, making them an excellent choice for any new installation where migration to Gigabit Ethernet is planned. Laser Ultra-Fox™ cables have controlled differential-mode-delay and refractive-index-profiles that are directly compatible with 850 nm VCSEL lasers, 1310 nm single-mode lasers, and LEDS. Laser Ultra-Fox™ cables are available in both 62.5 µm and 50 µm fiber types.

Laser Ultra-Fox™ Ten multimode cables are optimized for use with 10-Gigabit laser-based systems, such as 10-Gigabit Ethernet. Laser Ultra-Fox™ Ten cables also achieve extended distance operation with Gigabit Ethernet systems, and are fully compatible with all 50 µm LED based standards, making them the best choice for any new installation that might require future operation at 10-Gigabit speeds. Laser Ultra-Fox™ Ten-300, Ten-500, and Ten-XL cables are fully compliant with both the TIA-568-B.3-A-1 850 nm Laser-Optimized 50 µm Fiber Addendum and the ISO/IEC 11801 OM3 10-Gigabit standards.

Laser Ultra-Fox™ cables provide extended distance operation beyond the IEEE 802.3z Gigabit Ethernet standard link lengths. Laser Ultra-Fox™ cables are fully compatible with all 10-155 Mb/s data standards, such as Ethernet, Fast Ethernet, FDDI, ATM, Fibre Channel, and TIA-568-B.3. Laser Ultra-Fox™ cables are laser-ready, eliminating the need for expensive mode conditioning patch cords.

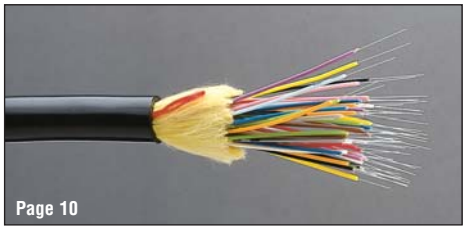
Laser Ultra-Fox™ DE Cables

Optical Cable Corporation's Laser Ultra-Fox™ DE Delay-Equalized fiber optic cables offer the unique combination of true-time-delay equalization and easy termination.

Laser Ultra-Fox™ DE cables are optimized for use in high-speed parallel data transmission, where minimal time skew of data between groups of fibers is important for proper system operation. Installations utilizing keyboard-video-mouse (KVM) access, where the actual computers are in a secure location separate from the KVM controls, often have demanding time skew requirements. With Laser Ultra-Fox™ DE cable, groups of 2 to 6 fibers may be delay-equalized. Higher fiber counts can be produced in GX-Series Subgrouping cables by using delay-equalized subunit cables.

Each individual fiber within a Laser Ultra-Fox™ DE cable equalized group is specially selected for equal group refractive index, allowing distance accuracy down to a few inches or less depending on overall cable length. In competing ribbon cable designs unequal group refractive index can change the relative propagation delay time by as much as 0.4%.

Contact Optical Cable Corporation and ask for more information on Laser Ultra-Fox™ DE Delay-Equalized fiber optic cables.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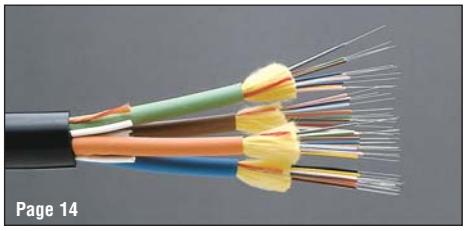
DX-Series Distribution Cables, Riser-Rated and Plenum-Rated
- Compact cable design for limited conduit space
- Flexible, rugged, high-strength construction for long cable pulls
- May be directly terminated with connectors with physical protection at termination points
- Lower total installed costs
- Suitable for both indoor and outdoor use – no need to splice outdoor cable to indoor cable at the building entrance
- 2 to 144 fibers, higher fiber counts are available upon request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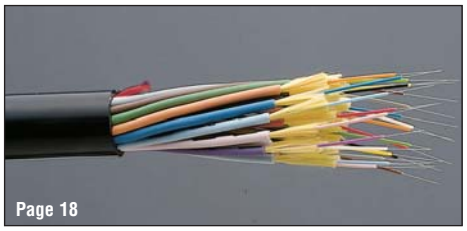
GX-Series Subgrouping Cables, Riser-Rated and Plenum-Rated
- Tight-buffered multifiber cable design allows subbundles to be routed to separate areas needing high fiber counts. Also available for fiber hybrid/composite cables
- Facilitates fiber identification in high-fiber-count cables
- Ideal separation and identification of single-mode and multimode fibers in a single cable
- Suitable for both indoor and outdoor use – no need to splice outdoor cable to indoor cable at the building entrance
- 12 to 288 fibers in various subgroup cable sizes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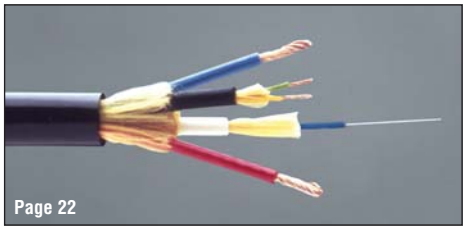
BX-Series Breakout Cables, Riser-Rated and Plenum-Rated
- Tight-buffered cable design allows the cable to be hung vertically in building risers without concern for fiber axial migration
- Most user-friendly design and construction for LAN applications
- Fibers may be directly terminated using connectors, with no further protection required
- Suitable for both indoor and outdoor use – no need to splice outdoor cable to indoor cable at the building entrance
- 2 to 108 fibers, higher fiber counts are available upon request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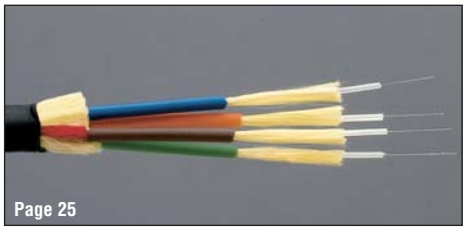
Composite Fiber/Copper Cables
- Combinations of copper conductors and optical fibers in a single composite cable
- Copper conductors such as category 3 and 5, other data and voice grade, or power conductors
- Copper and fiber individually subcabled for ease of separation, handling and termination
- Round cable design for easy installation and survivability
- Many combinations available with riser-ratings or plenum-ratings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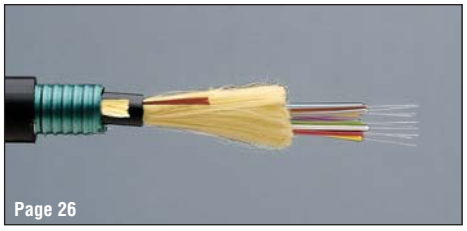
Zero Halogen Cables
- Meets low-smoke, low-toxicity standards
- For use in confined spaces such as mass-transit systems, ships, and other transportation applications
- Suitable for both indoor and outdoor use – no need to splice outdoor cable to indoor cable at the building entrance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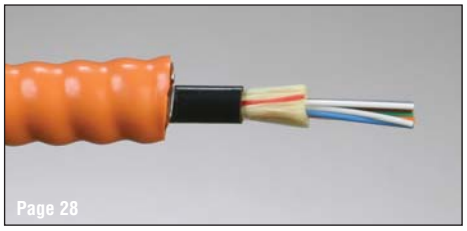
Armored Cables DX-Series Distribution, GX-Series Subgrouping, and BX-Series Breakout Cables
- Cost effective for direct burial and aerial applications
- Corrugated steel tape protects fiber optic cable from rodents, and provides additional stiffness for aerial lashing, if required
- The armor is easily removed with an internal aramid strength member ripcord, leaving a flame-retardant (OFNR or OFNP rated) inner cable with the original cable part number and length markings printed on the cable. This eliminates the need to splice outdoor cable to indoor cable to meet the National Electrical Code's 50-foot maximum length requirement for outdoor cable used inside buildings.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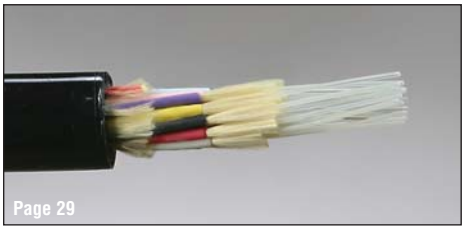
Interlocked Armored Cables
- Greater flexibility, cut resistance, and crush resistance than standard corrugated steel armored cables
- Available for UL riser-rated and plenum-rated environments
- Ideal cable construction for industrial and other applications requiring metallic armor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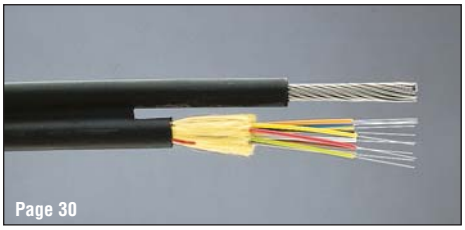
Festoon Cables

- Flexible, rugged, polyurethane outer cable jacket
- Resistant to oils, gases, and acidic gases
- Wide operating and storage temperature range
- Suitable for continuous exposure to UV light
- Minimum operating bend radius of 10 times the cable OD
- Capable of withstanding 100 mph side-wind loading
- Capable of vertical distances greater than 1,000 meters – still meets and maintains performance requirements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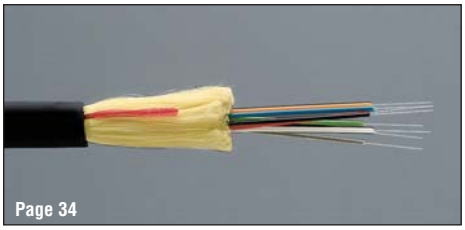
MX-Series Figure-Eight Messenger Cables

- Galvanized steel and all-dielectric self-supporting messengered construction for DX-Series multifiber tight-buffered cables
- Designed to meet NESC storm load rating of light, medium or heavy
- Cable can cut installation costs by half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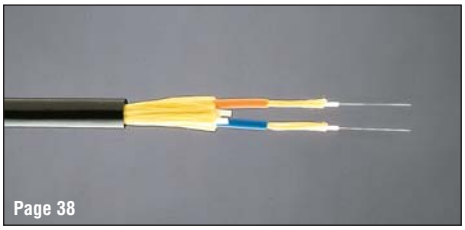
RM-Series Round Messenger Cables (ADSS)

- Lightweight, all-dielectric self-supporting (ADSS) construction is ideal for use near electrical power lines and in areas of frequent lightning
- Round cable construction for minimum wind drag and ice buildup
- Increases span length capability
- Aramid strength members reduce weight for longer span lengths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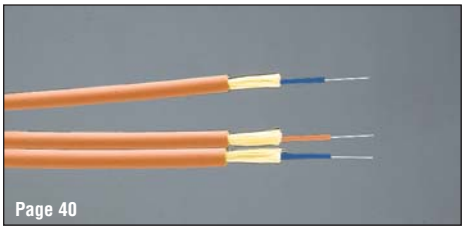
Military Tactical Cables D-Series Distribution and B-Series Breakout Cables

- Extra rugged, high-strength cable design
- Crush-resistant and resilient
- Excellent for use in deployment/retrieval applications
- Tested and in use in military applications worldwide
- Suitable for manufacturing, mining and petrochemical environments
- Excellent chemical resistance
- 2 to 24 fiber count in B-Series Breakout or D-Series Distribution construction available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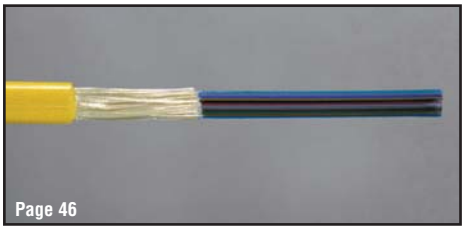
AX-Series Assembly Cables, Riser-Rated, Plenum-Rated, and Zero Halogen

- Resilient and flexible for jumpers, patch cords, and pigtails
- Suitable for general purpose indoor use, such as routing connections in patching systems
- Short “patch cord” cables ideal for links between electronic equipment and main fiber optic cables
- Compatible with all standard fiber optic connectors
- Available in 1.6 mm diameter micro design for small form-factor simplex and duplex connectors
- 1 (simplex) and 2 (duplex) fibers available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RB-Series Ribbon Cables, Riser-Rated, Plenum-Rated, and Zero Halogen

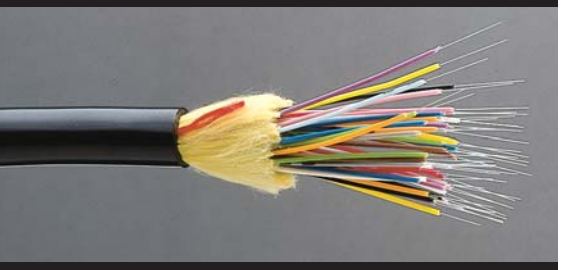
- High density interconnect cable for use with MT, MTP, MPO, and MTX connectors
- Rugged and flexible for use in patch panels and runs to workstations
- Flame-retardant UL OFNR or OFNP rated
- Zero Halogen construction available
- 4 and 6 fiber configurations are available

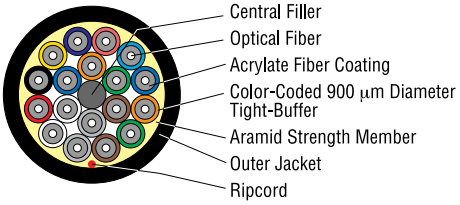
OPTICAL CABLE CORPORATION

Custom Cables

- Optical Cable Corporation welcomes new fiber optic cable design challenges for your unique applications. Call Optical Cable Corporation with your special fiber optic cable requirements.

DX-Series Distribution Cables





Standards List

Optical Cable Corporation's indoor/outdoor tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- GR-409-CORE
- ICEA-S-83-596
- ICEA-S-87-640
- ICEA-S-104-696
- TIA-568
- TIA-598-B
- TIA-758 (water-blocked cables)

UL-listed type OFNR in accordance with NEC sections 770-51 (b) and 770-53 (b) for use in vertical runs in building riser shafts or from floor to floor. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

UL-listed type OFNP in accordance with NEC sections 770-51 (a) and 770-53 (a) for use in ducts, plenums, and air-handling spaces. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

See page 50 for complete OptiReel™ details.

Features and Applications

- Used in trunking, LAN and distribution applications where small size, lightweight, and versatile installation capability are required
- Suitable for both indoor and outdoor use – no need to splice outdoor cable to indoor cable at the building entrance
- Flame-retardant for indoor installations
- Fungus-resistant, water-resistant and UV-resistant for outdoor use
- Cable can be armored for additional protection in direct burial and aerial installations
- Highest specific strength-to-weight ratio and compact cable design for limited conduit space and tight bends in long cable pulls
- Helically stranded cable core for flexibility, survival in difficult pulls, and mechanical protection for the optical fibers
- Lower total installed costs
- Economical for longer distance runs where size and cable cost are more significant
- High performance tight-buffered coating on each optical fiber for environmental and mechanical protection
- 2 to 144 fibers without subgrouping for the most size efficient tight-buffered fiber optic cable available. Higher fiber counts are available upon request.
- Water-blocked D-Series and DX-Series Cables contain super-absorbent-polymer coated yarn that swells upon exposure to water

General Characteristics for DX-Series Distribution Cables

	RISER	PLENUM (Page 12)
Minimum Bend Radius:		
Under Installation Tensile Load	15X outside diameter	15X outside diameter
Under Long-Term Tensile Load	10X outside diameter	10X outside diameter (15X outside diameter for hard fluoropolymer (K) outer jacket)
Operating Temperature	-40°C to +85°C	-20°C to +85°C (S) -40°C to +85°C (K)
Storage Temperature	-55°C to +85°C	-40°C to +85°C
Crush Resistance	1,800 N/cm	1,500 N/cm
Impact Resistance	1,500 impacts	1,000 impacts
Flex Resistance	2,000 cycles	1,000 cycles

These specifications are subject to change without prior notification.

DX-Series Distribution Cables Product Specifications—Riser

Riser

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
2	DX02-045D-■■■/900-OFNR	4.5 (.18)	21 (14)	1,400 (310)	450 (100)
4	DX04-050D-■■■/900-OFNR	5.0 (.20)	25 (17)	1,400 (310)	450 (100)
6	DX06-055D-■■■/900-OFNR	5.5 (.22)	28 (19)	1,400 (310)	450 (100)
8	DX08-060D-■■■/900-OFNR	6.0 (.24)	33 (22)	1,600 (360)	525 (120)
10	DX10-065D-■■■/900-OFNR	6.5 (.26)	37 (25)	1,800 (400)	600 (135)
12	DX12-065D-■■■/900-OFNR	6.5 (.26)	37 (25)	2,700 (600)	600 (135)
14	DX14-070D-■■■/900-OFNR	7.0 (.28)	48 (32)	2,700 (600)	600 (135)
16	DX16-070D-■■■/900-OFNR	7.0 (.28)	48 (32)	2,700 (600)	700 (160)
18	DX18-070D-■■■/900-OFNR	7.0 (.28)	48 (32)	2,700 (600)	700 (160)
24	DX24-085D-■■■/900-OFNR	8.5 (.33)	65 (44)	3,000 (670)	1,000 (220)
30	DX30-090D-■■■/900-OFNR	9.0 (.35)	76 (51)	3,000 (670)	1,000 (220)
36	DX36-090D-■■■/900-OFNR	9.0 (.35)	76 (51)	3,000 (670)	1,000 (220)
48	DX48-105D-■■■/900-OFNR	10.5 (.41)	102 (69)	4,200 (940)	1,400 (310)
60	DX60-120D-■■■/900-OFNR	12.0 (.48)	127 (85)	4,800 (1,080)	1,600 (360)
72	DX72-135D-■■■/900-OFNR	13.5 (.53)	153 (103)	5,400 (1,210)	1,800 (400)
84	DX84-130D-■■■/900-OFNR	13.0 (.51)	165 (111)	6,000 (1,350)	2,000 (450)
96	DX96-150D-■■■/900-OFNR	15.0 (.59)	238 (160)	6,000 (1,350)	2,000 (450)
108	DX108-145D-■■■/900-OFNR	14.5 (.57)	186 (125)	6,000 (1,350)	2,000 (450)
120	DX120-150D-■■■/900-OFNR	15.0 (.59)	194 (130)	6,000 (1,350)	2,000 (450)
132	DX132-155D-■■■/900-OFNR	15.5 (.61)	207 (139)	6,000 (1,350)	2,000 (450)
144	DX144-195D-■■■/900-OFNR	19.5 (.76)	315 (212)	6,000 (1,350)	2,000 (450)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Installation loads in excess of 2,700 N (600 lbs.) are not recommended.
Other fiber counts available upon request.

For Ultra-Fox™ Plus (Page 6)
Cable type designation is "D" rather than "DX".
A typical part number would be
D06-055D-ALT/900-OFNR.

DX-Series Distribution Cables Product Specifications—Plenum

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

Plenum

Fiber Count	(62.5/125) Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
2	DX02-040S-■■■/900-OFNP	4.0 (.16)	14 (9)	1,200 (270)	400 (90)
4	DX04-045S-■■■/900-OFNP	4.5 (.18)	17 (11)	1,200 (270)	400 (90)
6	DX06-050K-■■■/900-OFNP ▲	4.5 (.18)	20 (13)	1,400 (310)	450 (100)
6	DX06-050S-■■■/900-OFNP	5.0 (.20)	22 (15)	1,400 (310)	450 (100)
8	DX08-055K-■■■/900-OFNP ▲	5.5 (.22)	28 (19)	1,600 (360)	525 (120)
8	DX08-055S-■■■/900-OFNP	5.5 (.22)	28 (19)	1,600 (360)	525 (120)
12	DX12-060K-■■■/900-OFNP ▲	6.0 (.24)	28 (19)	2,700 (600)	600 (135)
12	DX12-055S-■■■/900-OFNP	5.5 (.22)	28 (19)	1,800 (400)	600 (135)
18	DX18-060K-■■■/900-OFNP ▲	6.0 (.24)	41 (28)	2,700 (600)	700 (160)
18	DX18-065S-■■■/900-OFNP	6.5 (.26)	41 (28)	2,100 (470)	700 (160)
24	DX24-070K-■■■/900-OFNP ▲	7.0 (.28)	54 (36)	3,000 (670)	1,000 (220)
30	DX30-080K-■■■/900-OFNP ▲	8.0 (.31)	78 (52)	3,000 (670)	1,000 (220)
36	DX36-080K-■■■/900-OFNP ▲	8.0 (.28)	78 52	3,000 (670)	1,000 (220)
42	DX42-095K-■■■/900-OFNP ▲	9.5 (.37)	92 (62)	4,200 (940)	1,400 (310)
48	DX48-095K-■■■/900-OFNP ▲	9.5 (.37)	92 (62)	4,200 (940)	1,400 (310)
54	DX54-100K-■■■/900-OFNP ▲	10.0 (.39)	104 (70)	4,800 (1,080)	1,600 (360)
60	DX60-100K-■■■/900-OFNP ▲	10.0 (.39)	108 (73)	4,800 (1,080)	1,600 (360)
66	DX66-105K-■■■/900-OFNP ▲	10.5 (.41)	113 (76)	5,400 (1,200)	1,800 (400)
72	DX72-125K-■■■/900-OFNP ▲	12.5 (.50)	124 (83)	5,400 (1,200)	1,800 (400)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

▲ – K jacket material should be specified for indoor/outdoor plenum applications including severe chemical environments such as petrochemical.

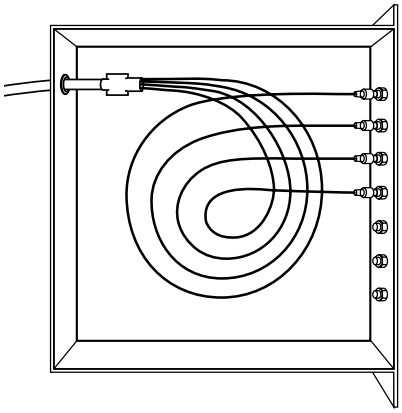
S jacket material for indoor use only.

2-fiber to 18-fiber cables standard with soft plenum (S) thermoplastic outer jacket, optional hard fluoropolymer (K) outer jacket. 24-fiber to 84-fiber cables standard with hard fluoropolymer (K) outer jacket, including severe chemical environments such as petrochemical.
Installation loads in excess of 2,700 N (600 lbs.) are not recommended.
Other fiber counts available upon request.

DX-Series Distribution Cables
Typical Termination Approach

In a Typical Installation, DX-Series Distribution Cables:

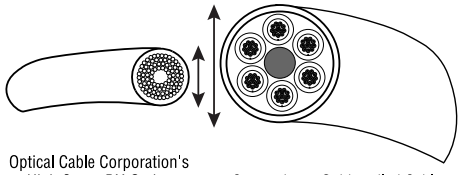
- Allow direct termination with connectors
- Reduce installation cost –
  - eliminate breakout/fanout kits and tubing, splicing of pigtails
  - reduce material cost
  - reduce labor cost
- Improve link budget –
  - eliminate splice loss
- Can be used both indoors and outdoors –
  - eliminate splices and discontinuities
  - improve reliability
  - reduce cost



Simplified Direct Termination in a Protective Box

Patch Cable Connection to Equipment

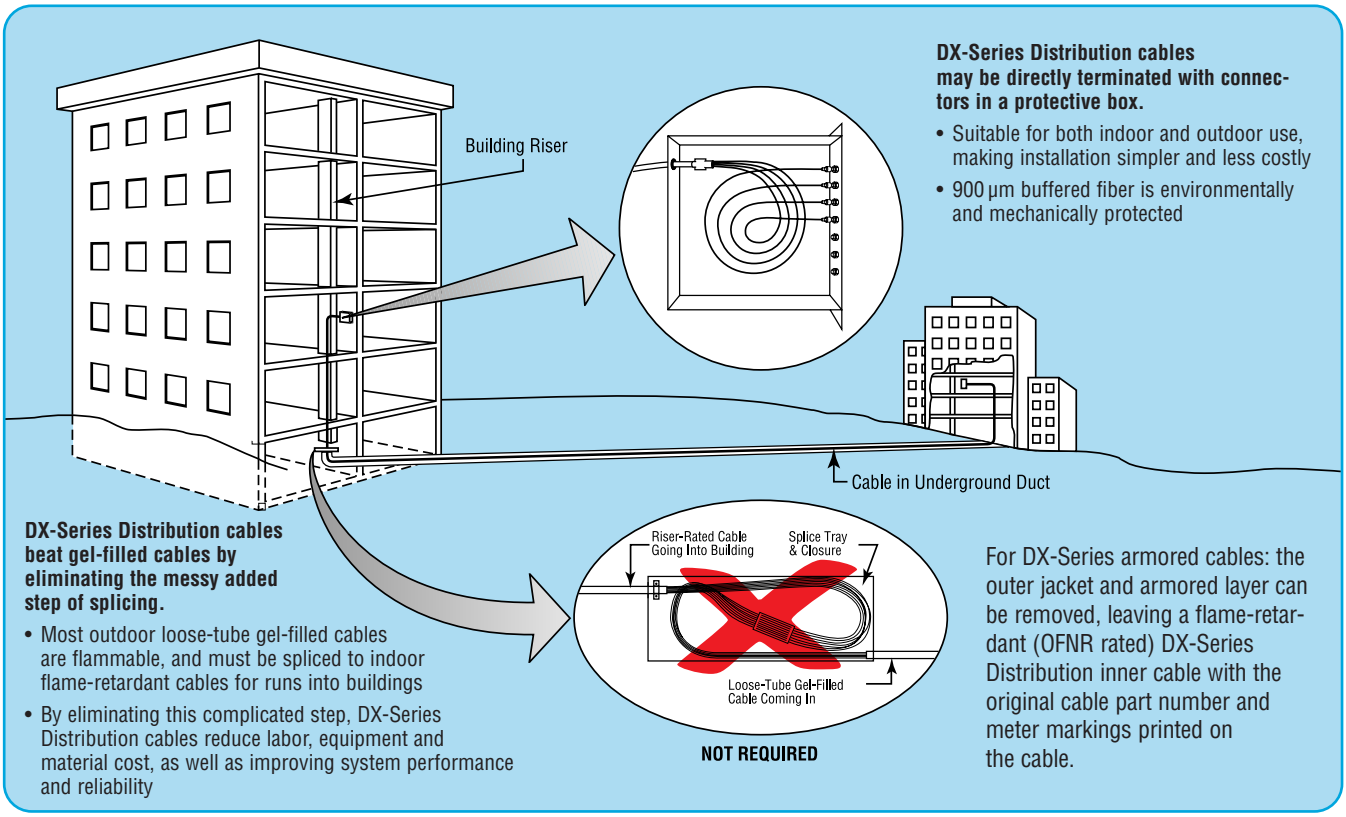
50% smaller diameter than competing cables



Optical Cable Corporation's High Count DX-Series Distribution Cable

Competitor's Subbundled Cable

High-density packaging gives DX-Series Distribution cables half the diameter of competing cables. As a result, they can deliver high fiber counts through cramped spaces and around tight corners.



DX-Series Distribution cables may be directly terminated with connectors in a protective box.

- Suitable for both indoor and outdoor use, making installation simpler and less costly
- 900 µm buffered fiber is environmentally and mechanically protected

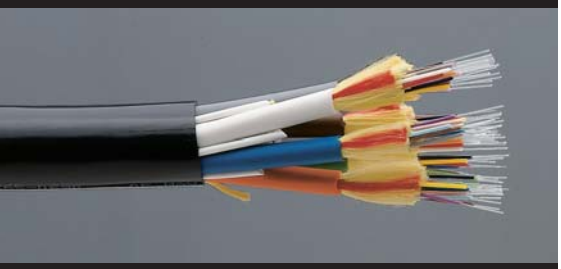
DX-Series Distribution cables beat gel-filled cables by eliminating the messy added step of splicing.

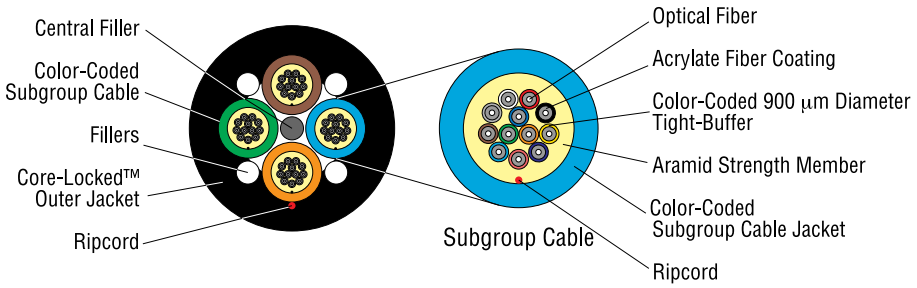
- Most outdoor loose-tube gel-filled cables are flammable, and must be spliced to indoor flame-retardant cables for runs into buildings
- By eliminating this complicated step, DX-Series Distribution cables reduce labor, equipment and material cost, as well as improving system performance and reliability

For DX-Series armored cables: the outer jacket and armored layer can be removed, leaving a flame-retardant (OFNR rated) DX-Series Distribution inner cable with the original cable part number and meter markings printed on the cable.

GX-Series Subgrouping Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU





Features and Applications

- Tight-buffered multifiber cable design allows subcables to be routed to multiple locations such as in wiring racks or wiring closets
- Core-Locked™ outer jacket surrounds the subcables for excellent crush resistance, survivability and use in long vertical installations
- Multifiber color-coded subcables, each similar to the DX-Series Distribution Cable
- Best design for multimode and single-mode fiber hybrid/composite cables (See part number note on page 24.)
- Color-coded subcables are easy to identify for improved cable management in routing and termination
- Helically stranded cable core for flexibility, survival in difficult pulls, and mechanical protection for the optical fibers
- Cable ideal for direct pulling with wire mesh grips
- High performance tight-buffered coating on each optical fiber for environmental and mechanical protection
- Suitable for both indoor and outdoor use — no need to splice outdoor cable to indoor cable at the building entrance
- Flame-retardant for indoor installations
- Fungus-resistant, water-resistant and UV-resistant for outdoor use
- Subgroup cables of GX-Series plenum cables are individually plenum-rated and can be UL plenum labeled
- 12 to 288 fibers in various subgroup cable sizes, higher fiber counts available upon request
- Water-blocked G-Series and GX-Series Cables contain super-absorbent-polymer coated yarn that swells upon exposure to water

Standards List

Optical Cable Corporation's indoor/outdoor tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- GR-409-CORE
- ICEA-S-83-596
- ICEA-S-87-640
- ICEA-S-104-696
- TIA-568
- TIA-598-B
- TIA-758 (water-blocked cables)

UL-listed type OFNR in accordance with NEC sections 770-51 (b) and 770-53 (b) for use in vertical runs in building riser shafts or from floor to floor. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

UL-listed type OFNP in accordance with NEC sections 770-51 (a) and 770-53 (a) for use in ducts, plenums, and air-handling spaces. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

General Characteristics for GX-Series Subgrouping Cables

	RISER	PLENUM (Page 16)
Minimum Bend Radius:		
Under Installation Tensile Load	15X outside diameter	15X outside diameter
Under Long-Term Tensile Load	10X outside diameter	15X outside diameter
Operating Temperature	-40°C to +85°C	-40°C to +85°C
Storage Temperature	-55°C to +85°C	-40°C to +85°C
Crush Resistance	2,100 N/cm	2,100 N/cm
Impact Resistance	1,500 impacts	1,500 impacts
Flex Resistance	2,000 cycles	2,000 cycles

These specifications are subject to change without prior notification.

GX-Series Subgrouping Cables Product Specifications—Riser

Riser

6-Fiber Subgroups (4.5 mm Bundles) 900 µm Buffer (Up to 72 fiber count cable available.)

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
12	GX12-145D-■■■/900-OFNR	14.5 (.57)	186 (125)	3,800 (850)	1,200 (270)
18	GX18-145D-■■■/900-OFNR	14.5 (.57)	186 (125)	4,700 (1,060)	1,800 (400)
24	GX24-145D-■■■/900-OFNR	14.5 (.57)	186 (125)	5,600 (1,260)	1,800 (400)
30	GX30-150D-■■■/900-OFNR	15.0 (.59)	194 (130)	7,500 (1,690)	2,400 (540)
36	GX36-170D-■■■/900-OFNR	17.0 (.67)	235 (158)	8,900 (2,000)	2,850 (640)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Higher fiber counts are also available in 6-fiber subgroups.

12-Fiber Subgroups (5.5 mm Bundles) 900 µm Buffer

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
24	GX24-165D-■■■/900-OFNR	16.5 (.65)	235 (158)	4,600 (1,030)	1,500 (340)
36	GX36-165D-■■■/900-OFNR	16.5 (.65)	235 (158)	5,900 (1,330)	1,950 (440)
48	GX48-165D-■■■/900-OFNR	16.5 (.65)	235 (158)	7,200 (1,620)	2,400 (540)
60	GX60-185D-■■■/900-OFNR	18.5 (.73)	315 (212)	9,500 (2,140)	3,150 (710)
72	GX72-205D-■■■/900-OFNR	20.5 (.80)	305 (205)	11,300 (2,540)	3,750 (840)
84	GX84-220D-■■■/900-OFNR	22.0 (.87)	342 (230)	13,100 (2,950)	4,350 (980)
96	GX96-245D-■■■/900-OFNR	24.5 (.96)	393 (264)	14,900 (3,350)	4,950 (1,110)
108	GX108-265D-■■■/900-OFNR	26.5 (1.0)	426 (286)	18,200 (4,090)	6,000 (1,350)
120	GX120-285D-■■■/900-OFNR	28.5 (1.12)	712 (478)	19,500 (4,380)	6,450 (1,450)
132	GX132-280D-■■■/900-OFNR	28.0 (1.10)	597 (400)	20,800 (4,680)	6,900 (1,550)
144	GX144-280D-■■■/900-OFNR	28.0 (1.10)	597 (400)	22,100 (4,970)	7,350 (1,650)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

*Note: 144-, 216-, and 288-fiber cables available using 24-, 36-, and 48-fiber subgroups, respectively. Call Optical Cable Corporation for complete details.

Installation loads in excess of 2,700 N (600 lbs.) are not recommended.
Other fiber counts available upon request.

For Ultra-Fox™ Plus (Page 6)
Cable type designation is "G" rather than "GX".
A typical part number would be
G48-165D-ALT/900-OFNR.
(12-fiber subgroups, 5.5 mm bundles).

Plenum

6-Fiber Subgroups (4.5 mm Bundles) 900 µm Buffer (Up to 144 fiber count cable available.)

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
12	GX12-125K-■■■/900-OFNP	12.5 (.49)	139 (93)	3,800 (850)	1,200 (270)
18	GX18-125K-■■■/900-OFNP	12.5 (.49)	142 (95)	4,700 (1,060)	1,500 (340)
24	GX24-125K-■■■/900-OFNP	12.5 (.49)	145 (97)	5,600 (1,260)	1,800 (400)
30	GX30-135K-■■■/900-OFNP	13.5 (.53)	158 (106)	7,500 (1,690)	2,400 (540)
36	GX36-150K-■■■/900-OFNP	15.0 (.59)	184 (124)	8,900 (2,000)	2,850 (640)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Higher fiber counts are also available in 6-fiber subgroups.

12-Fiber Subgroups (5.5 mm Bundles) 900 µm Buffer

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
24	GX24-140K-■■■/900-OFNP	14.0 (.55)	158 (106)	4,600 (1,030)	1,500 (340)
36	GX36-140K-■■■/900-OFNP	14.0 (.55)	161 (108)	5,900 (1,330)	1,950 (440)
48	GX48-140K-■■■/900-OFNP	14.0 (.55)	218 (146)	7,200 (1,620)	2,400 (540)
60	GX60-160K-■■■/900-OFNP	16.0 (.63)	232 (156)	9,500 (2,140)	3,150 (710)
72	GX72-175K-■■■/900-OFNP	17.5 (.69)	256 (172)	11,300 (2,540)	3,750 (840)
84	GX84-190K-■■■/900-OFNP	19.0 (.75)	506 (340)	13,100 (2,950)	4,350 (980)
96	GX96-225K-■■■/900-OFNP	22.5 (.88)	609 (409)	14,900 (3,350)	4,950 (1,110)
108	GX108-255K-■■■/900-OFNP	25.5 (1.0)	562 (378)	18,200 (4,090)	6,000 (1,350)
120	GX120-280K-■■■/900-OFNP	28.0 (1.10)	617 (415)	19,500 (4,380)	6,450 (1,450)
132	GX132-255K-■■■/900-OFNP	25.5 (1.0)	562 (378)	20,800 (4,680)	6,900 (1,550)
144	GX144-255K-■■■/900-OFNP	25.5 (1.0)	562 (378)	22,100 (4,970)	7,350 (1,650)

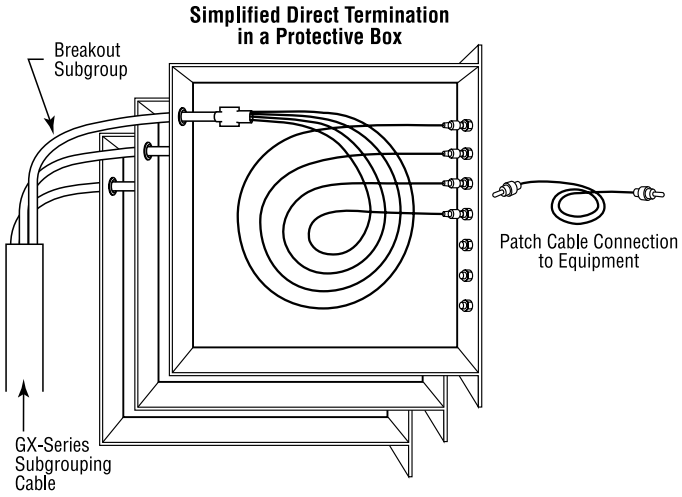
* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

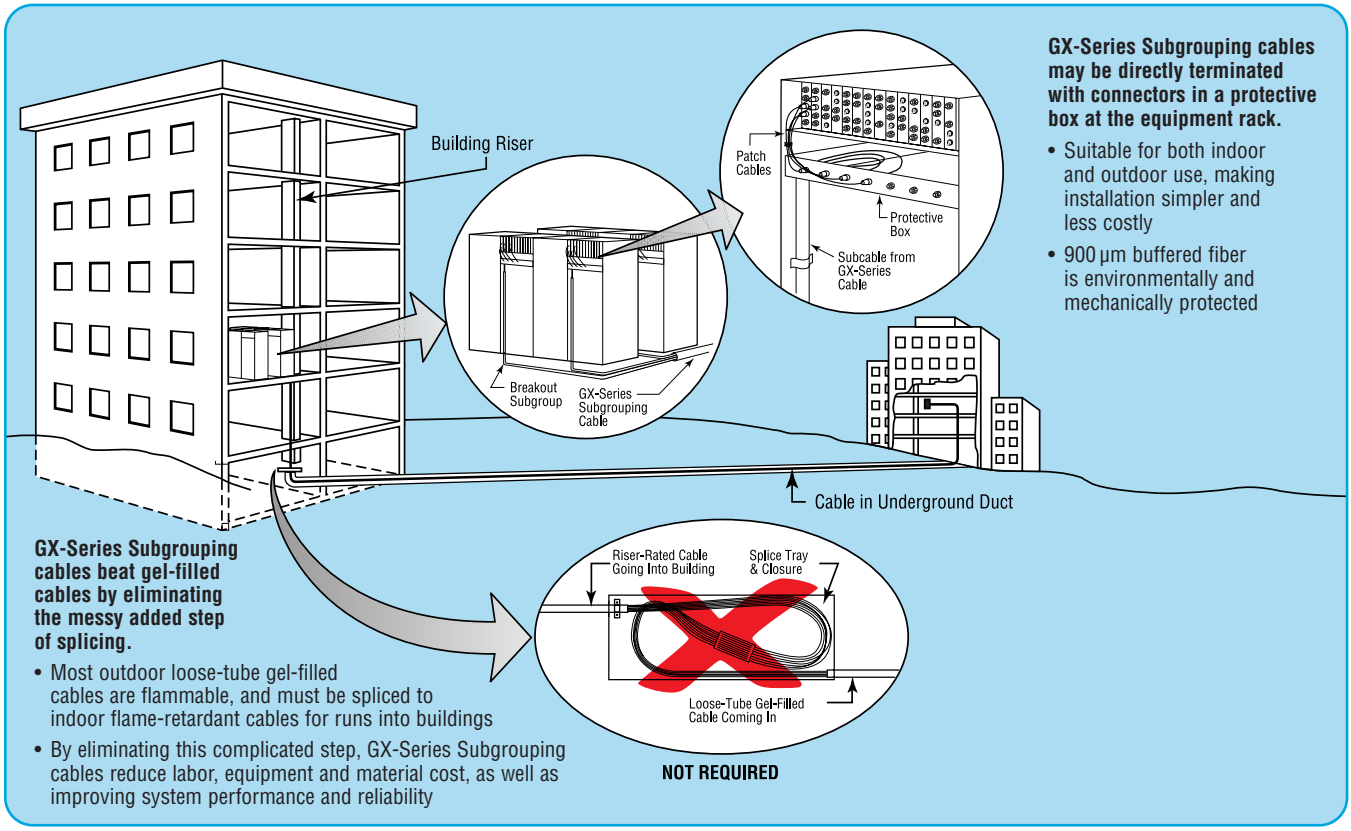
Ideal for indoor/outdoor and harsh chemical environments including petrochemical.

GX-Series Subgrouping Cables
Typical Termination Approach

In a Typical Installation, GX-Series Subgrouping Cables:

- Provide efficient, economical cabling to multiple destinations within a facility without further protection, splicing or retermination for distribution
- Permit easy installation of high fiber counts, even through tight spaces, due to highly dense cable construction
- Allow separation and identification of groups of different fibers, such as single-mode and multimode, each in different subgroup cables
- Permit direct termination with connectors, reducing material and installation cost
- Can be used both indoors and outdoors –
  - eliminate splices and discontinuities
  - improve reliability
  - reduce cost





GX-Series Subgrouping cables may be directly terminated with connectors in a protective box at the equipment rack.

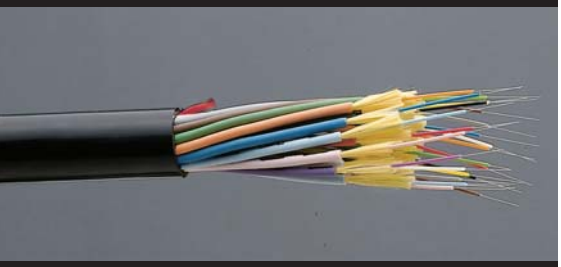
- Suitable for both indoor and outdoor use, making installation simpler and less costly
- 900 µm buffered fiber is environmentally and mechanically protected

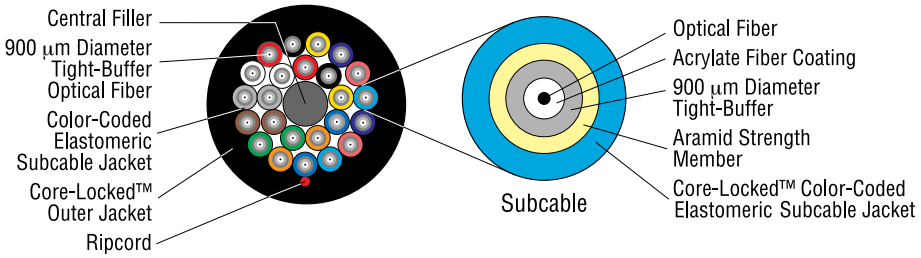
GX-Series Subgrouping cables beat gel-filled cables by eliminating the messy added step of splicing.

- Most outdoor loose-tube gel-filled cables are flammable, and must be spliced to indoor flame-retardant cables for runs into buildings
- By eliminating this complicated step, GX-Series Subgrouping cables reduce labor, equipment and material cost, as well as improving system performance and reliability

BX-Series Breakout Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU





Standards List

Optical Cable Corporation's indoor/outdoor tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- GR-409-CORE
- ICEA-S-83-596
- ICEA-S-87-640
- ICEA-S-104-696
- TIA-568
- TIA-598-B
- TIA-758 (water-blocked cable)

UL-listed type OFNR in accordance with NEC sections 770-51 (b) and 770-53 (b) for use in vertical runs in building riser shafts or from floor to floor. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

UL-listed type OFNP in accordance with NEC sections 770-51 (a) and 770-53 (a) for use in ducts, plenums, and air-handling spaces. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

Features and Applications

- Most rugged and "installer 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
- Core-Locked™ outer jacket design for installation survivability, long-term, trouble-free service and use in long, vertical installations
- Subcables are designed for direct termination with standard connectors
- Cable ideal for direct pulling with wire mesh grips
- Helically stranded cable core for flexibility, survival in difficult pulls, and mechanical protection for the optical fibers
- Suitable for both indoor and outdoor use – no need to splice outdoor cable to indoor cable at the building entrance
- Flame-retardant for indoor installations
- Fungus-resistant, water-resistant and UV-resistant for outdoor use
- High performance tight-buffered coating on each optical fiber for environmental and mechanical protection
- Elastomeric jacket encases each optical fiber and surrounding aramid strength members to provide a ruggedized subcable
- 2 to 108 fibers, higher fiber counts are available upon request
- Water-blocked B-Series and BX-Series Cables contain super-absorbent-polymer coated yarn that swells upon exposure to water

General Characteristics for BX-Series Breakout Cables

	RISER	PLENUM (Page 20)
Minimum Bend Radius:		
Under Installation Tensile Load	15X outside diameter	15X outside diameter
Under Long-Term Tensile Load	10X outside diameter	15X outside diameter
Operating Temperature	-40°C to +85°C	-40°C to +85°C
Storage Temperature	-55°C to +85°C	-40°C to +85°C
Crush Resistance	2,200 N/cm	2,100 N/cm
Impact Resistance	1,500 impacts	1,000 impacts
Flex Resistance	2,000 cycles	2,000 cycles

These specifications are subject to change without prior notification.

BX-Series Breakout Cables Product Specifications—Riser

Riser

Standard (2.5 mm Subcable) (Up to 108 fiber count cable available.)

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
2	BX02-070D-■■■/900-OFNR	7.0 (.28)	50 (34)	1,200 (270)	500 (110)
4	BX04-080D-■■■/900-OFNR	8.0 (.31)	65 (44)	2,000 (450)	800 (180)
6	BX06-095D-■■■/900-OFNR	9.5 (.37)	82 (55)	3,000 (670)	1,200 (270)
8	BX08-115D-■■■/900-OFNR	11.5 (.45)	111 (75)	4,000 (900)	1,700 (380)
12	BX12-125D-■■■/900-OFNR	12.5 (.49)	150 (101)	6,000 (1,350)	2,500 (560)
18	BX18-150D-■■■/900-OFNR	15.0 (.59)	210 (141)	8,000 (1,800)	3,500 (790)
24	BX24-175D-■■■/900-OFNR	17.5 (.69)	273 (183)	10,000 (2,250)	3,800 (850)
30	BX30-200D-■■■/900-OFNR	20.0 (.79)	318 (214)	14,000 (3,150)	6,000 (1,350)
36	BX36-200D-■■■/900-OFNR	20.0 (.79)	318 (214)	14,000 (3,150)	6,000 (1,350)
48	BX48-235D-■■■/900-OFNR	23.5 (.93)	393 (264)	18,000 (4,050)	7,500 (1,690)
60	BX60-255D-■■■/900-OFNR	25.5 (1.0)	577 (388)	22,000 (4,950)	8,800 (1,980)
72	BX72-275D-■■■/900-OFNR	27.5 (1.08)	612 (411)	26,000 (5,845)	11,000 (2,470)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

*Note: Also available in 2.0 mm subcable

Installation loads in excess of 2,700 N (600 lbs.) are not recommended.
Other fiber counts available upon request.

For Ultra-Fox™ Plus (Page 6)
Cable type designation is "B" rather than "BX".
A typical part number would be
B06-095D-ALT/900-OFNR

Plenum

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
Mini	**(2.0 mm Subcable)**				
2	BX02-060K-■■■/900-OFNP	6.0 (.24)	34 (23)	1,600 (360)	400 (90)
4	BX04-060K-■■■/900-OFNP	6.0 (.24)	34 (23)	1,600 (360)	400 (90)
6	BX06-070K-■■■/900-OFNP	7.0 (.28)	48 (32)	2,400 (540)	600 (130)
8	BX08-085K-■■■/900-OFNP	8.5 (.33)	71 (48)	3,200 (720)	800 (180)
12	BX12-100K-■■■/900-OFNP	10.0 (.39)	94 (63)	4,800 (1,080)	1,200 (270)
18	BX18-110K-■■■/900-OFNP	11.0 (.43)	114 (77)	6,000 (1,350)	1,500 (340)
24	BX24-130K-■■■/900-OFNP	13.0 (.51)	147 (99)	7,200 (1,620)	1,800 (400)
30	BX30-145K-■■■/900-OFNP	14.5 (.57)	218 (154)	9,600 (2,160)	2,400 (540)
36	BX36-160K-■■■/900-OFNP	16.0 (.63)	218 (154)	9,600 (2,160)	2,400 (540)
48	BX48-185K-■■■/900-OFNP	18.5 (.73)	274 (184)	12,000 (2,700)	3,000 (670)
60	BX60-195K-■■■/900-OFNP	19.5 (.77)	333 (224)	14,400 (3,240)	3,600 (810)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

*Note: Available with 2.5 mm or 3.0 mm subcables.

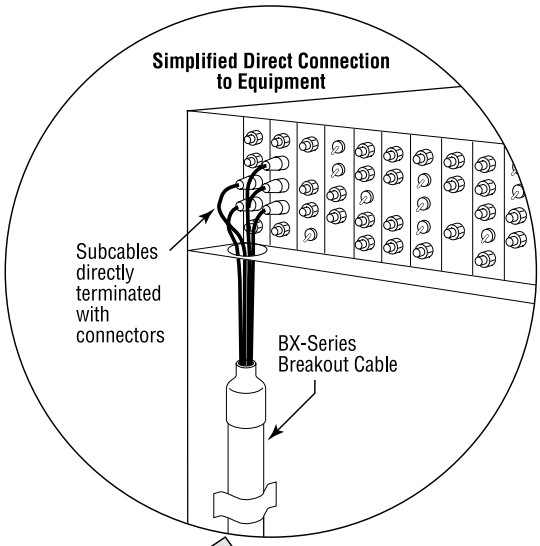
Installation loads in excess of 2,700 N (600 lbs.) are not recommended.
Other fiber counts available upon request.

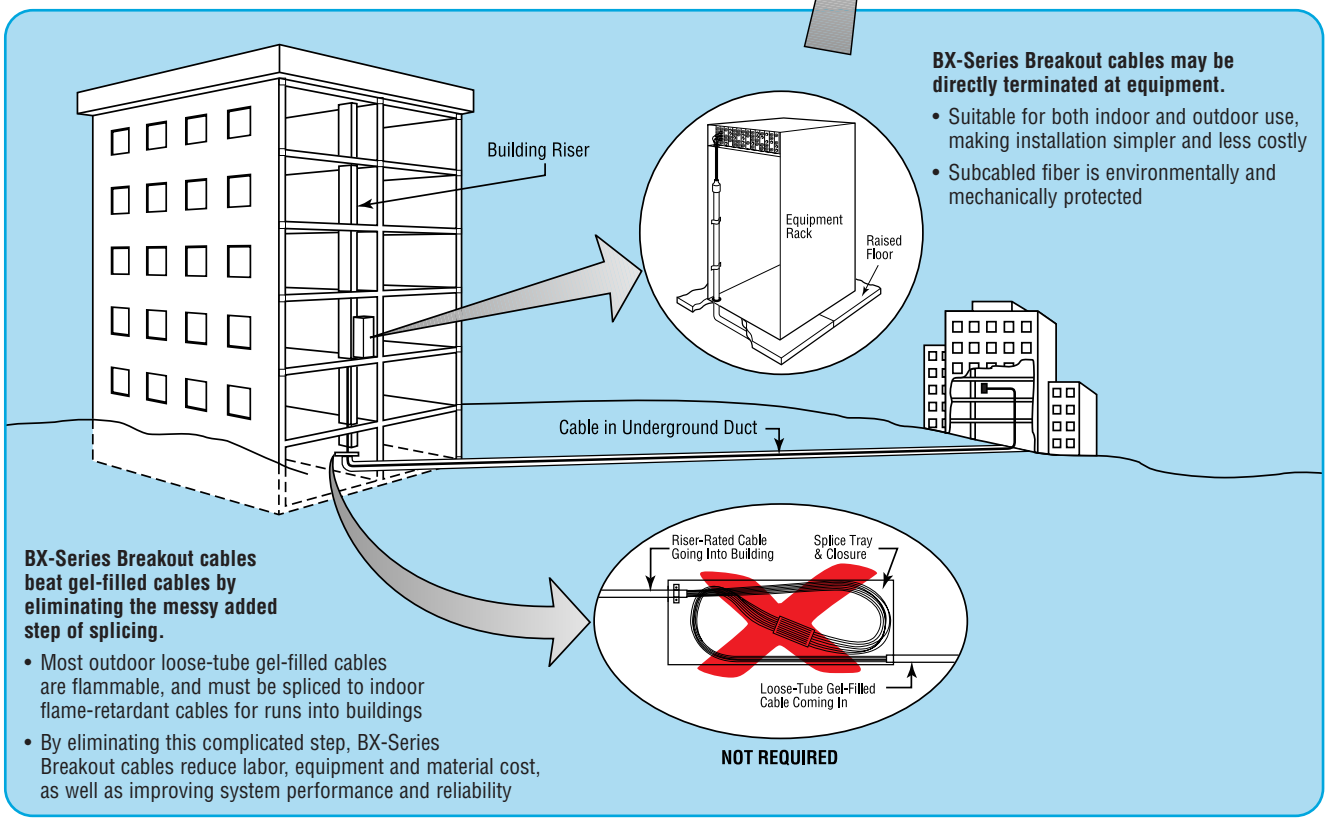
"K" jacket material for indoor/outdoor plenum applications including severe chemical environments such as:
- Petrochemical
- Acids
- Chlorine

BX-Series Breakout Cables
Typical Termination Approach

In a Typical Installation, BX-Series Breakout Cables:

- Allow direct termination of subcables with connectors –
  - full mechanical termination to subcable strength members
  - total environmental protection from connector end to connector end
- Reduce installation cost –
  - eliminate breakout/fanout kits and tubing, splicing of pigtails
  - eliminate patch panels, patch cords and connector losses
  - reduce material cost
  - reduce labor cost
- Ideal for use in point-to-point runs in adverse environments
- Improve link budget –
  - eliminate splice loss
- Can be used both indoors and outdoors –
  - eliminate splices and discontinuities
  - improve reliability
  - reduce cost





BX-Series Breakout cables may be directly terminated at equipment.

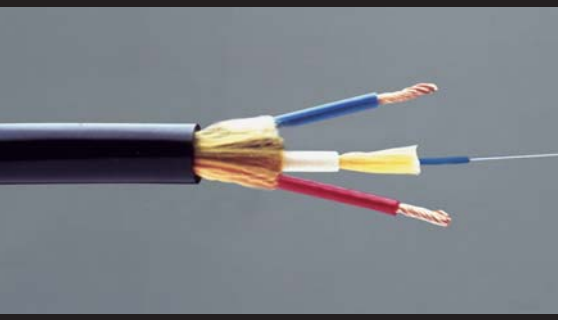
- Suitable for both indoor and outdoor use, making installation simpler and less costly
- Subcabled fiber is environmentally and mechanically protected

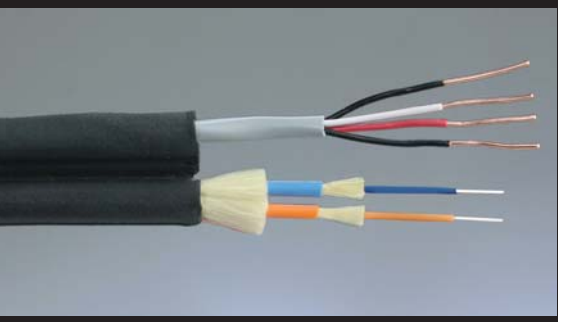
BX-Series Breakout cables beat gel-filled cables by eliminating the messy added step of splicing.

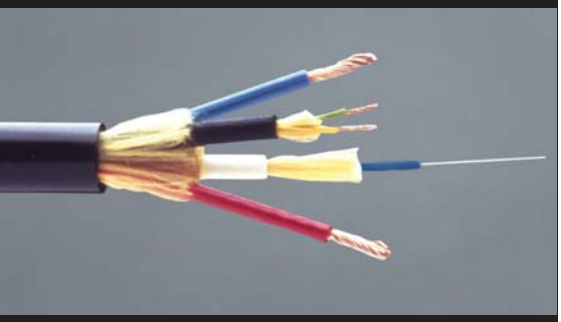
- Most outdoor loose-tube gel-filled cables are flammable, and must be spliced to indoor flame-retardant cables for runs into buildings
- By eliminating this complicated step, BX-Series Breakout cables reduce labor, equipment and material cost, as well as improving system performance and reliability

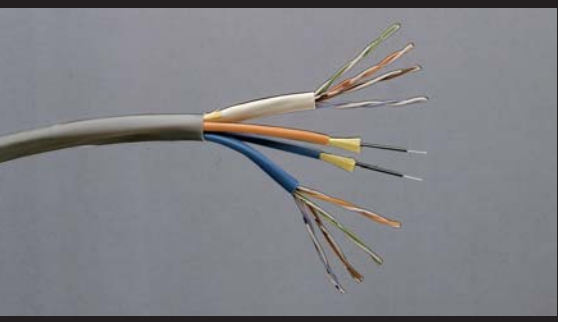
Composite Fiber/Copper Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

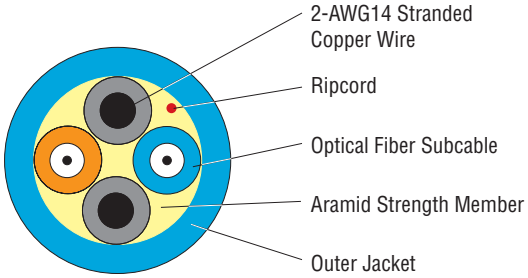








Any combination of optical fibers and wires can be manufactured to your specific requirements. Please contact Optical Cable Corporation for a price quotation for the Composite Fiber/Copper Cable design that meets all your special application requirements.



Features and Applications

- Various combinations of copper conductors and optical fibers in a single composite cable
- Other data and voice grade, or power conductors are available
- Larger gauge wires overcome powering distance limitations of CAT 3 and CAT 5
- Copper and fiber individually subcabled for ease of separation, handling and termination
- Round cable design for easy installation and survivability
- Many combinations available with riser-ratings or plenum-ratings
- Excellent chemical-resistant outer cable jacket for inside/outside plant environments

General Characteristics for Composite Fiber/Copper Cables

	PLENUM (Indoor/Outdoor)	Outdoor
Minimum Bend Radius:		
Under Installation Tensile Load	15X outside diameter	15X outside diameter
Under Long-Term Tensile Load	15X outside diameter	10X outside diameter
Operating Temperature	-20ºC to +85ºC	-20ºC to +85ºC
Storage Temperature	-40ºC to +85ºC	-40ºC to +85ºC

These specifications are subject to change without prior notification.

Composite Fiber/Copper Cables
Product Specifications

Plenum (Indoor/Outdoor)

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')
18-Gauge			
1	CX03-065K-1■■■-2AWG18/900-CL2P-OF	6.5 (.26)	55 (37)
2	CX04-065K-2■■■-2AWG18/900-CL2P-OF	6.5 (.26)	55 (37)
4	CX06-080K-4■■■-2AWG18/900-CL2P-OF	8.0 (.32)	69 (47)
6	CX08-100K-6■■■-2AWG18/900-CL2P-OF	10.0 (.39)	92 (62)
16-Gauge			
1	CX03-070K-1■■■-2AWG16/900-CL2P-OF	7.0 (.31)	73 (49)
2	CX04-070K-2■■■-2AWG16/900-CL2P-OF	7.0 (.31)	73 (49)
4	CX06-090K-4■■■-2AWG16/900-CL2P-OF	9.0 (.35)	95 (64)
6	CX08-100K-6■■■-2AWG16/900-CL2P-OF	10.0 (.39)	120 (81)
14-Gauge			
1	CX03-080K-1■■■-2AWG14/900-CL2P-OF	8.0 (.32)	121 (81)
2	CX04-080K-2■■■-2AWG14/900-CL2P-OF	8.0 (.32)	121 (81)
4	CX06-095K-4■■■-2AWG14/900-CL2P-OF	9.5 (.37)	143 (96)
6	CX08-130K-6■■■-2AWG14/900-CL2P-OF	13.0 (.51)	168 (113)
12-Gauge			
1	CX03-090K-1■■■-2AWG12/900-CL2P-OF	9.0 (.35)	163 (109)
2	CX04-090K-2■■■-2AWG12/900-CL2P-OF	9.0 (.35)	163 (109)
4	CX06-115K-4■■■-2AWG12/900-CL2P-OF	11.5 (.45)	179 (120)
6	CX08-150K-6■■■-2AWG12/900-CL2P-OF	15.0 (.60)	204 (137)

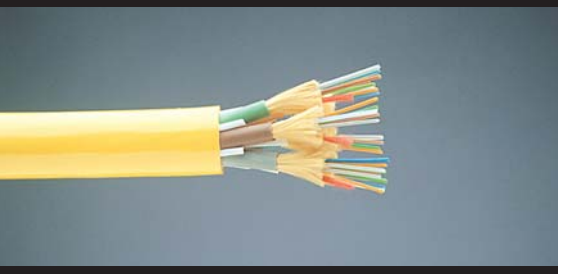
* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Outdoor

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')
18-Gauge			
1	CX03-065A-1■■■-2AWG18/900	6.5 (.26)	65 (44)
2	CX04-065A-2■■■-2AWG18/900	6.5 (.26)	65 (44)
4	CX06-080A-4■■■-2AWG18/900	8.0 (.32)	74 (50)
6	CX08-100A-6■■■-2AWG18/900	10.0 (.39)	95 (64)
16-Gauge			
1	CX03-085A-1■■■-2AWG16/900	8.5 (.33)	96 (64)
2	CX04-085A-2■■■-2AWG16/900	8.5 (.33)	96 (64)
4	CX06-100A-4■■■-2AWG16/900	10.0 (.39)	101 (68)
6	CX08-125A-6■■■-2AWG16/900	12.5 (.49)	111 (74)
14-Gauge			
1	CX03-090A-1■■■-2AWG14/900	9.0 (.35)	120 (81)
2	CX04-090A-2■■■-2AWG14/900	9.0 (.35)	120 (81)
4	CX06-110A-4■■■-2AWG14/900	11.0 (.43)	144 (96)
6	CX08-135A-6■■■-2AWG14/900	13.5 (.54)	151 (102)
12-Gauge			
1	CX03-105A-1■■■-2AWG12/900	10.5 (.41)	161 (109)
2	CX04-105A-2■■■-2AWG12/900	10.5 (.41)	161 (109)
4	CX06-125A-4■■■-2AWG12/900	12.5 (.49)	235 (158)
6	CX08-155A-6■■■-2AWG12/900	15.5 (.62)	276 (186)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

DX-Series



GX-Series

Features and Applications

- Hybrid cables are for applications requiring both multimode and single-mode optical fibers within one jacket
- Hybrid cables can be UL rated for either riser or plenum environments
- Many other cable types and fiber counts are available

Riser

Fiber Count	Multimode Fibers	Single-Mode Fibers	Sample Part Number*
DX-Series Distribution Cables (See pages 10-11 for complete Product Specifications)			
12	6	6	DX12-065D-6■■■-6■■■/900-OFNR
12	8	4	DX12-065D-8■■■-4■■■/900-OFNR
18	12	6	DX18-070D-12■■■-6■■■/900-OFNR
24	12	12	DX24-085D-12■■■-12■■■/900-OFNR
36	24	12	DX36-090D-24■■■-12■■■/900-OFNR

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Riser

Fiber Count	Multimode Fibers	Single-Mode Fibers	Sample Part Number*
GX-Series Subgrouping Cables (See pages 14-15 for complete Product Specifications) **The optical fibers are in 6-fiber subgroups (4.5 mm bundles).**			
12	6	6	GX12-145D-6■■■-6■■■/900-OFNR
24	6	18	GX24-145D-6■■■-18■■■/900-OFNR
24	12	12	GX24-145D-12■■■-12■■■/900-OFNR
36	24	12	GX36-170D-24■■■-12■■■/900-OFNR

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

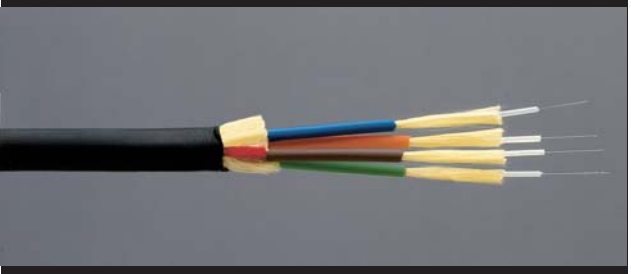
Riser

Fiber Count	Multimode Fibers	Single-Mode Fibers	Sample Part Number*
GX-Series Subgrouping Cables (See pages 14-15 for complete Product Specifications) **The optical fibers are in 12-fiber subgroups (5.5 mm bundles).**			
24	12	12	GX24-165D-12■■■-12■■■/900-OFNR
36	24	12	GX36-165D-24■■■-12■■■/900-OFNR

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

*Sample part numbers are for riser-rated cables. Plenum-rated cables have a different diameter number, jacket cable and -OFNP suffix on the part number.
**Many other cable type and fiber count options are available.
Please contact Optical Cable Corporation for details.**

Zero Halogen Cables



Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- MIL-C-24643
- NES 711
- NES 713
- TIA-568
- TIA-598-B
- TIA-758 (water-blocked cable)

Features and Applications

- LSZH (Low Smoke/Zero Halogen)
- Meets low-smoke, low-toxicity standards
- Round cable construction for easy handling and termination, and includes a ripcord for easy outer jacket removal
- Indoor/outdoor cable jacket is free of halogens including chlorine, fluorine, bromine and iodine
- Essentially similar to the cable design of the DX-Series Distribution, BX-Series Breakout and AX-Series Assembly riser-rated cables. Fiber count range is 2-40 fibers for the Distribution and Breakout cables, and 1-2 fibers for the Assembly Cables.
- In case of a fire, some cables release toxic gases which can be harmful to the public and firefighters, as well as corrosive to electronic equipment. The low-smoke, zero-halogen outer cable jacket material meets the requirements of NES 713 (toxicity index), NES 711 (smoke index) and MIL-C-24643 (acid gas test).
- Available UL-listed Riser-rated OFNR. Cables meet NEC sections 770-51 (b) and 770-53 (b) for use in vertical runs in building riser shafts or from floor to floor
- Suitable for indoor/outdoor confined spaces including:
  - Building risers
  - Cable trays
  - Central offices
  - Mass-transit rail systems
  - Nuclear plants
  - Oil refineries
  - Petrochemical facilities
  - Ships
  - Underground subway stations and tunnels
- –40°C to +85°C operating temperature

The outer jacket part number designation for indoor riser-rated Zero Halogen Cables is "F". Examples of Zero Halogen Cables are as follows:

12-fiber DX-Series Distribution Cables
DX12-065F-ALT/900-OFNR

4-fiber BX-Series Breakout Cables (Standard 2.5 mm subcables)
BX04-080F-ALT/900-OFNR

2-fiber AX-Series Assembly Cables
AX02-030F-ALT/900-OFNR

ALT - See Fiber P/N Code on Fiber Specification Guide on page 52-53.

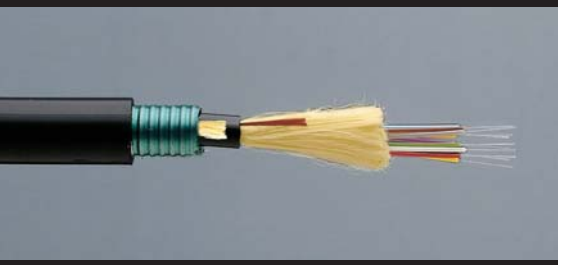
Zero Halogen Cables for special applications:

F = indoor use, riser-rated

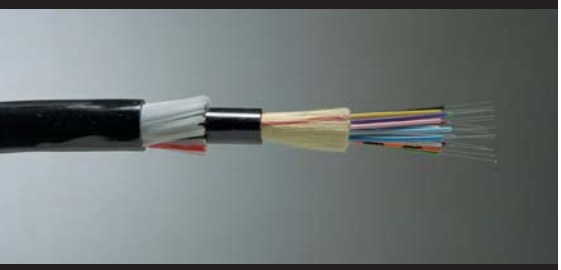
G = military simplex and duplex

Z = indoor/outdoor armored and shipboard applications

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU



Corrugated Steel Tape



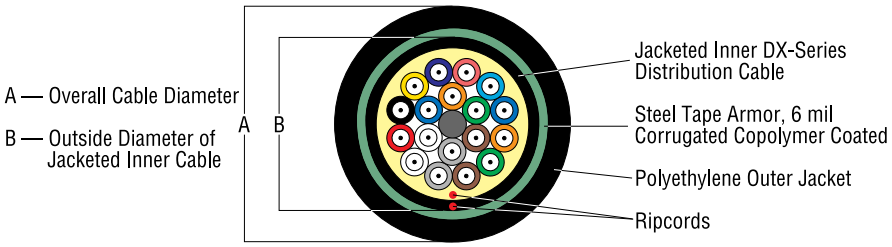
All-Dielectric

Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- TIA-568
- TIA-598-B
- TIA-758 (water-blocked cable)

Steel Armor/Polyethylene Overjacket
Construction for Rodent and Lightning Protection



Features and Applications

- Cable is suitable for direct burial and aerial applications, as well as indoor/outdoor
- Corrugated steel tape (CST) protects the fiber optic cable from rodents, and provides additional stiffness for aerial lashing, if required
- The armor is easily removed with an internal aramid strength member ripcord, leaving a flame-retardant (OFNR or OFNP rated) inner cable with the original cable part number and length markings printed on the cable. This eliminates the need to splice outdoor cable to indoor cable to meet the National Electrical Code's 50-foot maximum length requirement for outdoor cable used inside buildings.
- Armored jacket is an add-on option which can be applied to most of the riser-rated and plenum-rated cable products
- Suitable for direct field termination with most standard optical connectors
- Optional all-dielectric fiberglass yarn armor (FRP) available for rodent protection where dielectric properties, lightweight and flexibility are primary requirements of the cable. Benefits:
  (1) FRP provides an effective deterrent to damage caused by small non-burrowing rodents
  (2) FRP is ideal for use where cable is exposed in subterranean tunnels, ducts and surface installations

  Please contact Optical Cable Corporation for complete FRP specifications.
- Water-blocked Armored Cables contain super-absorbent-polymer coated yarn that swells upon exposure to water

General Characteristics for Armored Cables

Minimum Bend Radius:	
Under Installation Tensile Load	15X outside diameter
Under Long-Term Tensile Load	10X outside diameter
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +85°C
Crush Resistance	440 N/cm
Impact Resistance	20 Impacts
Flex Resistance	25 Cycles
Part Number Suffix	**-CST** (Corrugated electrolytic chrome-coated steel tape, 0.006 inch thickness) **-FRP** (Fiberglass Rodent Protection)

These specifications are subject to change without prior notification.

CST Armor Design Parameters

Inner* Diameter mm (in)	Weight Adder kg/km (lbs/1,000')	Overall Diameter mm (in)	Inner* Diameter mm (in)	Weight Adder kg/km (lbs/1,000')	Overall Diameter mm (in)	Inner* Diameter mm (in)	Weight Adder kg/km (lbs/1,000')	Overall Diameter mm (in)
5.0 (.20)	76 (51)	10.0 (.39)	12.0 (.47)	148 (99)	17.5 (.69)	19.0 (.75)	259 (174)	26.0 (1.02)
5.5 (.22)	76 (51)	10.0 (.39)	12.5 (.49)	165 (111)	19.0 (.75)	19.5 (.77)	259 (174)	26.0 (1.02)
6.0 (.24)	90 (60)	11.0 (.43)	13.0 (.51)	165 (111)	19.0 (.75)	20.0 (.79)	270 (181)	27.0 (1.06)
6.5 (.26)	90 (60)	11.0 (.43)	13.5 (.53)	169 (114)	20.0 (.79)	20.5 (.81)	270 (181)	27.0 (1.06)
7.0 (.28)	95 (64)	12.0 (.47)	14.0 (.55)	169 (114)	20.0 (.79)	21.0 (.83)	270 (181)	28.0 (1.10)
7.5 (.30)	95 (64)	12.0 (.47)	14.5 (.57)	183 (123)	21.0 (.83)	21.5 (.85)	285 (192)	28.0 (1.10)
8.0 (.31)	109 (73)	13.0 (.51)	15.0 (.59)	183 (123)	21.0 (.83)	22.0 (.87)	285 (192)	29.0 (1.14)
8.5 (.33)	109 (73)	13.0 (.51)	15.5 (.61)	188 (126)	22.0 (.87)	22.5 (.89)	295 (198)	29.0 (1.14)
9.0 (.35)	111 (75)	14.0 (.55)	16.0 (.63)	188 (126)	22.0 (.87)	23.0 (.91)	295 (198)	30.0 (1.18)
9.5 (.37)	127 (85)	15.0 (.59)	16.5 (.65)	195 (131)	23.0 (.91)	23.5 (.93)	305 (205)	30.0 (1.18)
10.0 (.39)	127 (85)	15.0 (.59)	17.0 (.67)	206 (138)	24.0 (.94)	24.0 (.94)	318 (214)	32.0 (1.26)
10.5 (.41)	134 (90)	16.5 (.65)	17.5 (.69)	221 (149)	24.0 (.94)	24.5 (.96)	318 (214)	32.0 (1.26)
11.0 (.43)	134 (90)	16.5 (.65)	18.0 (.71)	234 (157)	25.0 (.98)	25.0 (.98)	338 (227)	34.0 (1.34)
11.5 (.45)	148 (99)	17.5 (.69)	18.5 (.73)	259 (174)	25.0 (.98)			

**See DX-Series Distribution, GX-Series Subgrouping, or BX-Series Breakout riser and plenum specifications to determine the inner cable outside diameter (mm) and the tensile load rating.*

How to Use the Product Specifications Chart

Select the inner cable for which armoring is desired. Determine its outside diameter from the cable product specifications page. (For DX-Series Distribution Cables, see page 11; for GX-Series Subgrouping Cables, see page 15; for BX-Series Breakout Cables, see page 19.) In the first column of the above chart, find the diameter of the chosen inner cable. The second column in that row shows the additional weight of the armored layer. The third column shows the total diameter of the armored cable.

Example

For a 24-fiber DX-Series Distribution riser-rated Cable (page 11), the cable diameter would be 8.5 mm (.33 inches). Entering the Armor Design Parameters chart above from the "Inner Diameter" column at "8.5", the additional weight would be 109 kg/km (73 lbs/1,000 ft) and the new overall diameter would be 13.0 mm (.51 inches). A part number suffix of -CST should be added to the end of the part number taken from page 11.

Part Number Example:

DX24-085D-ALT/900-CST
8.5 diameter references subcable diameter

DX24-125D-ALT/900-FRP
12.5 diameter references overall cable diameter with a PVC jacket. FRP jacket nominally adds 4 mm to the overall cable diameter.

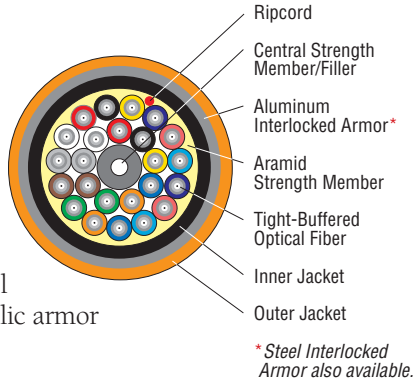
Interlocked Armored Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

Riser-Rated

Features and Applications

- Greater flexibility, cut resistance, and crush resistance than standard corrugated steel armored cables
- Available for UL riser-rated and plenum-rated environments
- Ideal cable construction for industrial and other applications requiring metallic armor
- May eliminate the need for conduit



*Steel Interlocked Armor also available.

Riser

Fiber Count	Interlocked Armored Cable Part Number*	Bare Interlocked Armor Diameter** mm (in)	Jacketed Interlocked Armor Diameter** mm (in)	Bare Interlocked Armor+Cable Weight*** kg/km (lbs/1,000')	Jacketed Interlocked Armor+Cable Weight*** kg/km (lbs/1,000')	Interlocked Armored Cable Tensile Load Rating Short-Term N (lbs)	Long-Term N (lbs)
4	DX04-050D-■■■/900-OFCR-IAD	11.4 (.45)	13.68 (.54)	87 (58)	148 (99)	1350 (304)	396 (89)
6	DX06-055D-■■■/900-OFCR-IAD	11.4 (.45)	13.68 (.54)	90 (60)	151 (101)	1350 (304)	396 (89)
12	DX12-065D-■■■/900-OFCR-IAD	12.7 (.50)	14.98 (.59)	107 (72)	174 (117)	1350 (304)	396 (89)
24	DX24-085D-■■■/900-OFCR-IAD	13.9 (.55)	16.18 (.64)	144 (97)	217 (146)	1350 (304)	396 (89)
36	DX36-090D-■■■/900-OFCR-IAD	15.2 (.60)	17.48 (.69)	163 (110)	241 (162)	1350 (304)	396 (89)
48	DX48-105D-■■■/900-OFCR-IAD	16.5 (.65)	18.78 (.74)	197 (132)	384 (258)	1350 (304)	396 (89)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

**Diameters represent the bare and jacketed interlocked armor outer diameter.

***Weights are the combined total weight of cable plus either bare interlocked armor or jacketed interlocked armor.

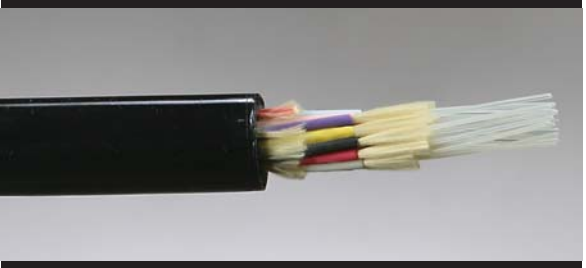
Plenum

Fiber Count	Interlocked Armored Cable Part Number*	Bare Interlocked Armor Diameter** mm (in)	Jacketed Interlocked Armor Diameter** mm (in)	Bare Interlocked Armor+Cable Weight*** kg/km (lbs/1,000')	Jacketed Interlocked Armor+Cable Weight*** kg/km (lbs/1,000')	Interlocked Armored Cable Tensile Load Rating Short-Term N (lbs)	Long-Term N (lbs)
4	DX04-045K-■■■/900-OFCP-IAK	11.4 (.45)	13.94 (.55)	79 (53)	172 (116)	1350 (304)	396 (89)
6	DX06-050K-■■■/900-OFCP-IAK	11.4 (.45)	13.94 (.55)	84 (56)	177 (119)	1350 (304)	396 (89)
12	DX12-060K-■■■/900-OFCP-IAK	11.4 (.45)	13.94 (.55)	98 (66)	200 (134)	1350 (304)	396 (89)
24	DX24-070K-■■■/900-OFCP-IAK	12.7 (.50)	15.24 (.60)	133 (89)	227 (153)	1350 (304)	396 (89)
36	DX36-080K-■■■/900-OFCP-IAK	13.9 (.55)	16.44 (.65)	165 (111)	268 (180)	1350 (304)	396 (89)
48	DX48-095K-■■■/900-OFCP-IAK	15.2 (.60)	17.74 (.70)	187 (126)	299 (201)	1350 (304)	396 (89)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Festoon Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU



Features and Applications

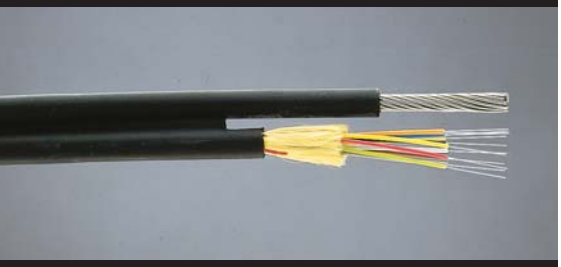
- Flexible, rugged, polyurethane outer cable jacket
- Each fiber has military-grade 900 µm buffer with aramid strength members and 2.5 mm subcable jacket for excellent fiber protection
- Resistant to oils, gases, and acidic gases
- Wide operating and storage temperature range
- Suitable for continuous exposure to UV light
- Minimum operating bend radius of 10 times the cable OD
- Capable of withstanding 100 mph side-wind loading
- No gel to migrate down the cable due to vibration or vertical installation and no axial migration of fibers
- Capable of vertical distances greater than 1,000 meters – still meets and maintains performance requirements
- Helically stranded subunits ensure flexibility and increased mechanical strength
- Core-Locked™ outer jacket for excellent crush and impact protection and improved tear resistance

Fiber Count	Single-Mode	62.5/125 Multimode	50/125 Multimode
6	OCO20912-01	OCO20912-11	OCO20912-21
8	OCO20912-02	OCO20912-12	OCO20912-22
10	OCO20912-03	OCO20912-13	OCO20912-23
12	OCO20912-04	OCO20912-14	OCO20912-24
18	OCO20912-05	OCO20912-15	OCO20912-25

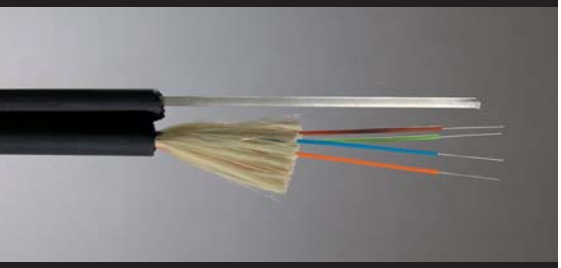
High strength fiber optic Festoon and Fixed Crane Cables

MX-Series Figure-Eight Messenger Cables

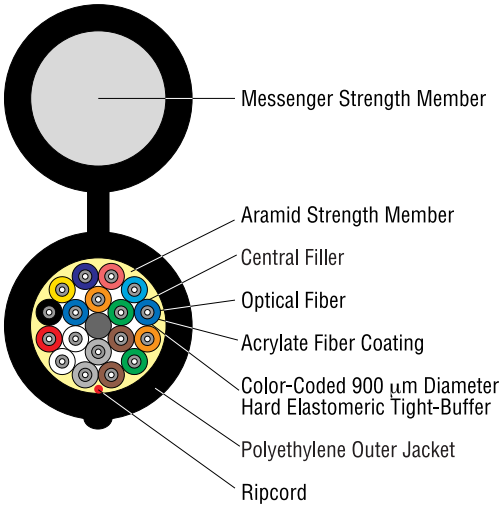
FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU



Steel



Dielectric



Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- TIA-568
- TIA-598-B
- TIA-758 (water-blocked cables)

Features and Applications

- Figure-eight construction for use with standard messenger clamping and support hardware. Two options are available:

  (1) Galvanized Steel (GS) Messenger is a cost-saving option where ultimate durability and survival are not required

  (2) Dielectric Strength Member (DS) Messenger is a fiberglass/aramid strength members/epoxy messenger for high strength. This all-dielectric construction is ideal for use near electrical power lines and in areas of frequent lightning.
- Ideal for new installations. The figure-eight messenger cable reduces installation time and cost by approximately 50% compared to separate installation of a messenger wire and the lashing of the cable to the messenger.
- Wide operating temperature range of -55°C to +85°C
- Water-blocked MX-Series Figure-Eight Messenger Cables contain super-absorbent-polymer coated yarn that swells upon exposure to water

How to Use the Figure-Eight Galvanized Steel and Dielectric Strength Member Messenger Cable Specifications Charts (Pages 32-33) To Determine Weight

After your desired cable construction is defined utilizing the chart on pages 32-33, calculate the weight adder of the messenger from the charts on this page. First, using the chart at right, select the part number for the number of optical fibers required. Then take the beginning cable weight from the next column over. Finally, use one of the weight adder charts — for either Galvanized Steel Messenger or Dielectric Strength Member Messenger — to find the weight adder for the type of messenger you have selected. Add the weight adder to the beginning cable weight to obtain the total cable weight.

Part Number Example and Description

MX36-090A-ALT/900-EGS = MX-Series Messenger 36-fiber cable; polyethylene outer jacket. The 50/125 optical fiber specification is 3 dB/km and 200 MHz-km at 850 nm; 1 dB/km at 1,300 nm wavelength; with a 900 µm buffer coated fiber. The cable has a messenger designation of "E", 3⁄32" (2.4 mm) galvanized steel (GS) messenger; beginning cable weight of 65 kg/km (44 lbs/1,000'); weight adder for messenger of 40 kg/km (27 lbs/1,000'); total cable weight of 105 kg/km (71 lbs/1,000').

MX-Series Figure-Eight Messenger Cable Specifications Chart

Fiber Count	Part Number*	Weight kg/km (lbs/1,000') (not including messenger)
2	MX02-060A-■■■/900-■■■	24 (16)
4	MX04-060A-■■■/900-■■■	24 (16)
6	MX06-060A-■■■/900-■■■	24 (16)
8	MX08-060A-■■■/900-■■■	29 (19)
10	MX10-065A-■■■/900-■■■	34 (23)
12	MX12-065A-■■■/900-■■■	36 (24)
18	MX18-070A-■■■/900-■■■	39 (26)
24	MX24-080A-■■■/900-■■■	48 (32)
30	MX30-090A-■■■/900-■■■	63 (42)
36	MX36-090A-■■■/900-■■■	65 (44)
48	MX48-105A-■■■/900-■■■	82 (55)
60	MX60-110A-■■■/900-■■■	90 (60)
72	MX72-120A-■■■/900-■■■	109 (73)
84	MX84-130A-■■■/900-■■■	117 (79)
96	MX96-140A-■■■/900-■■■	124 (83)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Note: other outer cable jacket materials are available

For Ultra-Fox™ Plus (Page 6)
Cable type designation is "M" rather than "MX". A typical part number would be M36-090A-ALT/900-EGS.

Galvanized Steel Messenger Weight Adder kg/km (lbs/1,000')			
Part No. Suffix	EGS	GGS	JGS
Messenger Designation	3/32 (2.4 mm)	5/32 (4.0 mm)	1/4 (6.4 mm)
Weight kg/km Adder (lbs/1,000')	40 (27)	96 (65)	225 (151)

Dielectric Strength Member Messenger Weight Adder kg/km (lbs/1,000')			
Part No. Suffix	DDS	EDS	GDS
Messenger Designation	.080 (2.0 mm)	.098 (2.5 mm)	.157 (4.0 mm)
Weight kg/km Adder (lbs/1,000')	21 (14)	21 (14)	42 (28)

■■■ - 3 letter part number suffix for messenger type/size.

MX-Series Figure-Eight Messenger Cables—Product Specifications

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

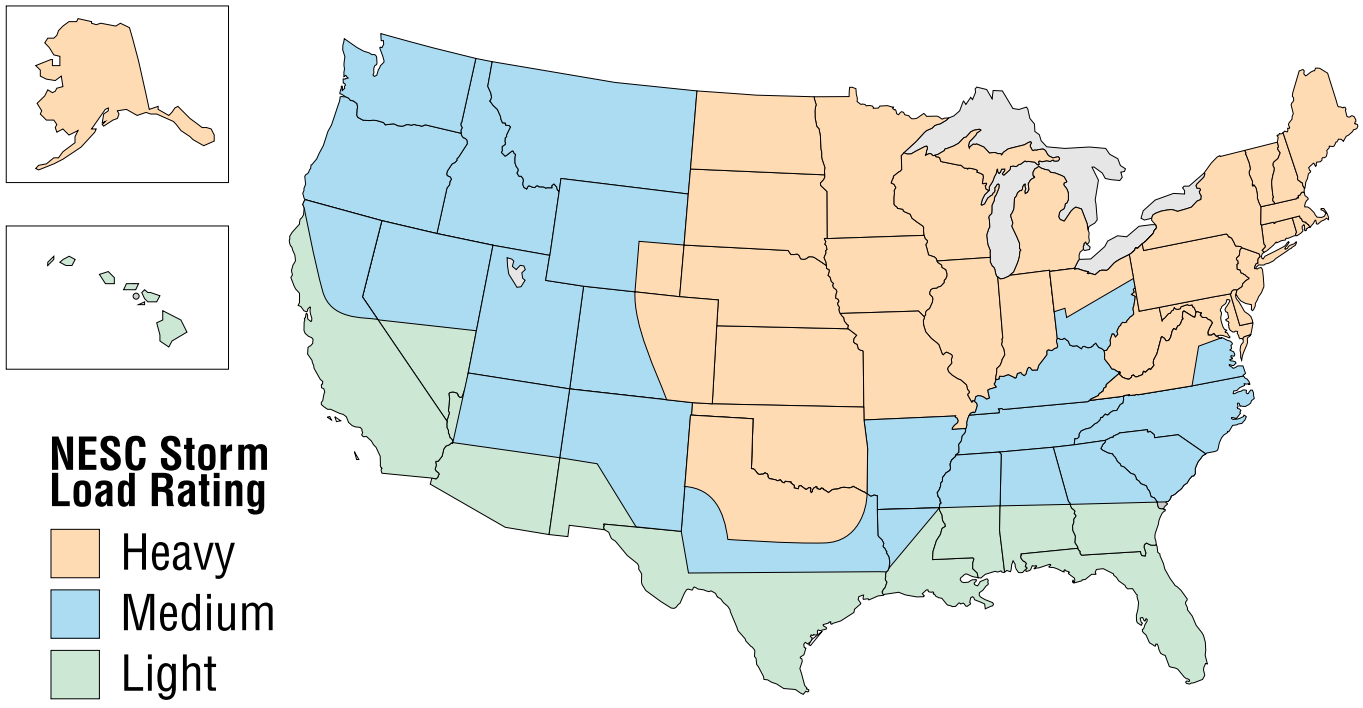
How to Use the Product Specification Charts

Determine the desired fiber count, span length (pole spacing) and storm load rating for your application. Select the chart which describes your NESC Storm Load Rating (from the map below) and the desired cable style. Enter the selection chart from the left, selecting the row for the appropriate fiber count. Then go across this row until you reach the number equal to or greater than the desired span length in meters. At the bottom of this column is the "Messenger Designation" for the desired cable. Complete the part number suffix with this Messenger Designation and the selection of strength member type.

Example

If the application is in Florida, the storm load map indicates that this is NESC Storm Load Rating "Light". Considering the prevalence of thunder-storms, the Dielectric Messenger is chosen. If the requirement is for an 8-fiber cable, with the longest span length being 65 meters, enter the chart from the left (at 8 fibers), go across that row to "70," the next higher span length, and down that column to the letter "E". The part number suffix then becomes "-EDS" (Messenger Designation "E" with dielectric strength member "DS").

Storm Load Map



Strength Member Type	Strength Member Size Messenger Part Number Designation D	E	G	J
Galvanized Steel (GS)	——	3/32 (2.4 mm)	5/32 (4.0 mm)	1/4 (6.4 mm)
Dielectric Strength Member (DS)	.080 (2.0 mm)	.098 (2.5 mm)	.157 (4.0 mm)	——

MX-Series Figure-Eight Messenger Cables—Product Specifications

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

NESC (Heavy) Galvanized Steel Messenger			
Fiber Count	Span Length (meters)		
2	20	50	120
4	20	50	120
6	20	50	120
8	20	50	120
12	18	46	120
18	18	46	120
24	17	46	110
36	17	42	105
48	15	40	95
60	15	40	95
72	14	38	90
84	–	38	89
96	–	35	85
	EGS	GGS	JGS
	Messenger Designation Part Number Suffix		

NESC (Medium) Galvanized Steel Messenger			
Fiber Count	Span Length (meters)		
2	40	90	190
4	40	90	190
6	40	90	190
8	40	90	190
12	38	85	190
18	38	85	190
24	38	80	180
36	30	75	170
48	27	68	160
60	25	68	155
72	24	65	150
84	–	61	145
96	–	60	140
	EGS	GGS	JGS
	Messenger Designation Part Number Suffix		

NESC (Light) Galvanized Steel Messenger			
Fiber Count	Span Length (meters)		
2	50	140	285
4	50	140	285
6	50	140	285
8	50	140	285
12	45	130	285
18	45	130	285
24	40	110	260
36	32	100	210
48	28	85	190
60	–	80	185
72	–	75	180
84	–	75	170
96	–	65	155
	EGS	GGS	JGS
	Messenger Designation Part Number Suffix		

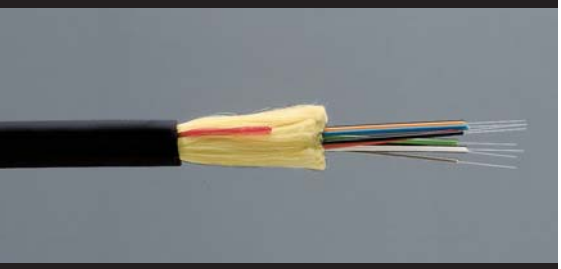
NESC (Heavy) Dielectric Messenger			
Fiber Count	Span Length (meters)		
2	15	27	55
4	15	27	55
6	15	27	55
8	15	27	55
12	13	25	53
18	13	25	53
24	12	24	52
36	11	24	47
48	–	23	45
60	–	23	45
72	–	–	40
84	–	–	40
96	–	–	38
	DDS	EDS	GDS
	Messenger Designation Part Number Suffix		

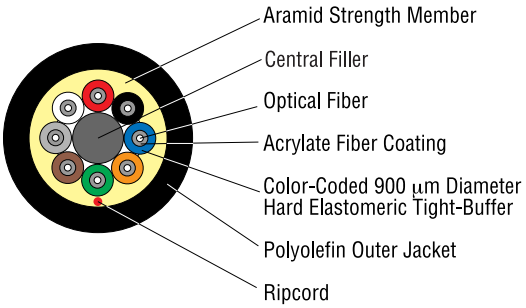
NESC (Medium) Dielectric Messenger			
Fiber Count	Span Length (meters)		
2	25	45	95
4	25	45	95
6	25	45	95
8	25	45	95
12	22	41	90
18	22	41	90
24	21	40	85
36	20	40	80
48	–	36	75
60	–	35	70
72	–	–	68
84	–	–	67
96	–	–	60
	DDS	EDS	GDS
	Messenger Designation Part Number Suffix		

NESC (Light) Dielectric Messenger			
Fiber Count	Span Length (meters)		
2	55	70	150
4	55	70	150
6	55	70	150
8	55	70	150
12	50	60	130
18	50	60	130
24	50	55	115
36	40	45	95
48	–	40	80
60	–	40	80
72	–	–	75
84	–	–	75
96	–	–	65
	DDS	EDS	GDS
	Messenger Designation Part Number Suffix		

RM-Series Round Messenger Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU





Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- TIA-568
- TIA-598-B
- TIA-758 (water-blocked cable)

Features and Applications

- Lightweight, all-dielectric self-supporting (ADSS) construction is ideal for use near electrical power lines and in areas of frequent lightning
- Round cable construction for minimum wind drag and ice buildup
- Increases span length capability
- Aramid strength members reduce weight for longer span lengths
- Wide operating temperature range of -55°C to +85°C

How to Use the Round Messenger Cable Specifications Chart

This round all-dielectric self-support (ADSS) messenger cable is designed to meet the NESC Storm Load Ratings from Light to Heavy loads. Using the chart, select the part number for the number of optical fibers required. Then read the maximum rated cable tension from the right-hand column. For messenger cable applications assistance, please contact Optical Cable Corporation for details.

Part Number Example and Description

RM72-145X-SLS/900 = RM-Series Messenger 72-fiber cable; 14.5 mm diameter polyolefin outer jacket. This example uses a standard single-mode optical fiber with a 900 µm buffered fiber. The cable has a weight of 159 kg/km (107 lbs/1,000'); maximum rated cable tension of 12,800 Newtons (2,880 lbs).

RM-Series Round Messenger Cables—Product Specifications

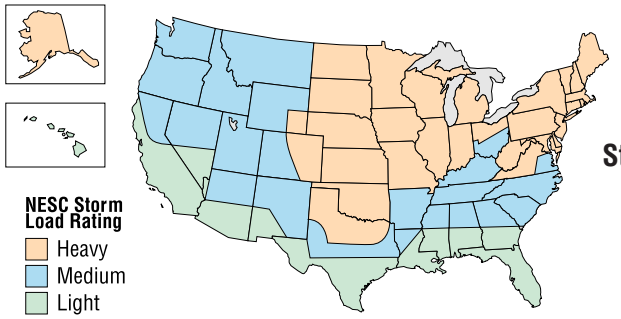
FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

RM-Series Round Messenger Cable Specifications Chart

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Max Rated Cable Tension N (lbs)	Example for Medium Storm Load: Span Length Meters (feet)
2	RM02-075X-■■■/900	7.5 (.30)	40 (27)	12,800 (2,880)	190 (623)
4	RM04-075X-■■■/900	7.5 (.30)	40 (27)	12,800 (2,880)	190 (623)
6	RM06-080X-■■■/900	8.0 (.31)	51 (34)	12,800 (2,880)	186 (610)
8	RM08-085X-■■■/900	8.5 (.33)	57 (38)	12,800 (2,880)	184 (603)
10	RM10-090X-■■■/900	9.0 (.35)	60 (40)	12,800 (2,880)	180 (590)
12	RM12-095X-■■■/900	9.5 (.37)	71 (48)	12,800 (2,880)	177 (580)
18	RM18-095X-■■■/900	9.5 (.37)	71 (48)	12,800 (2,880)	177 (580)
24	RM24-105X-■■■/900	10.5 (.41)	80 (54)	12,800 (2,880)	170 (558)
30	RM30-110X-■■■/900	11.0 (.43)	88 (59)	12,800 (2,880)	168 (551)
36	RM36-110X-■■■/900	11.0 (.43)	88 (59)	12,800 (2,880)	168 (551)
48	RM48-115X-■■■/900	11.5 (.45)	105 (70)	12,800 (2,880)	163 (534)
60	RM60-135X-■■■/900	13.5 (.53)	150 (101)	12,800 (2,880)	149 (488)
72	RM72-145X-■■■/900	14.5 (.57)	159 (107)	12,800 (2,880)	143 (469)
84	RM84-155X-■■■/900	15.5 (.61)	185 (124)	12,800 (2,880)	137 (449)
96	RM96-160X-■■■/900	16.0 (.63)	194 (130)	12,800 (2,880)	134 (439)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

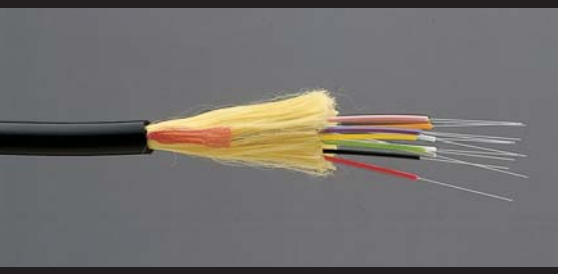
Please contact Optical Cable Corporation with span lengths, storm load rating and sag requirements.

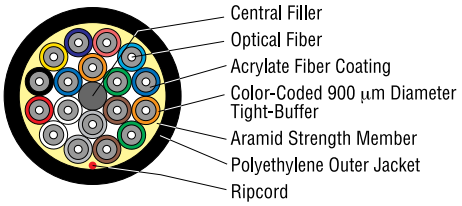


Storm Load Map

Aerial DX-Series Polyethylene Distribution Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU





Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- ICEA-S-87-640
- TIA-568
- TIA-598-B
- TIA-758 (water-blocked cables)

General Characteristics for Aerial DX-Series Polyethylene Distribution Cables

Minimum Bend Radius: Under Installation Tensile Load	20X outside diameter
Under Long-Term Tensile Load	10X outside diameter
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +85°C
Crush Resistance	1,500 N/cm
Impact Resistance	1,000 impacts
Flex Resistance	1,000 cycles

These specifications are subject to change without prior notification.

Features and Applications

- Tight-buffered construction with no messy gel to clean for termination or splicing
- Polyethylene outer cable jacket for excellent UV and weather resistance
- Ideal for conventional lashing techniques
- High performance tight-buffer on the optical fibers for excellent environmental and mechanical protection
- Suitable for use outdoors in wet environments
- Applications include:
  - Cable TV
  - Fiber in the Loop
  - Fiber to the Curb
  - Drop Cable
  - Any other lower fiber count applications where ease of termination, handling and rugged construction is a benefit
- Water-blocked Aerial DX-Series Polyethylene Distribution Cables contain super-absorbent-polymer coated yarn that swells upon exposure to water

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
2	DX02-060A-■■■/900	6.0 (.24)	41 (28)	2,670 (600)	890 (200)
4	DX04-060A-■■■/900	6.0 (.24)	41 (28)	2,670 (600)	890 (200)
6	DX06-060A-■■■/900	6.0 (.24)	41 (28)	2,670 (600)	890 (200)
8	DX08-065A-■■■/900	6.5 (.26)	44 (30)	2,800 (630)	900 (202)
12	DX12-075A-■■■/900	7.5 (.30)	51 (34)	2,800 (630)	900 (202)
18	DX18-075A-■■■/900	7.5 (.30)	51 (34)	2,800 (630)	900 (202)
24	DX24-095A-■■■/900	9.5 (.37)	65 (44)	3,000 (670)	1,000 (220)
36	DX36-100A-■■■/900	10.0 (.39)	68 (46)	3,000 (670)	1,000 (220)
48	DX48-110A-■■■/900	11.0 (.43)	75 (50)	4,200 (940)	1,400 (310)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Installation loads in excess of 2,700 N (600 lbs.) are not recommended.
Other fiber counts available upon request.

Rugged, Harsh Environment Military Style Cable Products

Features and Applications

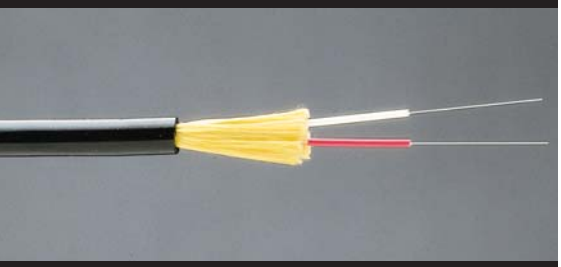
- Used in extreme severe environments
- Deployable, retrieval applications
- Ideally suited for:
  - Field video broadcast
  - Fixed or mobile communication shelters connectivity
  - Manufacturing, mining, oil rigs, and petrochemical environments
- Can be used with tactical/harsh environment connectors such as TFOCA, TFOCA II*, 38999, 28876, etc. or standard commercial optical connectors.
- Excellent impact and crush resistance
- Abrasion, cut, and chemical resistant
- For more Rugged, Harsh Environment Military Style Cable Product options, please call Optical Cable Corporation at 800-622-7711 and ask for the Military Sales Department.

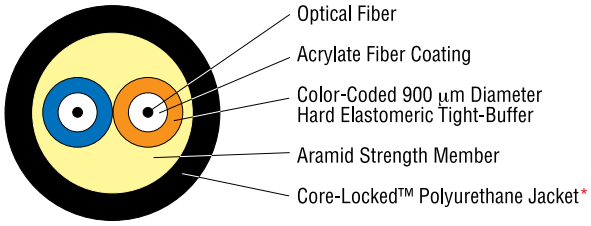
TFOCA Cable Assembly

* TFOCA II is a registered trademark of Fiber Systems International.

Military Tactical Cables
D-Series Distribution Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU





Flame-retardant available.

Features and Applications

- Extremely strong, lightweight, rugged, survivable tight-buffered cables designed for military tactical field use and commercial applications
- Compact, round cable design for ease of transportation and deployment
- Designed for use in adverse environments where reduced size and weight are important
- Helically stranded cable core for flexibility, survival in difficult pulls, and exceptional mechanical protection for the optical fibers
- Cables have been tested and are in use in military data communications applications worldwide
- Excellent for use in deployment/retrieval applications such as video coverage of news events or oil exploration
- Can be used outdoors on the ground in all terrain, including severe environments
- Suitable for manufacturing, mining and petrochemical environments and chemical resistance
- Crush-resistant and resilient with a thick layer of aramid strength members
- Polyurethane jacketed for abrasion, cut and chemical resistance
- Most commonly used with ruggedized multiway military tactical field connectors, for maximum connector retention (400 lbs)
- 2 to 24 fibers, higher fiber counts are available on request

General Characteristics for D-Series Distribution Military Tactical Cables

Minimum Bend Radius:	
Under Installation Tensile Load	16X outside diameter
Under Long-Term Tensile Load	8X outside diameter
Operating Temperature	-55ºC to +85ºC
Storage Temperature	-70ºC to +85ºC
Crush Resistance (TIA/EIA-455-41 mil. requirement)	440 N/cm
Impact Resistance (EIA/TIA-455-25 mil. requirement)	200 impacts
Flex Resistance (TIA/EIA-455-104 mil. requirement)	2,000 cycles

These specifications are subject to change without prior notification.

Specifications for D-Series Distribution Military Tactical Cables

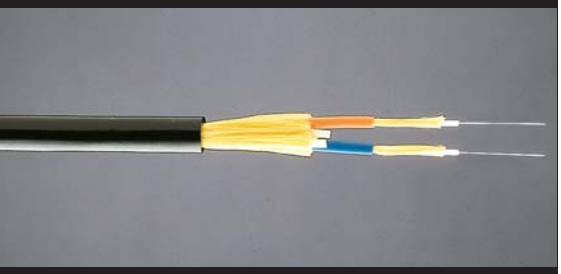
Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
2	D02-050C-■■■/900-MIL	5.0 (.20)	23 (15)	1,800 (400)	600 (130)
4	D04-055C-■■■/900-MIL	5.5 (.22)	28 (19)	1,800 (400)	600 (130)
6	D06-060C-■■■/900-MIL	6.0 (.24)	28 (19)	1,800 (400)	600 (130)
8	D08-065C-■■■/900-MIL	6.5 (.26)	38 (26)	1,800 (400)	600 (130)
10	D10-065C-■■■/900-MIL	6.5 (.26)	45 (30)	2,100 (470)	700 (160)
12	D12-065C-■■■/900-MIL	6.5 (.26)	51 (34)	2,100 (470)	700 (160)
18	D18-075C-■■■/900-MIL	7.5 (.30)	60 (40)	2,400 (540)	800 (180)
24	D24-085C-■■■/900-MIL	8.5 (.33)	74 (50)	3,000 (670)	1,000 (220)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

Part Number Example and Description

D24-085C-ALT/900-MIL = D-Series Distribution Military Tactical 24-fiber cable; 8.5 mm diameter polyurethane outer jacket. The 50/125 optical fiber specification is 3 dB/km and 200 MHz-km at 850 nm; 1 dB/km and 500 MHz-km at 1,300 nm wavelength; with a 900 µm buffer coated fiber.

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

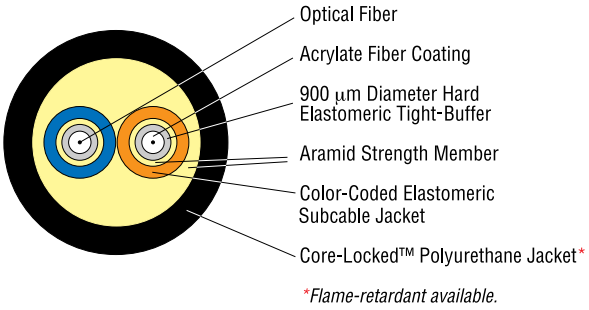


General Characteristics for B-Series Breakout Military Tactical Cables

Minimum Bend Radius:	
Under Installation Tensile Load	16X outside diameter
Under Long-Term Tensile Load	8X outside diameter
Operating Temperature	-55ºC to +85ºC
Storage Temperature	-70ºC to +85ºC
Crush Resistance (TIA/EIA-455-41 mil. requirement)	440 N/cm
Impact Resistance (EIA/TIA-455-25 mil. requirement)	200 impacts
Flex Resistance (TIA/EIA-455-104 mil. requirement)	2,000 cycles

These specifications are subject to change without prior notification.

Features and Applications



**Flame-retardant available.*

- Extremely strong, light-weight, rugged, survivable tight-buffered cables designed for military tactical field use and commercial applications
- Breakout cable design with an individual color-coded subcable surrounding each optical fiber
- Crush-resistant and resilient, with two separate layers of aramid strength members – in the subcables for individual single-fiber connector termination, and overall for termination to multiway connector backshells or other housings
- Helically stranded cable core for flexibility, survival in difficult pulls, and exceptional mechanical protection for the optical fibers
- Cables have been tested and are in use in military data communications applications worldwide
- Excellent for use in deployment/retrieval applications
- Can be used outdoors on the ground in all terrain, including severe environments
- Suitable for manufacturing, mining and petrochemical environments and chemical resistance
- Round cable design for easy installation and survivability
- Polyurethane jacketed for abrasion, cut and chemical resistance
- Often used with multiway military tactical connectors for maximum connector retention (400 lbs)
- Ideally suited for use with MIL-C-38999 style military connectors – subcables terminate to individual "pins" and overall aramid strength member terminates to backshell
- 2 to 24 fibers, higher fiber counts available on request

Specifications for B-Series Breakout Military Tactical Cables

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
Standard (2.0 mm Subcable)					
2	B02-065C-■■■/900-MIL	6.5 (.26)	31 (21)	2,200 (490)	550 (120)
4	B04-075C-■■■/900-MIL	7.5 (.29)	42 (28)	2,200 (490)	550 (120)
6	B06-085C-■■■/900-MIL	8.5 (.34)	53 (36)	2,400 (540)	600 (130)
8	B08-100C-■■■/900-MIL	10.0 (.39)	74 (50)	3,200 (720)	800 (180)
10	B10-115C-■■■/900-MIL	11.5 (.45)	96 (.65)	4,000 (900)	1,000 (220)
12	B12-110C-■■■/900-MIL	11.0 (.48)	88 (59)	4,800 (1,080)	1,200 (270)
18	B18-135C-■■■/900-MIL	13.5 (.57)	109 (73)	7,200 (1,620)	1,800 (400)
24	B24-145C-■■■/900-MIL	14.5 (.57)	156 (105)	9,600 (2,160)	2,400 (540)

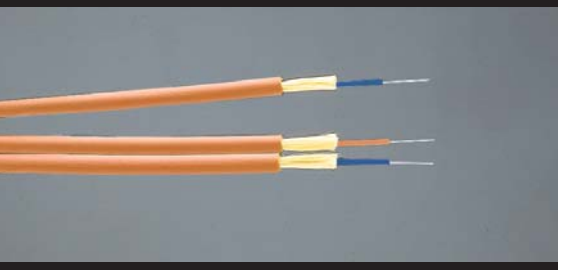
* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

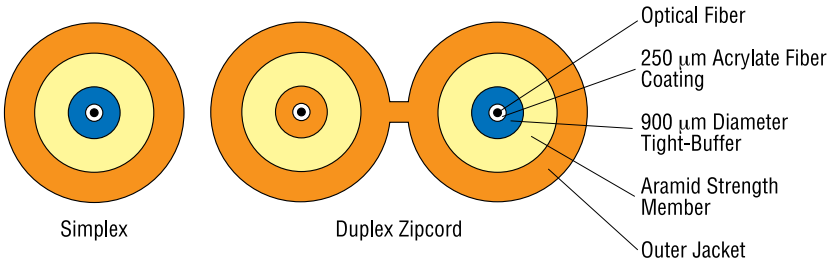
Part Number Example and Description

B12-110C-ALT/900-MIL = B-Series Breakout Military Tactical 12-fiber cable; 11.0 mm diameter polyurethane outer jacket. The 50/125 optical fiber specification is 3 dB/km and 200 MHz-km at 850 nm; 1 dB/km and 500 MHz-km at 1,300 nm wavelength; with a 900 µm buffer coated fiber.

AX-Series Assembly Cables

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU





Features and Applications

- Resilient and flexible for jumpers, patch cords, and pigtails
- Suitable for general purpose indoor use, such as routing connections in patching systems
- Short "patch cord" cables ideal for links between electronic equipment and main fiber optic cables
- Flame-retardant for indoor installations
- Compatible with all standard fiber optic connectors
- High performance tight-buffered coating on each optical fiber for environmental and mechanical protection
- Custom jacket colors are available to match connectors. Private labeling on the cable outer jacket is also available
- 1 (simplex) and 2 (duplex) fibers available

Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- GR-409-CORE
- ICEA-83-596
- TIA-568
- TIA-598-B

UL-listed type OFNR in accordance with NEC sections 770-51 (b) and 770-53 (b) for use in vertical runs in building riser shafts or from floor to floor. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

UL-listed type OFNP in accordance with NEC sections 770-51 (a) and 770-53 (a) for use in ducts, plenums, and air-handling spaces. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

See page 50 for complete OptiReel™ details.

General Characteristics for AX-Series Assembly Cables

	RISER	PLENUM	ZERO HALOGEN
Minimum Bend Radius: Under Installation Tensile Load	5 cm	5 cm	3.8 cm
Under Long-Term Tensile Load	3 cm	3 cm	2.5 cm
Jacket Type	"N"	"S"	"F"
Operating Temperature	-40°C to +85°C	-20°C to +85°C	-20°C to +85°C
Storage Temperature	-55°C to +85°C	-40°C to +85°C	-40°C to +85°C
Crush Resistance	750 N/cm	500 N/cm	500 N/cm
Impact Resistance	1,000 impacts	200 impacts	200 impacts
Flex Resistance	7,500 cycles	2,000 cycles	2,000 cycles

These specifications are subject to change without prior notification.

Riser

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
1	AX01-030N-■■■/900-OFNR	3.0 (.12)	8 (5)	500 (110)	300 (70)
2	AX02-030N-■■■/900-OFNR	3.0 X 6.0 (.12 X .26)	16 (11)	1,000 (220)	500 (110)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

For Ultra-Fox™ Plus (Page 6)
Cable type designation is "A" rather than "AX".
A typical part number would be
A02-030N-ALT/900-OFNR.

Plenum

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
1	AX01-030S-■■■/900-OFNP	3.0 (.12)	9 (6)	500 (110)	300 (70)
2	AX02-030S-■■■/900-OFNP	3.0 X 6.0 (.12 X .26)	18 (12)	1,000 (220)	500 (110)

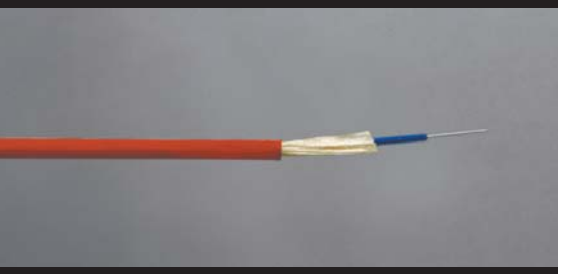
* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

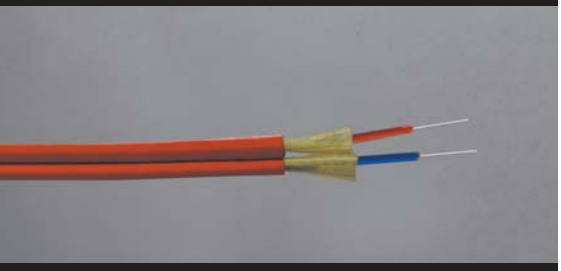
Zero Halogen

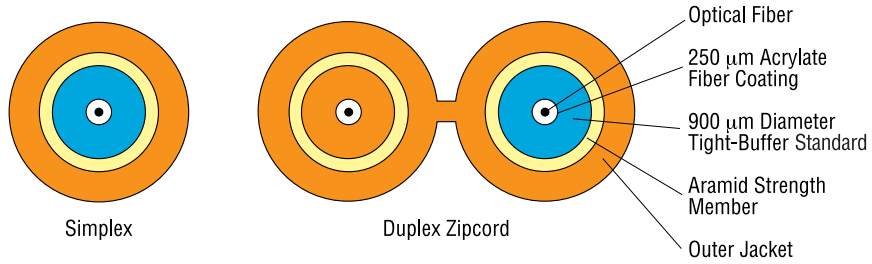
Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
1	AX01-030F-■■■/900-OFNR	3.0 (.12)	8 (5)	500 (110)	300 (70)
2	AX02-030F-■■■/900-OFNR	3.0 X 6.0 (.12 X .26)	16 (11)	1,000 (220)	500 (110)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU







Features and Applications

- Resilient and flexible for jumpers, patch cords, and pigtails
- Suitable for general purpose indoor use, such as routing connections in patching systems
- Short patch cord cables ideal for links between electronic equipment and main fiber optic cables
- Flame-retardant for indoor installations
- Small size for dense usage
- Specifically designed for small form-factor simplex and duplex connectors, such as the MT-RJ and LC connectors
- 900 µm buffer is standard; 600 µm buffer is optional
- Zero Halogen construction available
- Cable is available in other diameters

Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- GR-409-CORE
- ICEA-83-596
- TIA-568
- TIA-598-B

UL-listed type OFNR in accordance with NEC sections 770-51 (b) and 770-53 (b) for use in vertical runs in building riser shafts or from floor to floor. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

UL-listed type OFNP in accordance with NEC sections 770-51 (a) and 770-53 (a) for use in ducts, plenums, and air-handling spaces. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

General Characteristics for AX-Series Micro Assembly Cables

	RISER	PLENUM	ZERO HALOGEN
Minimum Bend Radius: Under Installation Tensile Load	3.8 cm	3.8 cm	3.8 cm
Under Long-Term Tensile Load	2.5 cm	2.5 cm	2.5 cm
Jacket Type	"D"	"S"	"F"
Operating Temperature	-40ºC to +85ºC	-20ºC to +85ºC	-20ºC to +85ºC
Storage Temperature	-55ºC to +85ºC	-40ºC to +85ºC	-40ºC to +85ºC
Crush Resistance	500 N/cm	500 N/cm	500 N/cm
Impact Resistance	750 impacts	150 impacts	200 impacts
Flex Resistance	2,000 cycles	1,000 cycles	2,000 cycles

These specifications are subject to change without prior notification.

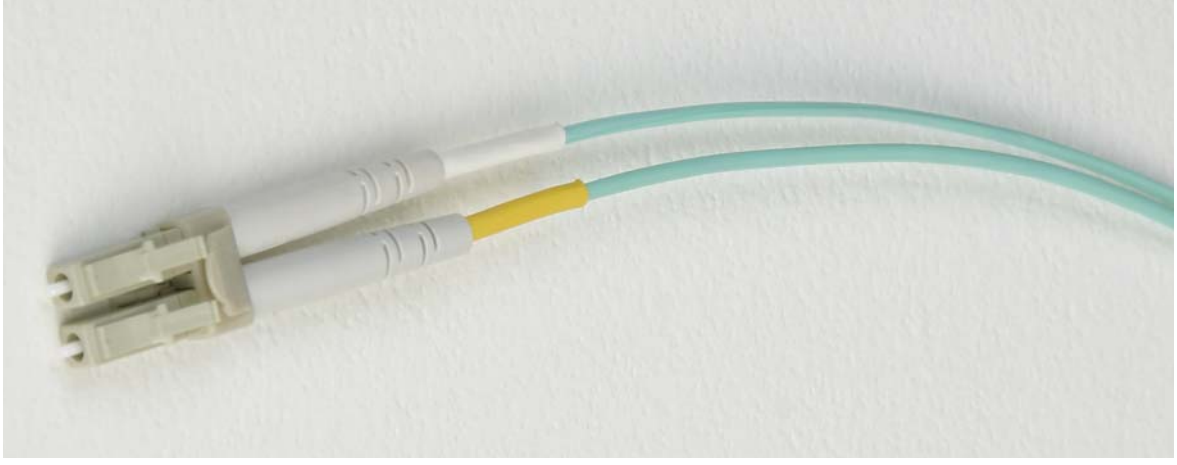
See page 50 for complete OptiReel™ details.

Specifications for AX-Series Micro Assembly Cables*

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
Riser Cables					
1	AX01-016D-■■■/900-OFNR	1.6 (0.063)	2.7 (1.8)	355 (80)	130 (30)
2	AX02-016D-■■■/900-OFNR	1.6 X 3.5 (.063 X .138)	7.0 (4.7)	450 (101)	167 (38)
Plenum Cables					
1	AX01-016S-■■■/900-OFNP	1.6 (0.063)	2.7 (1.8)	355 (80)	130 (30)
2	AX02-016S-■■■/900-OFNP	1.6 X 3.5 (.063 X .138)	7.0 (4.7)	450 (101)	167 (38)
Zero Halogen Cables					
1	AX01-016F-■■■/900-OFNR	1.6 (0.063)	2.7 (1.8)	355 (80)	130 (30)
2	AX02-016F-■■■/900-OFNR	1.6 X 3.5 (.063 X .138)	7.0 (4.7)	450 (101)	167 (38)

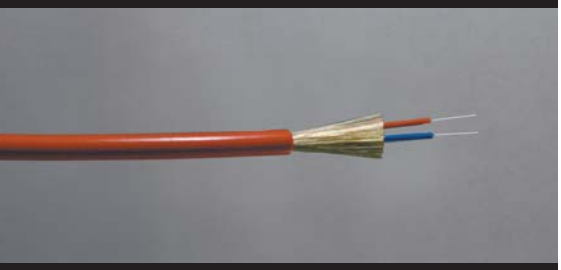
* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

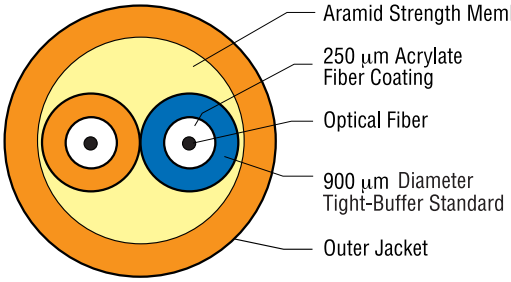
*Also available with 600 µm buffer coating



LC Connector

DX-Series Mini Round Duplex Assembly Cables





Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- GR-409-CORE
- ICEA-83-596
- TIA-568
- TIA-598-B

UL-listed type OFNR in accordance with NEC sections 770-51 (b) and 770-53 (b) for use in vertical runs in building riser shafts or from floor to floor. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

UL-listed type OFNP in accordance with NEC sections 770-51 (a) and 770-53 (a) for use in ducts, plenums, and air-handling spaces. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

See page 50 for complete OptiReel™ details.

Features and Applications

- Flexible, resilient for interconnect applications
- Small size for dense usage
- For small form-factor duplex connectors, such as MT-RJ
- 900 µm buffer is standard; 600 µm buffer is optional
- Zero Halogen construction available
- 900 µm buffer for excellent mechanical and environmental performance

General Characteristics for DX-Series Mini Round Duplex Assembly Cables

	RISER	PLENUM	ZERO HALOGEN
Minimum Bend Radius: Under Installation Tensile Load	4.5 cm	4.5 cm	4.5 cm
Under Long-Term Tensile Load	3.0 cm	3.0 cm	3.0 cm
Jacket Type	"N"	"S"	"F"
Operating Temperature	-40°C to +85°C	-20°C to +85°C	-20°C to +85°C
Storage Temperature	-55°C to +85°C	-40°C to +85°C	-40°C to +85°C
Crush Resistance	750 N/cm	500 N/cm	500 N/cm
Impact Resistance	1,000 impacts	200 impacts	200 impacts
Flex Resistance	5,000 cycles	2,000 cycles	5,000 cycles

These specifications are subject to change without prior notification.

DX-Series Mini Round Duplex Assembly Cables—Product Specifications

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

Specifications for DX-Series Mini Round Duplex Assembly Cables*

Fiber Count	Part Number*	Diameter mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
Riser Cables					
2	DX02-030N-■■■/900-OFNR	3.0 (.12)	8 (5)	500 (110)	300 (70)
Plenum Cables					
2	DX02-030S-■■■/900-OFNP	3.0 (.12)	8 (5)	500 (110)	300 (70)
Zero Halogen Cables					
2	DX02-030F-■■■/900-OFNR	3.0 (.12)	8 (5)	500 (110)	300 (70)

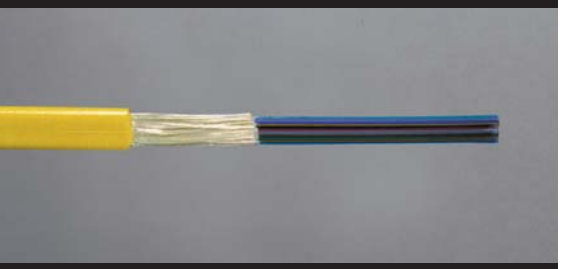
* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

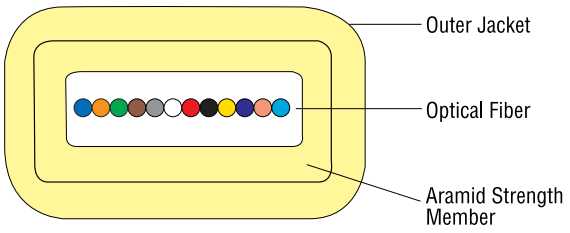
*Also available with 600 µm buffer coating

MT-RJ Connector

MT-RJ to ST Connectors

RB-Series Ribbon Cables





Standards List

Optical Cable Corporation's tight-buffered fiber optic cables meet the functional requirements of the following standards:

- ANSI X3T9.5 PMD
- ATM 155 Mb/s
- Fibre Channel FC-PH
- GR-409-CORE
- ICEA-83-596
- TIA-568
- TIA-598-B

UL-listed type OFNR in accordance with NEC sections 770-51 (b) and 770-53 (b) for use in vertical runs in building riser shafts or from floor to floor. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

UL-listed type OFNP in accordance with NEC sections 770-51 (a) and 770-53 (a) for use in ducts, plenums, and air-handling spaces. Meets or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.

Features and Applications

- High density interconnect cable for use with MT, MTP, MPO, and MPX connectors
- Rugged and flexible for use in patch panels and runs to workstations
- Flame-retardant UL OFNR or OFNP listed
- Zero Halogen construction available
- 4 and 6 fiber configurations are available

General Characteristics for RB-Series Ribbon Cables

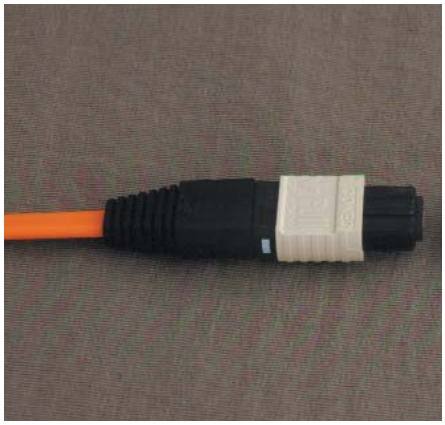
	RISER	PLENUM	ZERO HALOGEN
Minimum Bend Radius: Under Installation Tensile Load	3.0 cm	3.0 cm	3.0 cm
Under Long-Term Tensile Load	2.0 cm	2.0 cm	2.0 cm
Jacket Type	"D"	"S"	"F"
Operating Temperature	-40ºC to +85ºC	-20ºC to +85ºC (S)	-20ºC to +85ºC
Storage Temperature	-55ºC to +85ºC	-40ºC to +85ºC	-40ºC to +85ºC
Crush Resistance	350 N/cm	350 N/cm	350 N/cm
Impact Resistance	500 impacts	500 impacts	500 impacts
Flex Resistance	1,000 cycles	1,000 cycles	1,000 cycles

These specifications are subject to change without prior notification.

Specifications for RB-Series Ribbon Cables

Fiber Count	Part Number*	Dimensions mm (in)	Weight kg/km (lbs/1,000')	Tensile Load Rating Short-Term N (lbs)	Tensile Load Rating Long-Term N (lbs)
Riser Cables					
8	RB08-020D-■■■/250-OFNR	2.0 X 4.5 (.08 X .18)	8.4 (5.6)	500 (112)	250 (56)
12	RB12-020D-■■■/250-OFNR	2.0 X 4.5 (.08 X .18)	8.4 (5.6)	500 (112)	250 (56)
Plenum Cables					
8	RB08-020S-■■■/250-OFNP	2.0 X 4.5 (.08 X .18)	8.4 (5.6)	500 (112)	250 (56)
12	RB12-020S-■■■/250-OFNP	2.0 X 4.5 (.08 X .18)	8.4 (5.6)	500 (112)	250 (56)
Zero Halogen Cables					
8	RB08-020F-■■■/250-OFNR	2.0 X 4.5 (.08 X .18)	8.4 (5.6)	500 (112)	250 (56)
12	RB12-020F-■■■/250-OFNR	2.0 X 4.5 (.08 X .18)	8.4 (5.6)	500 (112)	250 (56)

* ■■■ - Fiber Part Number Code. See Fiber Specifications Guide on pages 52-53 for fiber options.

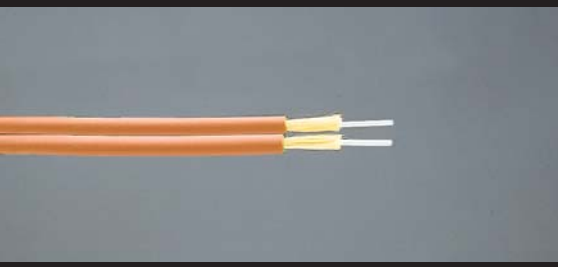


MT Connector

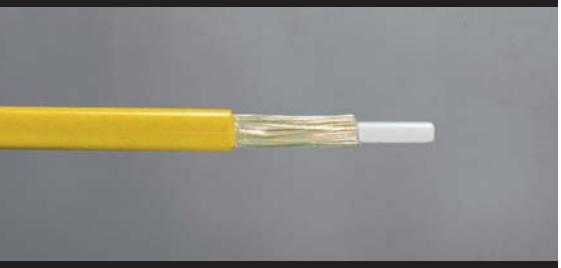
Furcation Tubing

FOR MORE CABLE OPTIONS, GO BACK TO THE MAIN MENU

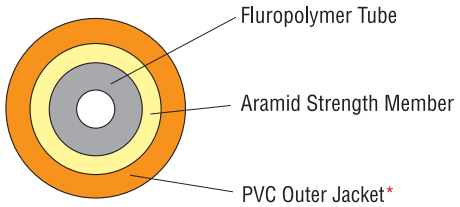
Breakout Tubing

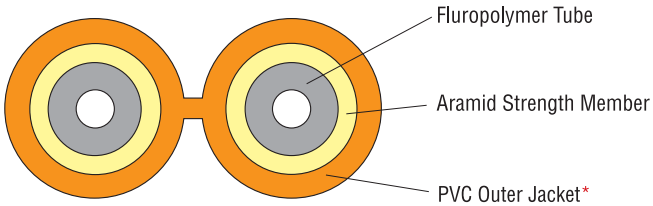


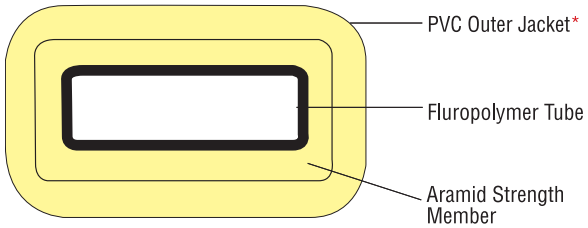
Duplex Assembly Tubing



Ribbon Tubing







** Other outer jacket materials are available.*

Features and Applications

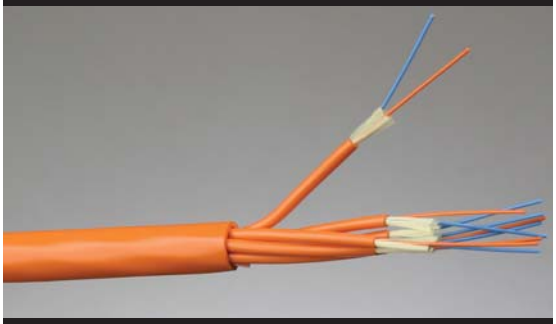
- Ideal for adding protection and strength to coated or buffered fibers.
  Sizes: 450/900 for 250 µm acrylate fibers
  1100/1500 for 900 µm buffered fibers
- Tubing for typical termination of loose-tube fibers
- Custom colors available
- Outer jacket materials available to meet application requirement
- Custom tubing available upon request
- -40˚ to +80˚C operating temperature

Furcation Tubing Product Selection

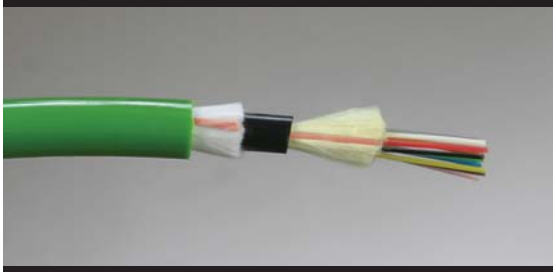
Part Number	Inner Tube (part number suffix) 450/900	1100/1500	Dimensions
L00-030D-	X	X	3.0 mm
L00-016D-	X		1.6 mm
L02-030D-	X	X	3.0 x 6.0 mm
L02-016D-	X		1.6 x 3.2 mm
RB00-025D	(For up to 12 fiber ribbon)		2.5 x 5.0 mm
L00-009-*	X		900 µm

* Tube only 450/900 – no aramid strength member.
Part number example: L00-030D-450/900 is 3.0 mm furcation tubing with 450 µm inner diameter.

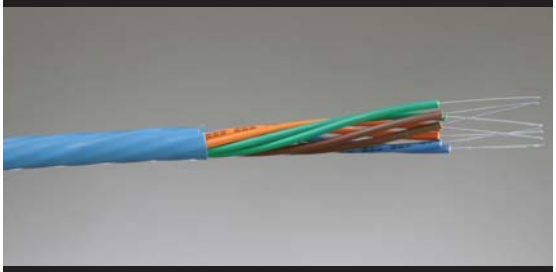
Custom Assembly Cables



MT-RJ Cable



Double Jacketed Cables

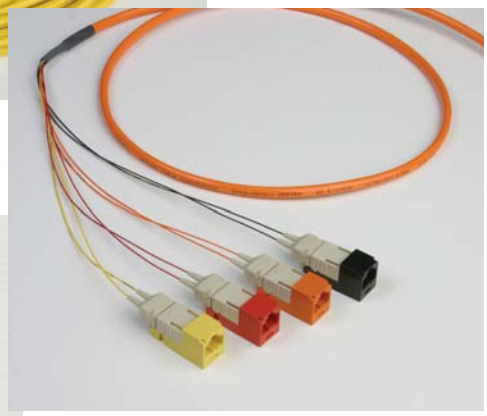


Custom Cable Without Yarn

Features and Applications

- Indoor only cables are available
- Riser-rated cables are available with a very flexible outer cable jacket
- Our Easy Strip options permit easily removing long lengths (20-30 cm) of the 900 µm buffer and leaving the 250 µm acrylate coating. This is well suited when the 900 µm buffer must be removed to allow for splicing or ribbonizing.
- Tubed on outer cable jackets are available on D-Series and DX-Series Distribution Cables, G-Series and GX-Series Subgrouping Cables, and B-Series and BX-Series Breakout Cables
- Plenum-rated cables are available with a flexible outer cable jacket
- G-Series and GX-Series Subgrouping Cables can be manufactured with custom fiber count subcables
- For more Custom Assembly Cable options, please call Optical Cable Corporation at 800-622-7711 and ask for the OEM Sales Department.

Color-coded fiber buffers to match connector color



Breakout Assembly Cable with custom diameter subunits

LC Connector

Trunk Cable with ES2 for ribbonizing to MTP connectors

Features and Applications

OptiReel™ cable box saves installers time

- Always know remaining cable length
- AT-A-GLANCE decreasing cable length markings
- Faster installation for multiple fiber optic cable drops
- Easy cable handling and storage, and excellent protection at job sites
- Available in popular fiber types and up to 12-fiber cables
- Can be stacked with other boxes containing data cables
- Contains optimum performance fiber optic cable

OptiReel™ is a self-contained payout box to facilitate storage, handling and pulling of the cables. The packaging greatly reduces set-up time for each pull. Therefore, the box is ideally suited for cable pulls through building duct systems, walls and ceilings where multiple cables may be pulled together and many relatively short runs need to be installed.

OptiReel™ cable boxes can be easily stacked and staged together with other types of data cables for faster installations. The compact boxes contain an internal reel so that cable stands do not have to be used. Cables in the boxes are marked with decreasing length markings, so that the installer always knows the length of the remaining cable in the box.

OptiReel™ cable packaging is available for Optical Cable Corporation's simplex and duplex AX-Series and DX-Series types of cables, either riser-rated or plenum-rated, with 62.5/125, 50/125, and single-mode fibers.

Contact your local Optical Cable Corporation representative or distributor to order your next shipment of fiber optic cable in the OptiReel™ cable box.

Specifications for OptiReel™

Cable Type	Cable Length (ft)	Total Weight (lbs)	Box Type
AX01	3,000	18	12" x12" x12"
AX02	1,500	19	12" x12" x12"
DX02	2,000	40	16" x16" x16"
DX04	1,500	40	16" x16" x16"
DX06	1,500	42	16" x16" x16"
DX08	1,000	35	16" x16" x16"
DX12	1,000	40	16" x16" x16"

Outer Cable Jacket Materials

Outer Cable Jacket Materials for Tight-Buffered Cables

Jacket Material	Indoor/Outdoor			Indoor Only			Outdoor Only							
	Flame Retardant PVC	Fluoro-polymer Plenum	Flexible Fluoro-polymer Plenum	Flame Retardant Plenum	Flexible PVC	Low Smoke Zero Halogen	Tempest	Medium Density Poly-ethylene	Flame Retardant Poly-urethane	Hard Poly-urethane	Prop-rietary	Poly-urethane	Low Smoke Zero Halogen	Poly-urethane Low Smoke Zero Halogen
Material Code	D	K	W	S	N	F	T	A	E	R	X	C	Z	G
Duct Installation	■	■	■	■	■	■	■	■	■		■	■	■	
Fungus Resistant	■	■	■				■	■	■	■	■	■	■	■
UV Resistant	■	■	■	■				■	■	■	■	■	■	■
Water Resistant	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Direct Burial	■	■	■				■	■	■	■	■	■	■	
Aerial	■		■					■	■	■	■	■	■	
High Flex Life							■		■	■	■	■		■
Soft, Flexible				■	■	■			■			■		
Tight Bends	■				■	■	■		■		■	■		■
Mechanical Resistant	■	■	■				■		■	■	■	■	■	■
Low Friction	■	■	■				■		■			■		
Operating Cold Temp (°C)	-40	-40	-40	-20	-40	-20	-55	-40	-55	-55	-55	-55	-20	-55
Operating Hot Temp (°C)	+85	+85	+85	+85	+85	+85	+85	+65	+85	+85	+85	+85	+85	+85
Petrochemical Resistance	■	■	■				■	■		■	■	■	■	■
Severe Chemical Environments		■	■					■			■	■		
Plenum Installation		■	■	■										

Note: Cable design for some fiber counts may overide the general capabilities listed in the table above. Contact Optical Cable Corporation for the best solution for your application.

How to Order Information

Metric To English Units Conversion

CONVERT FROM:	CONVERT TO:	MULTIPLY BY:
TO:	**FROM:**	**DIVIDE BY:**
µm	mils	.03937
mm	in	.03937
cm	in	.39370
m	ft	3.2808
km	ft	3280.8
km	mi	.62137
kg	lbs	2.2046
kg/km	lbs/1000 ft.	.67197
N	lbs f	.22481
N-m	ft-lbs	.73756
N/cm	lbs/in	.57101
kPa	PSI	.14504
°C	°F	1.8 x °C + 32
°F	°C	(°F-32)/1.8

TIA-598-B Fiber Optic Cable Standard Color Code

1	Blue	7	Red
2	Orange	8	Black
3	Green	9	Yellow
4	Brown	10	Violet
5	Slate	11	Rose
6	White	12	*Aqua

* 13 fibers and higher, the color code is repeated every 12 and the buffered fibers or subcables are striped once for every additional 12 according to the TIA–598–B specifications.

Custom Cables

Optical Cable Corporation offers tremendous flexibility in providing customers with the best tight-buffered fiber optic cables for their special requirements — not just stock items. If you need a custom cable, please call Optical Cable Corporation at 1-800-622-7711 or (540) 265-0690.

Example Part No.: DX24-085D-ALT/900-OFNR-■■■
Cable Part No.: ■■■■-■■■■-■■■/■■■-■■■■-■■■

Series Code and Fiber Count

A- Series Assembly Cables
AX- Series Assembly Cables
B- Series Breakout Cables
BX- Series Breakout Cables
CX: Composite Fiber/Copper Cables
D- Series Distribution Cables
DX- Series Distribution Cables
G- Series Subgrouping Cables
GX- Series Subgrouping Cables
L: Furcation Tubing
MX- Series Messenger Cables
RB- Series Ribbon Cables
RM- Series Round Messenger Cables

Diameter in one-tenth mm (example: 250 = 25.0 mm)

Jacket Material Code (reference chart on page 51)

A: Polyethylene
C: Polyurethane
D: Flame-Retardant PVC
E: Flame-Retardant Polyurethane
F: Zero Halogen
G: Outdoor Polyurethane Low Smoke Zero Halogen
K: High-Temperature Plenum Fluoropolymer
N: Flexible PVC
R: Hard Polyurethane
S: Flexible Plenum
T: Tempest
W: High-Temperature Flexible Plenum Fluropolymer
X: Proprietary
Z: Outdoor Low Smoke Zero Halogen

Fiber Type Code

A: 50/125 Graded Index
C: 100/140 Graded Index
F: 200/230 HCS
P: 1,000 µm Plastic
S: 9/125 Single-Mode
W: 62.5/125 Graded Index

Optional: Special Construction (part number suffix)
CST: Corrugated Steel Tape (Page 26-27)
ES1: Easy Strip 1 (Page 6)
ES2: Easy Strip 2 (Page 6)
MIL: Military Tactical Cables (Pages 37-39)
WB: Water-Blocked (Pages 10, 14 and 18)

UL Listed
OFNR: riser-rated
OFNP: plenum-rated

Buffer Code
/250: 250 µm diameter
/500: 500 µm diameter
/600: 600 µm diameter
/900: 900 µm diameter

Part Number Example and Description
DX24-085D-ALT/900-OFNR = DX-Series Distribution 24-fiber cable; 8.5 mm diameter flame-retardant PVC outer jacket. The 50/125 optical fiber is optimized to a Gigabit Ethernet distance of 1,000 meters and a 10-Gigabit Ethernet distance of 300 meters. The maximum attenuation is 3.0 dB/km and 2,000 MHz-km minimum laser bandwidth at 850 nm. The maximum attenuation is 1.0 dB/km and 500 MHz-km minimum laser bandwidth at 1,310 nm wavelength. Each optical fiber is protected with a 900 µm buffer coating and the cable is OFNR riser-rated.

Fiber Specifications Guide

	WLS 62.5/125 Standard (850/1310)	WLX 62.5/125 XL (850/1310)	ALS 50/125 Standard (850/1310)	ALX 50/125 XL (850/1310)	ALT 50/125 Ten-300 (850/1310)	ALE 50/125 Ten-500 (850/1310)	SLS Single-Mode Conventional (1310/1550)	SLX Single-Mode Low Water-Peak (1310/1550)
Gigabit Ethernet Distance (m)	300/600	500/1000	600/600	750/600	1000/600	1040/600	Far exceeds distance requirements of TIA-568-B.1-3	
10-Gigabit Ethernet Distance (m)	—	—	—	150/300	300/300	500/300	Far exceeds distance requirements of TIA-568-B.1-3	
Maximum Attenuation (dB/km)	3.5/1.0	3.0/1.0	3.5/1.0	3.0/1.0	3.0/1.0	3.0/1.0	0.5/0.5	0.5/0.5
Minimum Laser Bandwidth* (MHz-km)	220/500	385/500	510/500	950/500	2000/500	4000/500	—	—
Minimum LED Bandwidth** (MHz-km)	200/500	200/500	500/500	700/500	1500/500	3000/500	—	—
Fiber Part Number Code	**WLS**	**WLX**	**ALS**	**ALX**	**ALT**	**ALE**	**SLS**	**SLX**

* Effective Modal Bandwidth, per TIA/EIA-492AAAC and draft IEC 60793-2-10 for type A1a.2, ensured by DMD performance specifications for sources meeting launch conditions specified in 10 Gigabit Ethernet (IEEE 802.3ae), OIF OC-192/STM-64 VSR-4-04, and draft 10 Gigabit Fibre Channel (10GFC).

**Only for backward compatibility to LED based systems, overfilled launch bandwidth measurement, minimum.

Many other fiber types, fiber bandwidth, and attenuation performances are available.

Standards Compliance

	62.5/125 Standard and XL	50/125 Standard and XL	50/125 Ten-300 and Ten-500
TIA-568-	B.3	B.3	B.3-A-1
TIA-492	AAAA	AAAB	AAAC
ISO/IEC 11801	OM1	OM2	OM3

Table Of Contents

The Glass Story

Multimode and Single-Mode Optical Fibers for LAN Systems

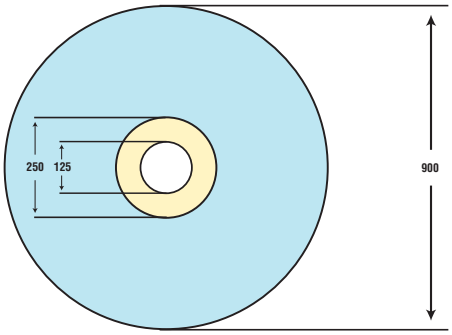
Two optical fiber categories with distinctive operational attributes are multimode and single-mode fibers. Within the multimode category, another important distinction is between step index and graded index. Further definition of fibers relates to physical size, optical performance, coatings, and strength.

All fibers consist of a number of substructures including:

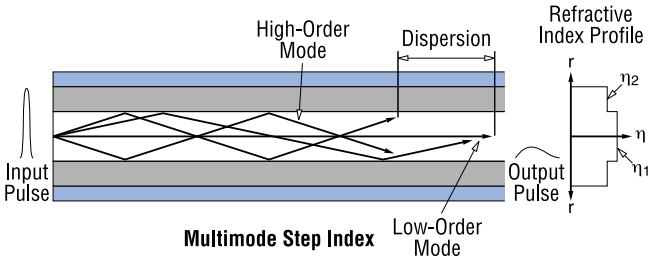
- a core, which carries most of the light, surrounded by
- a cladding, which bends the light and confines it to the core, surrounded by
- a substrate layer (in some fibers) of glass which does not carry light, but adds to the diameter and strength of the fiber, covered by
- a primary coating, which provides the first layer of mechanical protection, covered by
- a secondary buffer coating, which protects the relatively fragile primary coating and the underlying fiber.

Multimode Fiber

In the case of a multimode fiber, the core diameter is relatively large compared to a wavelength of light. Core diameters range from 50 micrometers (µm) to 1,000 µm, compared to the wavelength of light of about 1 µm. This means that light can propagate through the fiber in many different ray paths, or modes, hence the name multimode.



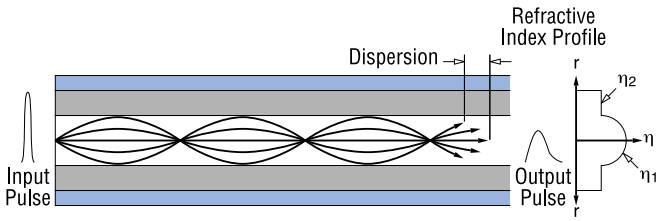
Two basic types of multimode fibers exist. The simpler and older type is a step index fiber, where the index of refraction (the ability of a material to bend light) is the same all across the core of the fiber. This leads to rays of light being propagated as shown below.



With all these different ray paths or modes of propagation, different rays travel different distances and take different amounts of time to transit the length of a fiber. This being the case, if a short pulse of light is injected into a fiber, the various rays emanating from that pulse will arrive at the other end of the fiber at different times. The output pulse will be of longer duration than the input pulse. This

The Glass Story (cont.)

phenomenon is called "modal dispersion" (pulse spreading). It limits the number of pulses per second that can be transmitted down a fiber and still be recognizable as separate pulses at the other end. Therefore, this limits the bit rate or bandwidth of a multimode fiber. For step index fibers, wherein no effort is made to compensate for modal dispersion, the bandwidth is typically 20 to 30 MHz over a length of one kilometer of fiber expressed as "MHz-km".



Multimode Graded Index

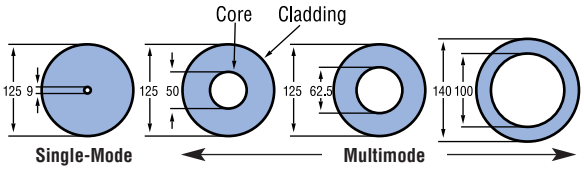
In the case of a graded index multimode fiber, the index of refraction across the core is gradually changed from a maximum at the center to a minimum near the edges, hence the name graded index. This design takes advantage of the phenomenon that light travels faster in a low-index-of-refraction material than in a high-index material. The light rays or modes of propagation that travel near the edges of the core travel faster for a longer distance, thereby transiting the fiber in approximately the same time as the "low-order modes", or rays traveling more slowly near the center of the core.

If a short pulse of light is launched into the graded index fiber, it may spread some during its transit of the fiber, but much less than in the case of a step index fiber. Therefore, multimode-graded index fibers have the ability to transport pulses closer together without spreading into each other than step index fibers. They can support a much higher bit rate or bandwidth. Typical bandwidths of graded index fibers range from 200 MHz-km to well over one GHz-km. The actual bandwidth depends on how well a particular fiber's index profile minimizes modal dispersion and on the wavelength of light launched into the fiber.

Multimode fibers are identified by the physical size of the core and the overall glass, often referred to as the cladding. The 62.5/125 fiber has historically been the most popular multimode fiber type used in North American LAN systems. The fiber numbers indicate a core diameter of 62.5 µm and a total glass diameter of 125 µm. Another common graded index multimode fiber in use today is the high bandwidth 50/125 used primarily in Europe and Asia LAN systems. The 100/140 fiber is an older LAN fiber, which is used in some industrial applications because of its large core size. It is decreasing in popularity due to its high cost and poor performance in attenuation and bandwidth.

Some multimode fibers are made of a glass core and a plastic cladding. These are called "plastic-clad silica" or "PCS" fibers. They are inherently a step index profile, and exhibit a limited bandwidth of approximately 20 MHz-km to 30 MHz-km. The most successful implementation of this design is the "hard-clad silica" or "HCS" type fiber. The most common construction of this fiber is the 200/230 size used primarily in industrial control applications.

There is also a family of all-plastic fibers. These also have a step index profile with the expected low bandwidth. The plastic fibers are not as "clear" as the glass fibers and exhibit much higher attenuation, typically 200 dB/km, limiting their transmission distance to 50 to 100 meters. They typically have a very large core, a popular size being 1,000 µm in diameter. They are used in short-distance, limited-bandwidth applications such as industrial control systems.



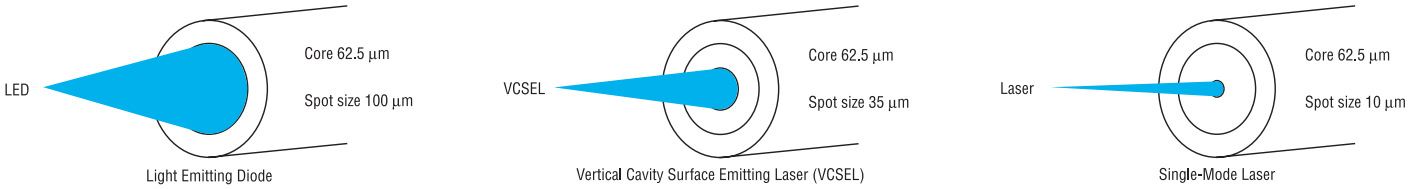
Typical Core and Cladding Diameters (µm)

High Performance Multimode Fibers for Gigabit Ethernet Applications

Until Gigabit Ethernet systems became available, the fiber most widely used in LAN and private network applications was the FDDI grade 62.5 µm core fiber with 160 MHz-km bandwidth at 850 nm wavelength and 500 MHz-km at 1310 nm. The bandwidth of these fibers has been measured with an overfilled-launch light source, which illuminates the entire core of the fiber, to simulate the performance of the fiber when used with the broad illumination pattern of light-emitting diode (LED) light sources. More recently, many networks are being designed for use with Gigabit Ethernet systems utilizing laser light sources, which have a much smaller spot of light illuminating the fiber core at smaller incidence angles than LED light sources.

The Glass Story (cont.)

Figure 1. Comparison of Optical Source Fiber Illumination



Fiber Specifications Guide	WLS 62.5/125 Standard (850/1310)	WLX 62.5/125 XL (850/1310)	ALS 50/125 Standard (850/1310)	ALX 50/125 XL (850/1310)	ALT 50/125 Ten-300 (850/1310)	ALE 50/125 Ten-500 (850/1310)	SLS Single-Mode Conventional (1310/1550)	SLX Single-Mode Low Water-Peak (1310/1550)
Gigabit Ethernet Distance (m)	300/600	500/1000	600/600	750/600	1000/600	1040/600	Far exceeds distance requirements of TIA-568-B.1-3	
10-Gigabit Ethernet Distance (m)	—	—	—	150/300	300/300	500/300	Far exceeds distance requirements of TIA-568-B.1-3	
Maximum Attenuation (dB/km)	3.5/1.0	3.0/1.0	3.5/1.0	3.0/1.0	3.0/1.0	3.0/1.0	0.5/0.5	0.5/0.5
Minimum Laser Bandwidth* (MHz-km)	220/500	385/500	510/500	950/500	2000/500	4000/500	—	—
Minimum LED Bandwidth** (MHz-km)	200/500	200/500	500/500	700/500	1500/500	3000/500	—	—
Fiber Part Number Code	**WLS**	**WLX**	**ALS**	**ALX**	**ALT**	**ALE**	**SLS**	**SLX**

* Effective Modal Bandwidth, per TIA/EIA-492AAAC and draft IEC 60793-2-10 for type A1a.2, ensured by DMD performance specifications for sources meeting launch conditions specified in 10 Gigabit Ethernet (IEEE 802.3ae), OIF OC-192/STM-64 VSR-4-04, and draft 10 Gigabit Fibre Channel (10GFC).

**Only for backward compatibility to LED based systems, overfilled launch bandwidth measurement, minimum.

Many other fiber types, fiber bandwidth, and attenuation performances are available.

Standards Compliance

	62.5/125 Standard and XL	50/125 Standard and XL	50/125 Ten-300 and Ten-500
TIA-568-	B.3	B.3	B.3-A-1
TIA-492	AAAA	AAAB	AAAC
ISO/IEC 11801	OM1	OM2	OM3

This Vertical Cavity Surface Emitting Laser (VCSEL), (Shown in Figure 1 above), does not energize as many dispersive modes of the fiber waveguide as does the overfilled-launch of an LED, so the fiber modal dispersion and bandwidth performance are different than might be expected from the overfilled-launch measurements. Laser based Gigabit and 10-Gigabit Ethernet systems are instead distance-limited by the system effective modal bandwidth and the total link attenuation. In addition, Differential Mode Delay (DMD) is an important measure for all fibers used for 10-Gigabit Ethernet. The Laser Ultra-Fox™ laser optimized cables listed on the above chart have effective modal bandwidth and DMD specifically designed for use with Gigabit and 10-Gigabit Ethernet systems, while maintaining backward compatibility with existing LED based systems.

While DMD and the resulting effective modal bandwidth are important when determining the maximum distance rating of the cable, link attenuation is also a very important and often overlooked distance limitation factor. Both Gigabit and 10-Gigabit Ethernet systems have allowable link

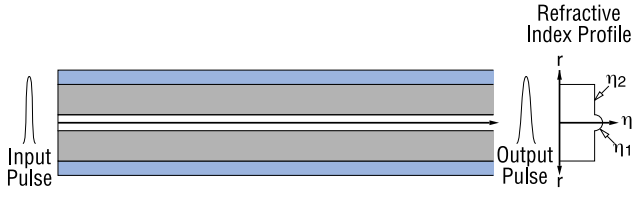
The Glass Story (cont.)

loss of half to one-third that of older 10 and 100 Megabit Ethernet systems. These extremely tight link budgets mean that every 0.1 dB cable loss can shorten the maximum achievable link distance. Optical Cable Corporation's Laser Ultra-Fox™ extended distance Gigabit and 10-Gigabit cables have 3.0 dB/km maximum attenuations at 850 nm instead of the 3.5 dB/km attenuation of many other cable manufacturers. This extra link margin can make the difference between a working extended distance link and a system failure.

Single-Mode Fiber

In the case of a single-mode fiber, the core diameter of about 9 µm is much closer in size to the wavelength of light being propagated, about 1.3 µm. This limits the light transmission to a single ray or mode of light to propagate down the core of the fiber.

In single-mode fibers, all the multiple-mode or multimode effects described above are eliminated; however, one pulse-spreading mechanism remains. Just as in the multimode fibers, different wavelengths of light travel at different speeds causing short pulses of light injected into the fiber to spread as they travel. This phenomenon is called "chromatic dispersion". The amount of pulse spreading depends on the spectral width or number of wavelengths or colors the light source produces. The lasers typically used as light sources for single-mode systems produce a relatively pure light output, with a narrow spectral width, reducing the chromatic dispersion effect in single-mode fibers. Nonetheless, the pulse broadening produced by chromatic dispersion ultimately limits the bandwidth of single-mode systems.



Single-Mode Step Index

Since fiber bandwidth determines the transmission distance capability of high-data-rate systems, several single-mode fiber designs have been developed to optimize this characteristic.

Single-Mode Fiber for Short-to-Moderate Distance Applications

When moderate distance transmission cannot be accomplished with multimode fiber and inexpensive multimode light sources, single-mode fiber is most commonly used in private network, campus, and building applications. It is designed for use at both 1310 nm and at 1550 nm wavelength windows. Because the 1310 nm lasers and detectors are less expensive than 1550 nm devices, most of these short-to-moderate distance applications use the 1310 nm wavelength. Single-mode fiber is the least expensive fiber available and is optimized for the lowest dispersion at 1310 nm. Single-mode fiber offers the best combination of cost and performance for most short-to-moderate distance private network, campus, and building applications when distances exceed multimode limits. Low water peak (enhanced) single-mode fiber is also available for such applications as Coarse Wavelength Division Multiplexing (CWDM).

Single-Mode Fiber for Long Distance Applications

Fibers for long distance applications are optimzed at the 1550 nm wavelength window where the loss of the single-mode fiber is lowest; they are generally not used at the 1310 nm window. These long distance fibers are usually not used for short-to-moderate distance applications because of the high cost of the 1550 nm laser sources. Several types of single-mode fibers have been developed for long distance applications:

(1) Dispersion Shifted Fiber

Dispersion shifted fiber was developed with a zero-dispersion wavelength at 1550 nm. This fiber works fine if only one laser is used, but it has dispersion non-linearities making it unsuitable for use with the multiple lasers needed for Dense Wavelength Division Multiplexing (DWDM). Non-linearity causes the generation of spurious interference crosstalk when several lasers are used with closely spaced center wavelengths. Dispersion shifted fibers are no longer commonly used and have been replaced by the newer Non-Zero Dispersion Shifted Fiber types.

(2) Non-Zero Dispersion Shifted Fiber (NZ-DSF)

Non-linearities of the dispersion shifted fiber are greatly reduced by suppressing the zero-dispersion wavelength within the operational 1550 nm window. These fibers have uniform dispersion characteristics over a wide range of wavelengths in the 1550 nm window. NZ-DSF fibers can accommodate many different closely spaced lasers with reduced crosstalk interference between channels. Crosstalk in NZ-DSF fibers can be further improved in large-effective-aperture fibers by reducing the power density within the fiber.

The Glass Story (cont.)

These enhanced NZ-DSF designs have large core size or mode field diameters and exhibit measureable performance improvements with DWDM systems for long distance links.

Single-mode fibers have the very broadest bandwidth, lowest cost, and lowest attenuation of any available optical fiber. Therefore, they are universally used in long-distance telephony and cable television applications.

Optical performance of fibers is relatively standardized in that the same optical characteristics may be found in fibers of the same type produced by several fiber manufacturers. The physical characteristics of the cabled fiber, however, are not necessarily uniform across the industry. The preservation of the fiber strength and its environmental performance are functions of the cable buffer materials and the cable structure. The multiple-layer tight-buffered system, if fabricated with the proper materials and technology, provides excellent physical, mechanical, and environmental protection for each fiber within the cable. It prevents the accumulation of moisture near the glass surface, which causes stress crack propogation and could ultimately cause fiber breakage. It also buffers or reduces the sensitivity of the fiber to repetitive small bends, referred to as "microbends", which cause an increase in fiber attenuation. The cable structure isolates and protects the fibers from the installation stresses and the installed environment.

Optical Cable Corporation has qualified all major fiber sources and, therefore, can incorporate any optical fiber into its fiber optic cable designs. The transmission system application will define the fiber type and fiber parameters required. The physical environment of the cable and the number of fibers required will determine the cable design most suitable for a particular installation. Please contact Optical Cable Corporation to discuss your fiber and cable requirements. Optical Cable Corporation can provide assistance in recommending the most suitable fiber optic cable products.

Water-Blocked Cables

Even though cables produced by Optical Cable Corporation are water tolerant without being water-blocked, some of our customers require water-blocking for outside plant cables. Water-blocking is very important to loose-tube cables, which have voids in and between the tubes, and loose-jacketed cables, which also allow large volumes of water to flow into the cable without effective water-blocking. These loose tubes and loose jackets act like water hoses sending water directly to the bare 250 µm coated fibers all along the length of the cable and allow enough water penetration to cause expansion problems upon freezing. An industry standard was developed (in GR-20-CORE) requiring loose-tube gel-filled cables to block water with no leakage for at least 24 hours from a 1-meter sample length of open-end cable, when exposed to 1-meter water head pressure. The test method is detailed in TIA-455-82B.

Optical Cable Corporation fiber optic cable designs eliminate both the loose-tube voids and the bare fibers by using water tolerant materials throughout, so water-blocking is usually not needed. Even the 900 µm fiber buffer is a fully outdoor rated water tolerant material, so the fiber itself is never exposed directly to water. Nevertheless, in response to some industry requirements for water-blocking of cables prompted by loose-tube designs, Optical Cable Corporation was the first company to manufacture a water-blocked fiber optic cable with no gel, having produced the first "WB" fiber optic cables in 1993. In 1995, a customer's specification required a cable to pass the TIA-455-82B water-block test for 72 hours, three times longer than the rating for the loose-tube gel-filled cables. The Optical Cable Corporation Core-Locked™ design with super-absorbent-polymer aramid yarn easily passed this 72-hour requirement and was purchased for the application. This particular cable passed TIA-455-82B tests for the full 136 hours tested, with water penetration of only 4 cm into the cable. In comparison, the normal requirement for loose-tube gel-filled cables in GR-20-CORE allows water penetration of one-meter length into the cable after exposure for 24 hours.

Several loose-tube cable manufacturers later introduced "dry water-blocked" designs to compete with numerous advantages of the Optical Cable Corporation gel-free designs. Most of these loose-tube cables have water swellable yarns and tapes around the loose tubes, but still use gel to fill the large voids inside the tubes. Some designs have a dry powder compound within the tube as well.

Q. What does "water-blocked" mean to these loose-tube cable manufacturers?

A. Apparently, it means that their "dry" loose-tube cables will retard the rate of water flow in the cable for about one hour. Manufacturer specifications for some well-known brands rate these cables for only one hour exposure to one-meter water head pressure, when tested to TIA-455-82B. When one loose-tube cable with dry powder compound within the tubes was exposed to the one-meter water head pressure test, fibers started emerging out of the open end of the cable after 15 minutes exposure. After one hour, all fibers had migrated six inches out of the cable end. The water-blockage system failed completely within two hours exposure time, when the powder within the tube broke loose, spewing fibers and water across the room!

Optical Cable Corporation's water-blocked fiber optic cables provide the best water protection system available by combining the inherent water tolerant features of tight-buffered and Core Locked™ tightbound cable with super-absorbent- polymer aramid yarn. This design provides superb water-blocking performance while retaining the termination cost advantages of totally gel-free and powder-free tight-buffered cable.

Since no conventional cable design can truly be labeled "waterproofed", water tolerant is clearly the design approach of choice.

Frequently Asked Fiber Optic Cable Questions

Q. Are all fiber optic cable jackets permeable to water and water vapor?

A. Yes. Every cable outer jacket material and everything that is not hermetically sealed can, in fact, pass extremely small amounts of water molecules. Optical Cable Corporation's tight-buffered, tight-bound fiber optic cable design confronts this potential problem head-on by protecting each individual fiber with a non-porous 900 micron buffer coating made from hard elastomers or high-performance PVC materials. This design effectively minimizes the presence of water molecules at the fiber's glass surface and eliminates potential embrittlement of the fiber in wet environments. Optical Cable Corporation's fiber optic cables are designed to be water tolerant and can function even if water molecules are present under the cable outer jacket.

For over 20 years, Optical Cable Corporation has led the industry developing and producing tight-buffered, tightbound fiber optic cables. These cables have been in use in many adverse, indoor/outdoor environments around the world with no failures reported due to damage from water or freezing water.

Q. What is a Core-Locked™ fiber optic cable and why is it important?

A. Some of Optical Cable Corporation's fiber optic cables feature a Core-Locked™ outer jacket that is pressure extruded over the interior cable structure. This jacket allows the cable to act as one mechanical unit and simplifies its installation because the pulling device (for example, Kellems® grips) is attached directly to the cable outer jacket.

The pulling forces on the cable outer jacket are directly transferred to the cable strength members with no slippage. In severe bends, the Core-Locked™ cable outer jacket keeps the cable elements in place, which retains the round shape of the cable, provides localized bend limits, and avoids wrinkling of the cable outer jacket. These effects combine to greatly enhance the survival of the cable if it is pulled over a sharp edge. This construction greatly resists tearing and prevents subsequent damage to the cable.

Optical Cable Corporation's B-Series and BX-Series Breakout Cables and G-Series and GX-Series Subgrouping Cables are manufactured with a Core-Locked™ pressure extruded outer jacket that fills the interstitial areas of the cable, which further reduces the voids under the cable outer jacket where moisture could otherwise accumulate. The tight Core-Locked™ outer jacket limits the volume of water to the point that expansion forces upon freezing are negligible and can cause no fiber or cable degradation.

Q. Are Optical Cable Corporation's Core-Locked™ fiber optic cable outer jackets difficult to remove for terminating?

A. No. All of Optical Cable Corporation's fiber optic cables are manufactured with an aramid yarn ripcord that easily opens up the cable outer jacket for removal of the interior elements. Some installers prefer to use an adjustable depth cable outer jacket removal tool instead of the internal ripcord on larger diameter cables or a coax-type stripping tool for smaller diameter cables. Of course, the installer should practice and set the proper depth of the tool on the end of the cable prior to entering the fiber optic cable mid-span. A local Optical Cable Corporation representative will be happy to demonstrate how this is done.

Q. Do Optical Cable Corporation's tight-buffered, tight-bound Core-Locked™ fiber optic cables contain excess fiber lengths in them to facilitate tight radius bends and give high tensile strength?

A. Yes. Optical Cable Corporation's fiber optic cables are all helically stranded to insure no inner fibers are compressed or any outer fibers are strained. Optical Cable Corporation's fiber optic cables have approximately the same amount of excess fiber length as does a telephone-style loose-tube gel-filled fiber optic cable. Regarding tensile strength, Optical Cable Corporation's fiber optic cables generally have a two-to-one advantage in strength-to-weight ratio over a loose-tube gel-filled cable of an equal fiber count.

Q. What does it mean to have three-way protection in Optical Cable Corporation's Core-Locked™ fiber optic cables compared to loose-tube gel-filled fiber optic cables?

A. Optical Cable Corporation's fiber optic cables do not rely on an application of gel, made from petroleum or other chemicals, to protect the optical fibers under the cable outer jacket. Instead, Optical Cable Corporation applies a 900 micron buffer coating over each individual optical fiber for added strength and to prevent moisture intrusion. Individual subcable jackets are added as another layer of protection for the fiber. The ruggedized riser-rated PVC cable outer jacket gives a third layer of protection from water molecules, and makes the cable fungus-resistant and UV-resistant.

Frequently Asked Fiber Optic Cable Questions (cont.)

Loose-tube gel-filled fiber optic cable designs are based on historical copper cable designs developed when utility companies needed to find ways of extending the life of their copper cables, many with pulp insulation. Optical Cable Corporation was never in the business of manufacturing copper cables for the utility market. Instead, Optical Cable Corporation has always specialized in manufacturing the highest quality tight-buffered, tightbound fiber optic cables in the industry. Its technology is directly derived from military tactical cable development programs, which conclusively demonstrated that correctly designed tight-buffered fiber optic cables, using the proper materials, need no gel and are the only design suitable for survival in a military tactical field environment.

Q. At what temperature can Optical Cable Corporation's indoor/outdoor riser-rated fiber optic cables be used?

A. All of Optical Cable Corporation's B-Series and BX-Series Breakout Cables, D-Series and DX-Series Distribution Cables, and G-Series and GX-Series Subgrouping Cables have an operating temperature of -40°C to +85°C with minimal shift in attenuation when tested in accordance with TIA-455-3A and TIA-455-71.

Q. Why do Optical Cable Corporation's fiber optic cables cost less to install than loose-tube gel-filled fiber optic cables?

A. The cables cost less to install because of Optical Cable Corporation's tight-buffered, tightbound cable construction. The installer merely removes the cable's outer jacket and the subcable jackets to expose the 900 micron buffer coated optical fiber. After the buffer is stripped from the optical fiber, it can be directly terminated without any additional preparation. No breakout kits, no epoxy gel blocks, no messy gel removal, and no furcation tubes are required. Depending on the fiber optic cable type, connector type, and level of craftsmanship, an Optical Cable Corporation fiber optic cable can be 30% to 50% less expensive to terminate per connector than loose-tube gel-filled cables. This will typically yield a lower overall installed cost for a fiber optic cable installation. The higher the fiber count and shorter the link length, the greater the cost savings from using Optical Cable Corporation's fiber optic cables.

Q. Are there regulatory agencies with the mission of defining standards of network construction and which strive to ensure the safety of the consumer?

A. Yes. The two organizations established to provide regulatory functions are the National Electrical Code (NEC) and the Underwriters Laboratory (UL).

Optical Cable Corporation's riser-rated fiber optic cables are UL listed in accordance with NEC sections 770-51 (b) and 770-53 (b). Optical Cable Corporation's plenum-rated fiber optic cables are UL listed in accordance with NEC sections 770-51 (a) and 770-53 (a).

Q. Are Optical Cable Corporation's fiber optic cables tested to specified standards of performance established by Bell Company Research (Bellcore) which is now Telcordia?

A. Yes. Bellcore was established and charged with the mission of providing research and development and establishing minimum standards for the Bell Telephone Company's infrastructure. It is specifically the research arm of the public telephone system in the United States. Bellcore has been changed to Telcordia™ Technologies. Telcordia™ does not establish the test procedures for these standards. The test procedures are provided by the TIA/EIA, specifically in the TIA/EIA 455 series of tests.

Optical Cable Corporation's fiber optic cables are tested to meet all of the applicable generic requirements outlined in GR-409-CORE for intra-building fiber optic cables. Optical Cable Corporation also offers an optional cable construction using polymer-coated aramid strength members that allow its cables to easily meet all applicable functional requirements of GR-20-CORE.

Indoor, Outdoor, Everywhere

Indoor/Outdoor Tight-Buffered Cable Lowers Installation Costs, Reduces Maintenance Time, and Increases Reliability

Introduction

Fiber optic cable that is capable of surviving the outdoor environment and meets the flammability requirements for use inside buildings offers many advantages to the end-user, as well as the installer and distributor. The use of only one type of cable between and within buildings can save many labor hours and reduce material costs by eliminating the need to splice outdoor cables to flame-retardant indoor cables. The tight-buffered indoor/outdoor fiber optic cables further save on termination costs by permitting direct installation of connectors on the fibers rather than requiring the splicing of preterminated pigtails onto the fibers. Eliminating the splicing not only saves installation costs in time and materials but also greatly improves the cable plant's reliability by eliminating the discontinuities and stresses on the fibers associated with splices.

Termination and Splicing Costs: Loose-Tube Gel-Filled Cable vs. Tight-Buffered Cable

Termination and splicing costs of fiber optic cable can be one of the largest line items in an installation budget. A large number of products and alternative approaches make it possible to devise system layouts with considerable variations in installed costs. The choice of the cable type is one of the biggest cost drivers in cable termination. There are three basic cable types used in system installations:

(A) Loose-Tube Gel-Filled Cable
(B) Tight-Buffered Distribution Cable
(C) Tight-Buffered Breakout Cable
(See Figures 1A, 1B, 1C on page 63)

Historically, loose-tube gel-filled cable has been used for outdoor long-haul routes (See Figure 1A). Due to the fragile bare fibers and gel filling, which must be cleaned prior to termination, loose-tube gel-filled cable is the most difficult to splice and terminate and also has the highest termination material costs. This cable type must normally be terminated or spliced close to the cable entryway of a building to switch to indoor-style cable, as it is generally incompatible with indoor fire (flammability) codes. Fibers within the loose-tube gel-filled cables typically have a 250 µm coating. In consideration of this small fiber size, care must be taken to avoid damaging the fibers when removing the outer cable jacket and buffered tubes, as well as when the fiber is being cleaned or spliced. Each fiber must be cleaned to remove gel, and the breakout point of the main cable must be blocked by some method to prevent oozing of the cable gel. This time consuming and labor intensive process adds hidden costs to the installation of loose-tube gel-filled cable, and it creates another future failure point. In the final termination with connectors, all fibers must be either spliced to pigtails or fed through the tubes of a breakout kit. Due to the fragile nature of the 250 µm coated fiber and the splices or breakout kits, it is necessary to protect them in a splice rack or patch panel housing and to use jumper cables for the final connection to the system electronics.

Properly designed and manufactured tight-buffered cable has been amply demonstrated to be suitable for both indoor and outdoor applications. Long before loose-tube cables were introduced, the oldest and longest duration field trial of fiber optic cable in the U.S. was a 22-mile installation in 1978 and located in central Pennsylvania for the Commonwealth Telephone Company of Pennsylvania. It was entirely constructed with tight-buffered cable. The cable system consisted of 10 miles direct-buried, about 10 miles aerial-lashed, and 2 miles in underground ducts. This system was in operation for over 20 years and was retired when their multimode electro-optics became obsolete. All military tactical cables are tight-buffered, and an increasing portion of interbuilding LAN systems are utilizing tight-buffered indoor/outdoor fiber optic cable.

Tight-buffered cables require less care to avoid damaging fibers when stripping back the cable. Each fiber is protected with its own 900 µm diameter buffer structure, which is nearly four times the diameter and six times the thickness of the 250 µm coating. This construction feature contributes to the excellent moisture and temperature performance of the tight-buffered indoor/outdoor cables and also permits their direct termination with connectors.

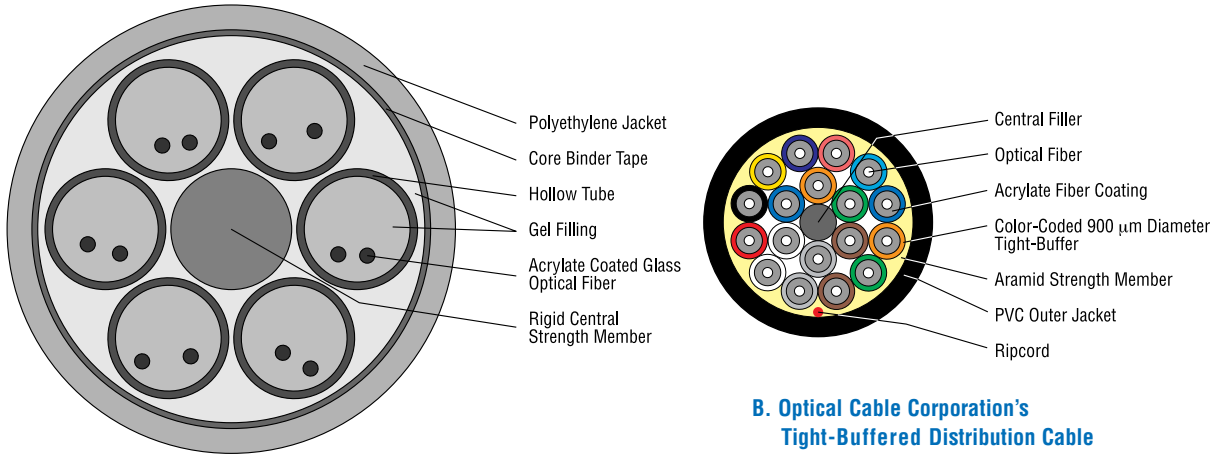
There are three types of tight-buffered indoor/outdoor cables offered by Optical Cable Corporation:

(1) Distribution Cable
(2) Breakout Cable
(3) Subgrouping Cable

The first cable type, Distribution Cable, is often used as a direct equivalent of loose-tube gel-filled cable because of its smaller size and capability to have a high fiber count (See Figure 1B). Direct connectorization is possible with Distribution Cable because the fibers normally have a 900 µm buffer. Terminated fibers may be directly connected to equipment without use of a patch panel and accompanying jumper cables. Also, no splices or splicing skills are needed, as with pigtails on loose-tube gel-filled cables. In situations where the fibers will be mated and unmated frequently,

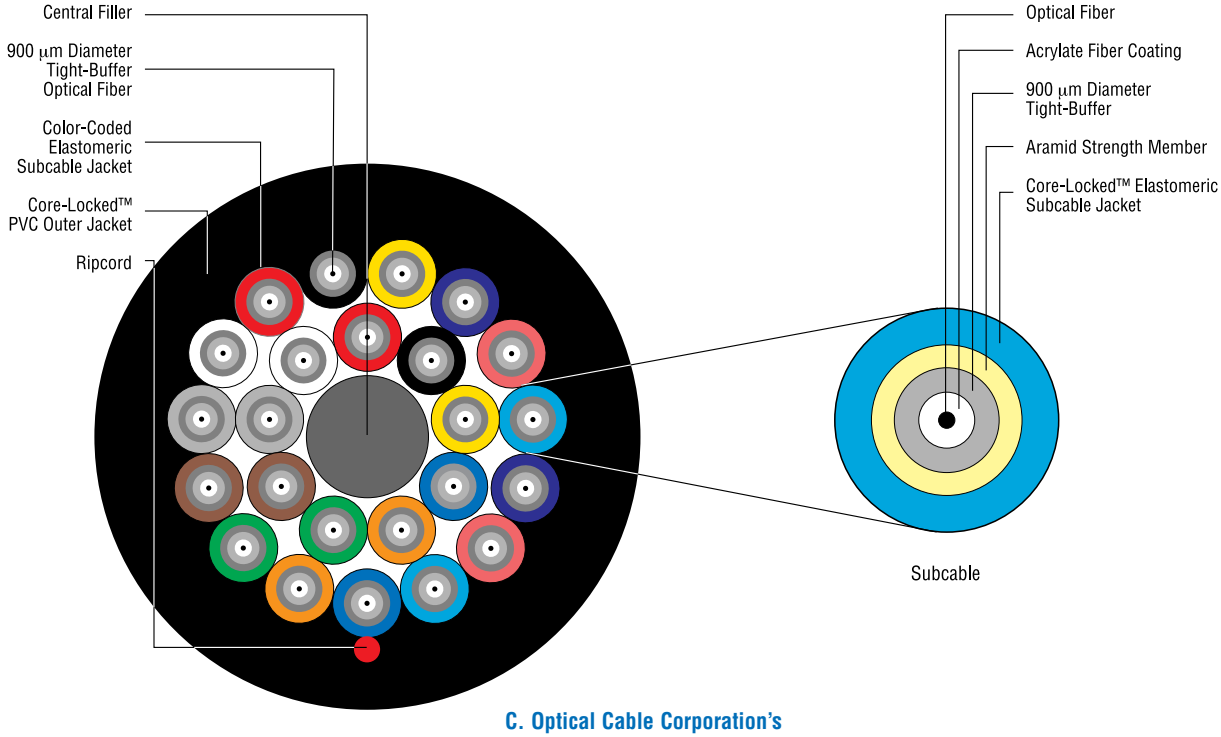
Indoor, Outdoor, Everywhere (cont.)

Figure 1. Three Basic Cable Types



A. Loose-Tube Gel-Filled Cable

B. Optical Cable Corporation's Tight-Buffered Distribution Cable



C. Optical Cable Corporation's Tight-Buffered Breakout Cable

Indoor, Outdoor, Everywhere (cont.)

or where there is general access to equipment, it is advisable to place terminated fibers in a patch panel to avoid damage to the connector/fiber interface.

The second cable type, Breakout Cable, has individual subcables within a primary outer cable sheath (See Figure 1C). This cable is the cable of choice for direct connectorization, as each fiber has its own aramid strength member for connector tie-off. The connectorized subcables may be directly connected to equipment without fear of fiber damage or connector/fiber interface damage in most situations. Breakout Cable is by far the least expensive and easiest cable type to terminate and requires the least experience on the part of the installer.

The third cable type, Subgrouping Cable, is similar to the Breakout Cable design, except that the subcables contain either 6 or 12 fibers. The subcable is, therefore, similar to the Distribution Cable and the same termination principles apply.

Cable prices are typically lower for tight-buffered cables than for loose-tube gel-filled cables when fiber counts are fairly low. Loose-tube gel-filled cables are lower in price for higher fiber counts. However, higher splicing and termination costs of loose-tube gel-filled cables over moderate-to-short lengths can far exceed the additional cost of tight-buffered cables.

The most common scenario in which termination costs dominate is an interbuilding (outdoor) cable entering a building where the required termination point of the cable is some distance from the building entryway, and it is necessary to switch from outdoor to indoor cable. Outdoor loose-tube gel-filled cable is typically required to be transitioned to indoor cable within 50 feet of the cable entry point to comply with fire codes. However, a tight-buffered indoor/outdoor cable can be used throughout the link, requiring no transitions at the building entryway.

Figure 2 on page 65 shows the cable system layout for the various cable types. The costs are based on typical catalog prices for elements in the installations. In this scenario, it is assumed there are 24 fibers being terminated. (Most splice trays allow placement of 12 fibers, and most patch panels have port counts which are multiples of 6.) It is also assumed the installer has selected Breakout Cable as the "indoor" cable used from the entry of the loose-tube gel-filled cable to the termination point. This Breakout Cable would be field terminated on both ends. Single-mode fiber and FC-PC connectors are used in the example. Multimode fiber labor costs would be approximately the same, but connector, jumper, and pigtail prices would be roughly 40% less. Mechanical splicing is assumed, which results in higher material costs but substantially less in equipment and maintenance costs. This cost analysis does not include equipment or tooling costs and attempts, where possible, to assume similar tooling used on each cable type. The actual termination cost will vary with the choice of connector style, connectivity system, and labor rates.

Another popular method of terminating loose-tube gel-filled cable is the use of a breakout kit. This can be used for lower cable counts (normally 24 fibers or less) in place of splicing.

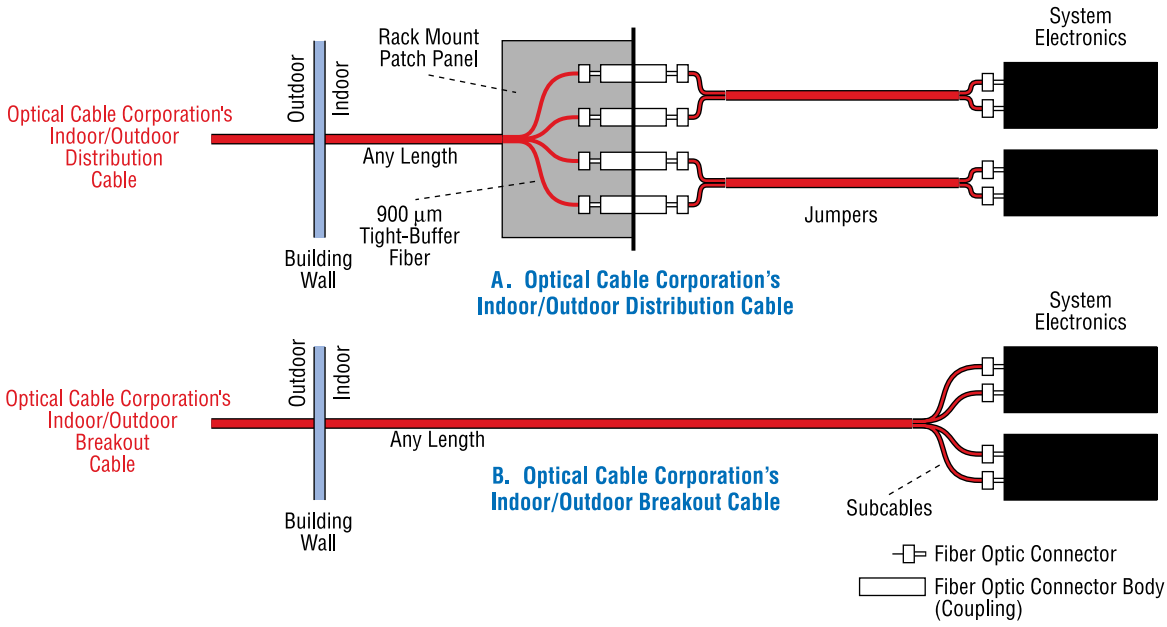
Obviously, in a campus-type environment with many building-to-building runs, the indoor/outdoor capability and ease of termination of Optical Cable Corporation's tight-buffered cables offer substantial reductions in the total cost of a cable plant installation. Other savings with the use of a single cable type for the indoor and outdoor portions of a network are fewer leftover cable "ends" and less material scrap. Any future emergency repairs are simplified with a single cable type.

Reliability

There are other less quantifiable costs and operational results associated with the selection of cable type and termination approach. One result is overall system reliability. Splices are the weakest link in a fiber optic cable installation. During the splice operation, the fiber is stripped of all its cable, coating, and buffering protection. This leaves the bare glass open to dust, dirt, water vapor, and handling — all factors that have been demonstrated to reduce fiber strength and increase brittleness. The bare fiber ends are then mechanically held in place by a mechanical splice or "welded" together in a fusion splice. Either operation is capable of inducing temporary and permanent stress on the glass. Once completed, the splice is placed in a splice holder, with the lead-in fibers protected only by the 62.5 µm wall thickness of the 250 µm coating. These relatively unprotected fibers are looped around in a small bend radius and are, therefore, potentially under stress in the splice housing. The splice housing may then be "filled" or "sealed" with varying degrees of success for outside use. The splices inside buildings may be held in a cabinet that is open to the air. These cabinets may be located in a basement near a building entrance or in an electrical closet, both of which are uncontrolled environments. The net effect is that in the region of the splices, the fiber is least protected, under the most stress, and usually in a non-ideal environment. This leads to the splices being the item with the greatest failure rate in the cable system. The obvious conclusion is that with the use of Optical Cable Corporation's

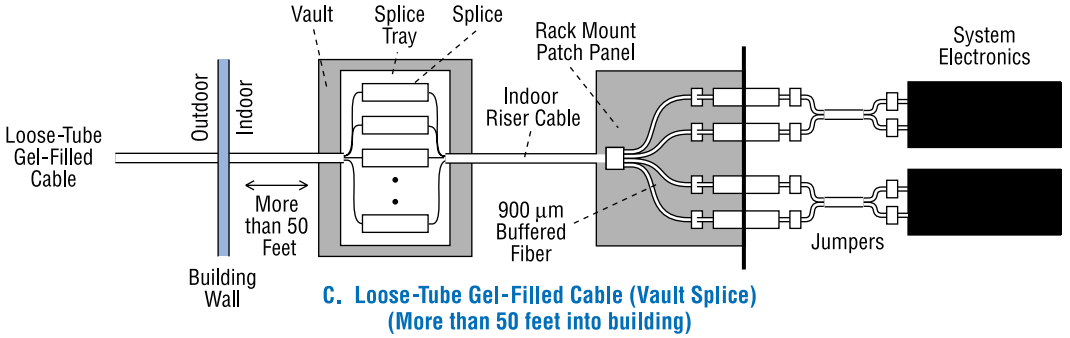
Indoor, Outdoor, Everywhere (cont.)

Figure 2. Cable System Layouts — Outdoor-to-Indoor Scenario

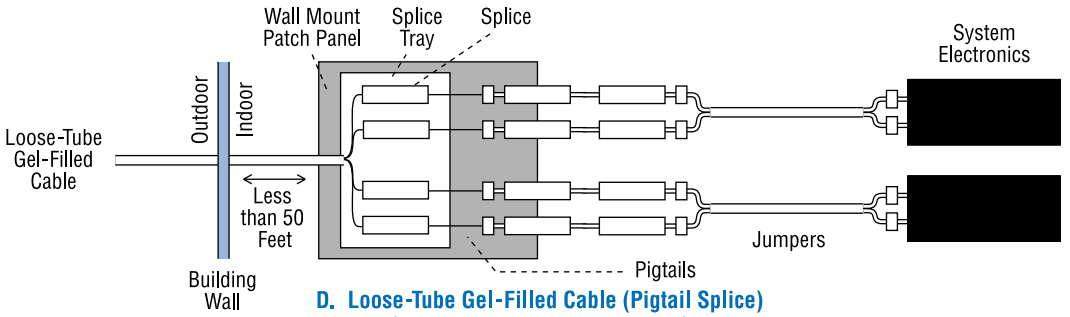


A. Optical Cable Corporation's Indoor/Outdoor Distribution Cable

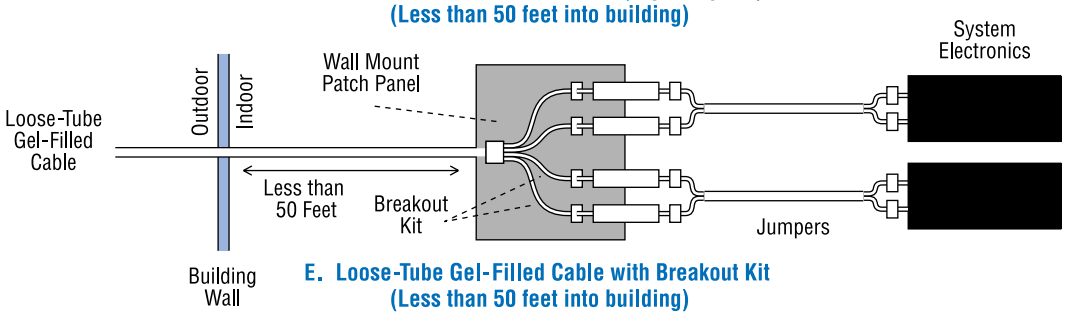
B. Optical Cable Corporation's Indoor/Outdoor Breakout Cable



C. Loose-Tube Gel-Filled Cable (Vault Splice)
(More than 50 feet into building)



D. Loose-Tube Gel-Filled Cable (Pigtail Splice)
(Less than 50 feet into building)



E. Loose-Tube Gel-Filled Cable with Breakout Kit
(Less than 50 feet into building)

Indoor, Outdoor, Everywhere (cont.)

tight-buffered indoor/outdoor cables, the splicing is eliminated and the installation reliability is greatly improved.

Maintenance

The use of tight-buffered indoor/outdoor cables greatly simplifies system maintenance and reduces restoration time. For routine terminations often required in moves, additions, and changes, only the skills and tooling for installing optical connectors are needed. In contrast, the loose-tube gel-filled cables require splicing with all the associated tooling and skills. Tight-buffered cables allow some portion of the fibers to be left dark for future termination with whatever type of connectors may be required. The installation of connectors on the ends of the optical fibers is the minimum skill required of the organization responsible for maintenance of a fiber optic cable plant. When using Optical Cable Corporation's tight-buffered indoor/outdoor cable, it is the only skill required.

Emergency restoration is also made much easier when tight-buffered cables are involved. All of the messy cable stripping, fiber end preparation, and cleaning required for splicing loose-tube gel-filled cables are time consuming and more likely to be successful in a controlled, clean environment. Emergency restoration is most likely to be required in less than ideal, adverse environmental conditions of temperature, rain, snow, mud, etc. In tight-buffered cables there is no gel – the mess and cleaning are completely eliminated. If splicing should be required on a tight-buffered indoor/outdoor cable, the tight-buffered fibers are inherently better protected, and the repair time is greatly reduced.

Optical Cable Corporation's tight-buffered indoor/outdoor cable is proven to be the cable of choice for interbuilding Local Area Network (LAN) cable installations, with its installation cost savings, reliability improvement, and maintenance advantages.

Termination Economies

The Bottom Line Advantage: Termination Cost Savings of Tight-Buffered and Breakout-Style Cables vs. Loose-Tube Gel-Filled Cables

Termination of fiber optic cables can be a major installation expense. By enabling direct field termination of B-Series and BX-Series Breakout or D-Series and DX-Series Distribution Cables, Optical Cable Corporation offers a major economic advantage to installers and users.

When you specify Optical Cable Corporation's tight-buffered B-Series and BX-Series Breakout or D-Series and DX-Series Distribution Cables, you may anticipate a cost savings approaching 66% of the estimated per-fiber cost of a typical furcation and field termination of a loose-tube gel-filled cable. Labor costs for loose-tube gel-filled cable are typically three times that of field termination for Optical Cable Corporation's tight-buffered indoor/outdoor cable. Other termination methods can result in costs four times higher than the direct termination of Optical Cable Corporation's tight-buffered indoor/outdoor fiber optic cables.

These estimates are based on installation of a 72-fiber cable. For lower fiber counts, field termination costs per fiber of Breakout and Distribution Cable will remain the same, while per-fiber cost for loose-tube gel-filled cable will rise as hardware, cleaning, and preparation time costs are amortized over fewer fibers.

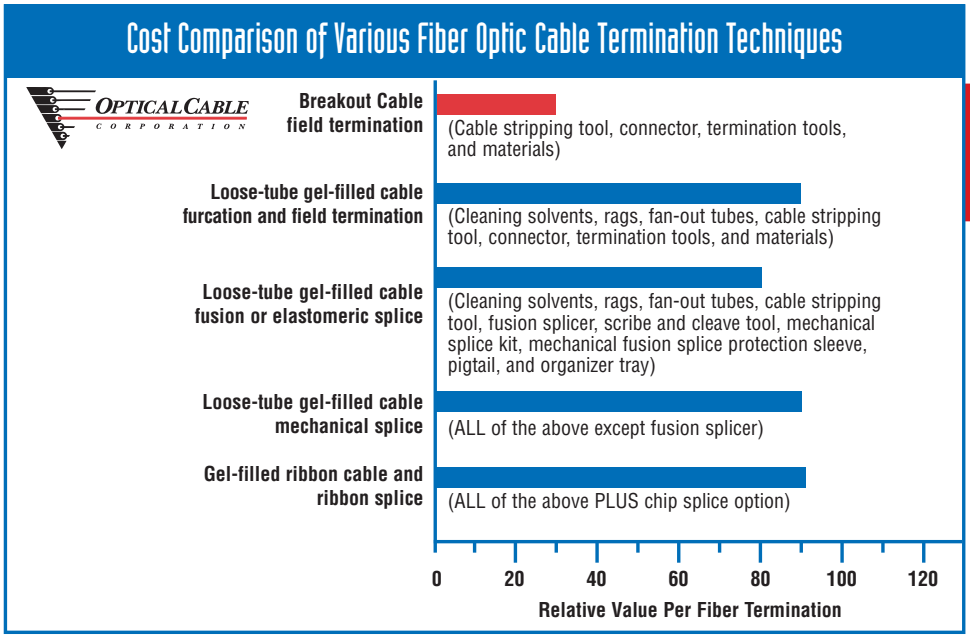
These savings are especially impressive when viewed in relation to cable link length. In a cable run of 400 fiber meters per connector (a link length of 800 meters), the savings will be approximately $.08 to $.13 per fiber meter. While this savings will decrease as link length increases, the economies remain impressive across the range of typical installations.

The simplicity of Optical Cable Corporation's field termination technique makes these savings possible. Terminating a tight-buffered cable requires only cable-stripping and connector installation tools and a few minutes of labor. When loose-tube gel-filled cable is used, installation expense must be elevated to include cleaning solvents, rags, fan-out tubes, splicers, splice housings, splice trays, splice closures, and the labor cost of extensive cleaning and preparation time.

Optical Cable Corporation's field termination technique offers several additional advantages:

- All buffer and coating layers are removed simultaneously with a simple mechanical stripper
- Since no gel filling is present, cleaning of the fibers is not necessary during termination
- Termination rework is drastically reduced
- Installation flexibility is improved, since it is not necessary to terminate all fibers at the same time
- Emergency restoration time, usually under the most adverse conditions, is dramatically reduced

When evaluating competitive cable alternatives, be sure to consider the installation economies inherent in Optical Cable Corporation's tight-buffered indoor/outdoor cable designs.



Water Tolerance vs. Waterproof

Tight-Buffered, Tightbound Cable Construction Provides Excellent Moisture Resistance

Optical Cable Corporation's tight-buffered B-Series and BX-Series Breakout Cables, D-Series and DX-Series Distribution Cables, and G-Series and GX-Series Subgrouping Cables offer excellent moisture protection over loose-tube gel-filled type cable constructions. They are suited for outdoor use. These tight-buffered, tightbound indoor/outdoor cables have demonstrated long-term survival in wet environments.

The basic mechanical failure mechanism for optical fibers is the slow to rapid growth of any glass imperfections in the fiber caused by the fiber being under stress. This "fatigue" phenomenon can be accelerated with the presence of moisture (H_20) molecules at the glass surface of the fiber. The greater the concentration of the water molecules (OH^- ions) at the glass surface, and the greater the stress applied to the glass, the more rapidly the surface imperfections will grow. This accelerated fatigue in the presence of OH^- ions is similar to "stress corrosion".

The speed of imperfection or "crack growth" in optical fibers is also very dependent on the size of the flaws in the fiber. To insure that no flaws greater than a predetermined size are present in finished fiber, fiber manufacturers subject their fibers to a brief elongation or stress, a process called proof testing.

All manufacturers of fiber optic cables intended for use outdoors must address the issue of protecting the fiber's glass surface from the presence of moisture. This is because the 250 µm primary fiber coating provides only a 62.5 µm-thick layer of UV-cured acrylate material as basic protection over the fiber's glass surface. This UV-cured acrylate material is not chosen by the fiber manufacturers for its optimal resistance to water or its minimal porosity. It is in fact chosen primarily because of its fast processing speed, since a primary cost driver for fiber manufacturers is the draw speed, which is steadily increasing. The very thin UV-cured acrylate layer is porous to water molecules and will permit concentration of OH^- ions at the fiber surface, if the fiber is immersed in water.

All plastic materials are porous to varying degrees. The general category of thermoplastic materials commonly used in cable constructions will to some extent absorb water; however, thermoplastic materials certainly do not act as a complete water block. Only materials like metals or glass can provide a true "hermetic" seal. Plastic materials are generally characterized with parameters such as water absorption, and absorption of other common solvents such as oils, gasoline, kerosene, etc. This being the case, water molecules cannot be eliminated from the glass surface of any fibers incorporated in a cable having plastic jackets. The issue is to minimize the concentration of water molecules at the glass surface so that stress crack growth effects are minimized.

There are two different design approaches to water and moisture protection in fiber optic cables. The loose-tube gel-filled cables (or slotted-core cables) must prevent water from reaching the 250 µm coated fibers. The approach is to "waterproof" the cable by "filling" the empty spaces in the cable with gel, theoretically preventing water from reaching the 250 µm coated fibers. To insure that this is accomplished, the "filled" cables are generally subjected to a hosing test to show that water will not flow through a short section (1 meter) of cables. Unfortunately, the gel filling in the cables can never be 100% and, in fact, is generally in the 85% to 90% range. This, plus the fact that gels can move, flow, and settle, leaves an uncertainty of the filling level of any particular point of a loose-tube gel-filled cable. This uncertainty of the filling is highlighted by the routine practice of water-blocking the loose-tube gel-filled cables at the entrance to splice housings to keep water from migrating from the cable into the splice housing. The loose-tube gel-filled structures, with the uncertainty of the filling and the 250 µm coated fibers, are at risk in the presence of water and stress to suffer fiber fatigue and breakage over time.

The tight-buffered, tightbound indoor/outdoor cables manufactured by Optical Cable Corporation utilize an entirely different design approach to deal with the moisture issue. Rather than attempting to be "water-proof", they are designed to be water tolerant. Recognizing the porosity of plastic materials and the inherent impossibility of waterproofing a cable, the moisture protection is concentrated at the fiber surface where it is most needed.

Optical Cable Corporation's tight-buffer systems consist of extremely low moisture absorption coefficient materials at the fiber coating. This provides a buffer system thickness of 387 µm over the glass, more than 6 times as thick as the 62.5 µm coating found in the loose-tube gel-filled cables.

Buffer materials are low-porosity plastics with excellent moisture resistance. This construction very

Water Tolerance vs. Waterproof (cont.)

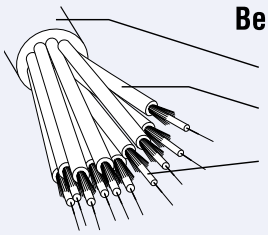
effectively minimizes the water molecule and OH^- ion concentration level at the glass surface and virtually eliminates the stress corrosion phenomenon. The tight-buffered design also has the great advantage of being a solid, non-flowing, non-moving structure. The same level of protection remains in place all along the fiber, regardless of installation conditions, environment, or time.

The balance of the tight-buffered, tightbound cable designs is such that it minimizes the open spaces available in the cable structure in which water can reside. Even if an outer cable jacket is cut, or water otherwise enters the cable structure, only a very small percentage of the cross-sectional area is open to water. This eliminates the other water-related failure mechanism, freezing, and expansion in the cable structure, causing stress on the fiber which could lead to failure. Optical Cable Corporation's tight-buffered, tightbound cables have been deliberately pumped full of water and frozen in a temperature chamber, and they show no damage and virtually no change in attenuation.

Optical Cable Corporation's excellent tight-buffered, tightbound cable construction results from extensive developmental efforts funded by the U.S. Government in the late 1970s and early 1980s. These efforts led to the highly successful military tactical fiber optic cable products offered by Optical Cable Corporation. These cables have been subjected to complete military qualification testing for outdoor field use. The same design approach, and many of the same materials, are used in our indoor/outdoor cables offered for commercial use. In 1978, the same technology was used for the first telephone installation field trial in central Pennsylvania. Twenty-two miles of tight-buffered fiber optic cable was installed outdoors, half aerially and half directly buried. This cable system was in continuous use for over 20 years without cable degradation or failures. This system was finally retired when their multimode electro-optics became obsolete.

The technology and construction of Optical Cable Corporation's tight-buffered, tightbound indoor/outdoor fiber optic cables offer a truly exceptional design for protection against moisture and for long-term survivability in outside-plant type applications.

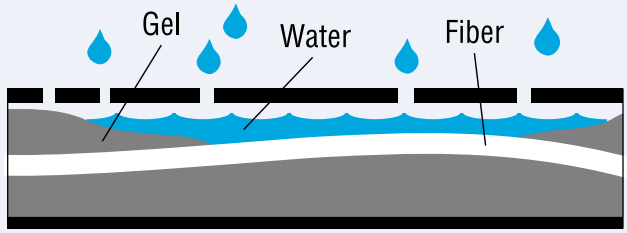
Optical Cable Corporation's Tight-Buffered Cable



Beats moisture 3 ways:

1. Outer Jacket
2. Subcable Jacket
3. 900 μm Tight-Buffer

Loose-Tube Gel-Filled Cable



Loose-tube gel-filled cables can leave fibers exposed to water.

The Case For Helically Stranded Cables

What Is Helically Stranded?

If you were a mountain climber using a rope to get up the sheer face of a cliff, would you rather have a nice round rope in your hands, or would you rather be hanging on to hundreds of straight filaments, each independent, and hopefully each bearing part of your weight? If you had to choose one of these designs on which to hang the survival of your communication network, which design would it be?

Since the dawn of time, with his interest in combining filaments, strands, fibers, or other elements into thread, yarn, cords, ropes, or lines, these elements have always been twisted together. More recently, virtually all wire ropes (electrical conductors made of multiple smaller wires and electrical cables made of multiple conductors) have been twisted or "helically stranded" together. The term "helically stranded" comes from the fact that each element of such a twisted together cable forms a helix. The "lay length" is the length along the cable required for one element to go all the way around a cable – from the top, around to the bottom, and back up to the top. *(See Figures 1 and 2 on page 71)*

Why Helically Stranded?

The helically stranded design is not a quirk, but a tried and time tested design and construction for cables of all kinds that has proven to offer many benefits, such as:

- All the many elements of the cable form a structure with a round cross section.
- A round cross section offers the least surface area for the enclosed volume. Therefore, when a rope slides across another object, there is less surface contact, friction, and wear for any given diameter or strength of the rope or cable.
- The cable elements are kept together despite bending and turning of the cable, because each helical element is always pulled toward the center of the cable. This helps maintain a round cross section despite radial forces (perpendicular to the length of the cable) on the cable.
- Since the helical elements are always pulled toward the center of the cable, and toward each other, there is increased friction among the elements so that load on any one element is shared with its adjacent elements, and in a short distance, among all the elements in the cable.
- Stresses on each element of the cable are averaged out and distributed among all the elements.
- As a cable is bent, each cable element rotates around the bend so that it is on the inside of the bend for a part of its length and on the outside for the next part. The tensile and compressive forces on the cable element average out within the "lay length".

Fiber Optic Cables

Helical stranding is of particular importance in the construction of fiber optic cables. Typically, fiber optic cables contain multiple optical fibers and a number of aramid yarns serving as strength members, all surrounded by a plastic jacket. All the mechanical factors relevant to the physical characteristics and performance of any cable apply. In addition, the glass fibers are sensitive to bending in two ways not found in elements of other cables.

(1) Excessive fiber bends or numerous "microbends" may cause significant signal loss that can degrade or prohibit system performance.

(2) Bends place the outer surface of the glass fibers under stress leading to the growth of any surface imperfections or microcracks. This growth of microflaws is known as "fatigue" and leads to "fatigue failure" which is fiber breakage.

In a fiber optic cable, helical stranding reduces the stresses that the fibers may be subject to during installation or in the installed condition.

- Helically stranded cable tends to stay round even when pulled around a bend or tight corner. This tends to limit the cable bending and associated stress on the fiber. In the case of a non-stranded or "straight lay" cable, each cable element essentially stands alone, and is unable to offer any resistance to bending. When a straight lay cable is pulled across a tight corner, it flattens its outer jacket against the fibers, which are then subjected to a great deal of stress and are highly likely to break. Even in a moderate bend in a large smooth duct, the cable flattens increasing surface area in contact with the duct, increasing friction and pulling force required during installation. A cable in this condition essentially has its fibers separate from whatever strength elements there may be, and is subject to both permanent stress from the installed condition and future stress from crush forces from additional cables being pulled in the duct.
- In a helically stranded cable, the cable elements are positioned in the cable cross sectional area during stranding. The elements always pull toward the center of the cable, and their relative positions remain predictable and unchanged over the life of the cable. Generally, the optical fibers of such a cable are placed near the center of the structure. This minimizes the stress when the cable is bent because while the outer curvature of the cable is under stress, the inner curvature is under compression, leaving the center of the cable essentially neutral. In addition, the outer elements of the cable are the aramid strength members. These outer elements provide cushioning for the fibers when the cable is subjected to crushing forces, and protection from cut through.

The Case For Helically Stranded Cables (cont.)

- In a straight lay cable, the fibers tend to be bunched on one side of the other cable elements, since there are no helical stranding forces to keep them centered or to offer any predictability to the configuration of the cable core. This bunching is quite likely since the fibers
  are mechanically different from the aramid strength members and react to mechanical forces on the cable in a fashion distinct from the aramid yarns. In this case, if a fiber is on the inside edge of the cable core in a bend, it is subject to compression that can cause macro or microbending and optical loss associated with the bending, and ultimately fatigue failure. If the fiber is on the outside of the cable core in a bend configuration, it is placed under elongation stress causing growth of imperfections in the glass of the fibers and could ultimately cause fiber breakage.
- An interesting side effect of the bunching and uncertain location of the elements of the cable core is that it requires the outer jacket to be loosely "tube extruded". If the jacket were tightly extruded, the hot material of the jacket could fuse into the plastic buffered material of the fibers during extrusion. This could lead to future bend losses or fiber breakage as the cable core and fibers move relative to the outer jacket. Unfortunately, this side effect aggravates the drawbacks of the straight lay design because a loose outer jacket is essentially a hollow PVC tube containing some fibers and aramid strength members. Much like a drinking straw, this tube has little resistance to collapsing when it is bent sharply or kinked, again leading to fiber stress and breakage.
- When a helically stranded cable is bent, the helical path taken by each fiber insures that the stresses it is subjected to are distributed and averaged over the lay length. In half the lay length, the fiber is both at the "top" and "bottom" of its helix, or in the case of the bent cable, both on the outside and the inside of the curve. Therefore, in half the lay length, the fiber is subjected to both tension and compression, which average out, leaving the fiber in an essentially neutral condition.

Figure 1: Helically Stranded Construction

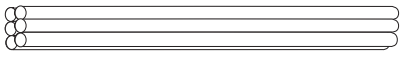


Figure 2: Straight Lay Construction

Specification: If there is a specification associated with the purchase or submitted with the offer or quotation, insist that it include a statement, "All cable elements shall be helically stranded, with a lay length not to exceed 30 times the finished cable diameter." Note: Relatively small cable diameters up to 3/8 inch (9.5 mm) with lay lengths of greater than 8 to 10 inches offer little advantage.

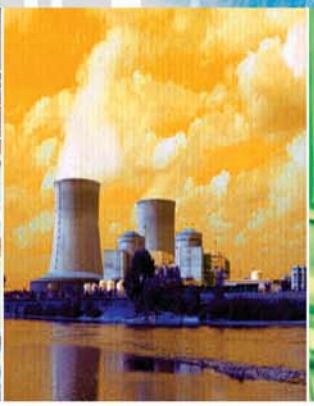
Inspection: Regardless of whether there is a specification, insist on your prospective vendors submitting samples for your approval. When you receive a sample, carefully slit the outer jacket longitudinally with a knife or razor blade for a length of about 24 inches to one end of the sample. Peel open the jacket at the cable end and grasp the cable core between your thumb and forefinger. Lift the cable core straight out of the slit cable jacket without twisting or untwisting it. If the cable is helically stranded, all the cable elements will show an obvious twisting (helical path) completely around the cable core, typically every 6 to 10 inches.

When cable is delivered to your order, make sure that it is indeed all helically stranded by repeating this test. On longer delivered lengths of cable, a 24 inch slit may be made in a length that is not to be installed and the cable core pulled out of the side of the cable jacket. This should clearly show a helix with cable elements spiraling all the way around the cable core.

Conclusion

Helically stranded cables provide the most robust cable design for your communication network.

Companies with vision choose Optical Cable Corporation.



Companies that choose Optical Cable Corporation understand that they aren't just installing a cable. They are investing in their infrastructure with a rugged cable available through a network of distributors. And they know they have a product that is engineered with a long-term view of communication needs. Where some companies see cable, other companies with vision see opportunity. Call Optical Cable Corporation to find out why.

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OPTICAL CABLE CORPORATION

Product Testing and Warranty

Product Testing

Every reel of fiber optic cable manufactured by Optical Cable Corporation is the product of a 100% quality manufacturing environment. Manufacturing processes are computer controlled for exacting tolerances, peak performance, and excellent repeatability.

All fiber optic cables manufactured by Optical Cable Corporation are 100% inspected. Optical Time Domain Reflectometer (OTDR) testing is used by the Quality Assurance Department to test buffered fibers, completed subcables, and completed cables after the final jacket is placed over all the internal components.

Optical Cable Corporation's quality management system is certified to ISO 9001:2000, the internationally recognized standard for quality management systems. The company's expertise assures that each customer will receive the highest quality products to allow their network to run at peak performance levels.

Certificate No. 007038

Extensive environmental and mechanical testing is performed on each fiber optic cable style to develop its performance characteristics and to verify compliance on a continuing basis. Independent testing and verification laboratories verify UL, CSA, IEC, and other applicable standards compliance.

c UL US LISTED

Optical Cable Corporation Standard Warranty

Optical Cable Corporation warrants that all fiber optic cables delivered will be free from defects in material and workmanship, and will conform to Optical Cable Corporation specifications in effect at the time of shipment. The terms, conditions, and limitations of this warranty are as follows:

For all fiber optic cables found to be defective under the terms of this warranty, Optical Cable Corporation will (a) repair or provide replacement cables, and (b) pay the shipping costs for returning defective cables and for furnishing repaired or replacement cables.

Optical Cable Corporation will repair and furnish replacement cables under this warranty if (a) Optical Cable Corporation receives, within twelve (12) months of the date Optical Cable Corporation originally shipped the cables in question, a written statement setting forth the nature and suspected cause of the alleged deficiencies in the cables, (b) Optical Cable Corporation is given reasonable opportunity to inspect the installed cables prior to removal for return to Optical Cable Corporation; (c) the cables are returned to Optical Cable Corporation under a factory-issued Return Material Authorization (RMA) number, transportation prepaid, for inspection at Optical Cable Corporation's factory; (d) Optical Cable Corporation testing and inspection disclose to the satisfaction of Optical Cable Corporation that the cables are defective in material or workmanship; and (e) the cables have not been subjected to misuse, improper installation, negligence, or shipping damage.

The stated warranties and remedies are exclusive and in place of all other remedies and warranties, express or implied, including without limitation any implied warranties of merchantability or fitness for a particular purpose and excluding any liability for incidental or consequential damages or for any other liability beyond repair or replacement as provided above. In no event will Optical Cable Corporation's liability exceed the purchase price paid to Optical Cable Corporation for the cables.

Please contact Optical Cable Corporation for optional extended warranties and connectivity partner system warranties.

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CORPORATION

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