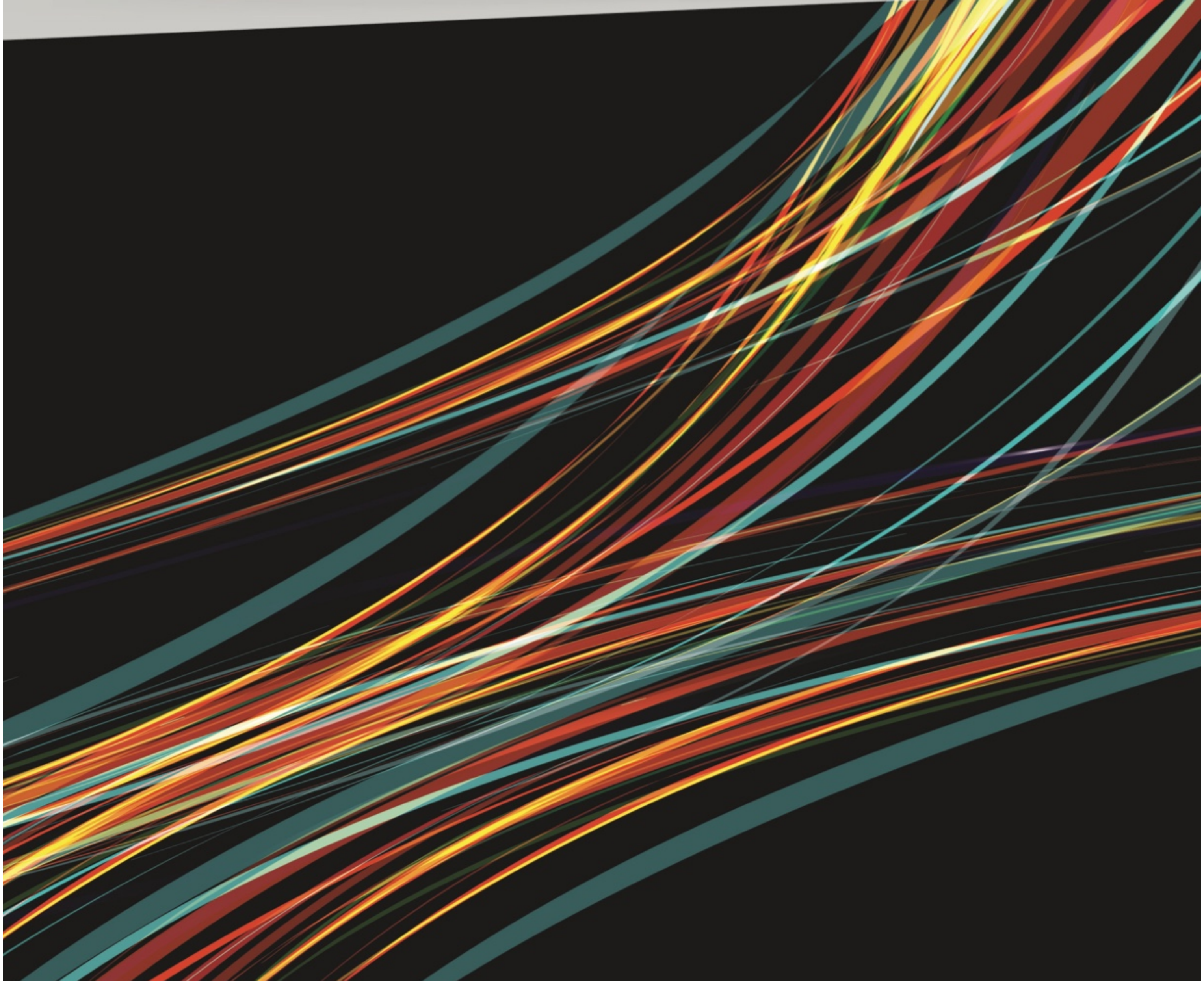
Prysmian Group

Optical Fiber Solutions

Single-Mode & Multimode



VISION

We believe in the effective, efficient and sustainable supply of energy and information as a primary driver in the development of communities

MISSION

We provide our customers around the world with superior cable solutions based on state-of-the-art technology and consistent excellence in execution, ultimately delivering sustainable growth and profit

VALUES

INTEGRITY

We uphold the highest standards of integrity in our actions

EXCELLENCE

Every day, we relentlessly pursue excellence in all we do

UNDERSTANDING

We listen closely to our customers to really understand their needs

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INTRODUCTION

In North America, Prysmian fiber cable is offered with 3 leading global brands of optical fiber – Draka®, Corning®, and Prysmian®. This unique position is an strategic advantage to our customers and demonstrates the strength of the Prysmian cable brand.

With over 100,000 varieties of fiber cable, Prysmian offers a fiber cable solution to meet customer needs. This catalog summarizes the breadth and depth of optical fibers offered in Prysmian fiber cable.

Fibers Available in Prysmian Cable

Low Water Peak Single-Mode

This single-mode optical fiber (SMF, ITU-T G.652.D) has significantly reduced attenuation in the 1383 nm water absorption wavelength region.

Bend-Insensitive Single-Mode

Bend-insensitive single mode fibers (SMF) answers the market demand for bend-optimized SMF with low bending loss.

Non-Zero Dispersion Shifted Single-Mode

Non-Zero Dispersion Shifted Fiber (NZDSF) are optimized for 1550 nm performance in long haul applications.

Low Loss and Ultra Low Loss Single-Mode

Low loss cables provides extented system reach while maintaining G.652 backwards compatibility.

OM1, OM2, OM3 OM4 & OM5 Multimode

Optical fiber widely used for campus, enterprise, and premise applications.

RadHard Single-Mode & Multimode

Optimized for use in highly irradiative environments.

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APPLICATIONS

Communication Networks | Long Haul | Fiber-To-The-Home (FTTH)

Wireless | Enterprise | Data Center | Security Systems

Industrial & Harsh Environment | Active Optical Networks

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INTERNATIONAL STANDARDS TABLE AND FIBER PRODUCTS TABLE

Industry Standard	Fiber Type	Fiber Summary	Prysmian OneSpec™		Corning® Optical Fiber		Draka	
			Product Name	Fiber Code	Product Name	Fiber Code	Product Name	Fiber Code
SINGLE-MODE FIBER								
ITU G.652.D & G.657.A1	SM	Low Water Peak, Low Loss, 10 mm bend radius	------	--	SMF-28® Ultra Fiber	CU	------	--
ITU G.652.D	SM	Low Water Peak	ITU G.652.D	HB	SMF-28e+® Fiber	CE	ESMF	ES
BEND-INSENSITIVE FIBER (BIF)								
ITU G.657.A1 & G.652.D	SM	Bend-Insensitive 10 mm bend radius	ITU G.657.A1	B1	SMF-28® Ultra Fiber	CU	BendBright™	BB
ITU G.657.A2 & G.652.D	SM	Bend-Insensitive 7.5 mm bend radius	ITU G.657.A2	B2	ClearCurve® LBL Fiber	CY	BendBright-XS™	BX
ITU G.657.B3 & G.652.D	SM	Bend-Insensitive 5 mm bend radius	ITU G.657.B3	B3	ClearCurve® ZBL Fiber	CZ	BendBright™ Elite	BE
LONG DISTANCE APPLICATIONS								
ITU G.655	SM	Non-Zero Dispersion Shifted	------	--	LEAF® Fiber	LE	------	--
ITU G.656	SM	Non-Zero Dispersion Shifted (med. dispersion)	------	--	------	--	TeraLight™ Ultra	TU
ITU G.652.B & G.654.C	SM	Ultra Low Attenuation	------	--	SMF-28® ULL Fiber	CP	-----	--
MULTIMODE FIBER								
ISO/IEC 11801 MMF Class OM1	MM	62.5 µm, OM1	62.5	G6	InfiniCor® 300 Fiber	C1	Legacy OM1 62.5	6S
ISO/IEC 11801 MMF Class OM2	MM	50 µm Bend-Insensitive, OM2, 150m 10G	OM2	G2	ClearCurve® OM2 Fiber	C2	MaxCap BB OM2	5E
ISO/IEC 11801 MMF Class OM3	MM	50 µm Bend-Insensitive, OM3, 300m 10G	OM3	G3	ClearCurve® OM3 Fiber	C3	MaxCap BB OM3	5F
ISO/IEC 11801 MMF Class OM4	MM	50 µm Bend-Insensitive, OM4, 550m 10G	OM4	G4	ClearCurve® OM4 Fiber	C4	MaxCap BB OM4	5G
ISO/IEC 11801 MMF Class OM4	MM	50 µm Bend-Insensitive, OM4+	------	--	ClearCurve® OM4+ Fiber (with EMB ≥ 5350 MHz.km)	CJ	MaxCap OM4 Plus (EB ≥ 5000 MHz.km)	5J
ISO/IEC 11801 MMF Class OM5	MM	50 µm Bend-Insensitive, OM5 Wideband	------	--	ClearCurve® OM4 Wideband Fiber	--	WideCap OM5	5K
RADIATION HARDENED FIBER								
MIL-PRF-49291/6	MM	62.5 µm OM1 Radiation Hardened	------	--	------	--	RadHard 62.5 µm	6R
MIL-PRF-49291/1	MM	50 µm OM2 Radiation Hardened	------	--	------	--	RadHard 50 µm	5R
MIL-PRF-49291/1	MM	50 µm OM3 Radiation Hardened	------	--	------	--	RadHard 50 µm	5T
MIL-PRF-49291/7	SM	SMF Radiation Hardened	------	--	------	--	RadHard SM	SH

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COLOR CODES & DISTANCE CHART

Premise Jacket Color Code Guide

Fiber Optic Color Code for Jackets (TIA-598)

Jacket Color	Description
Orange	**MMF - 62.5/50µm, OM1/OM2+** Interconect Series, Riser, Plenum and LSZH
Aqua	**OM3/OM4** Interconect Series, Riser, Plenum and LSZH
Green	**OM5** Interconect Series, Riser, Plenum and LSZH
Yellow	**Single-Mode including Bend-Insenstive Fiber** Interconect Series, Riser, Plenum and LSZH
Black	**Hybrid** Indoor-Outdoor Cables and Outside Plant Cable All Fiber Types

Fiber Specifications

Fiber Class	Fiber Type	1 GbE Max. Distance 850 nm / 1300 nm	10 GbE Max. Distance 850 nm / 1300 nm	Bandwidth MHz-hm (OFL) 850 nm / 1300 nm	Indoor Cable Jacket Color
62.5 µm	OM1	275 m / 550 m	36 m / 300 m	200 / 500	Orange
50 µm	OM2	550 m / 550 m	82 m / 300 m	1500 / 500	Orange
50 µm	OM3	1000 m / 550 m	300 m / 300 m	1500 / 500	Aqua
50 µm	OM4	1100 m / 550 m	550 m /300 m	3500 / 500	Aqua
50 µm	OM5	--	600 m* / --	3500 / 500	Green
Single-Mode	OS1 and OS2	5-40 km @ 1310 nm	10 km @ 1310 nm 40 km @ 1550 nm	N/A	Yellow

*200 m for 4λ

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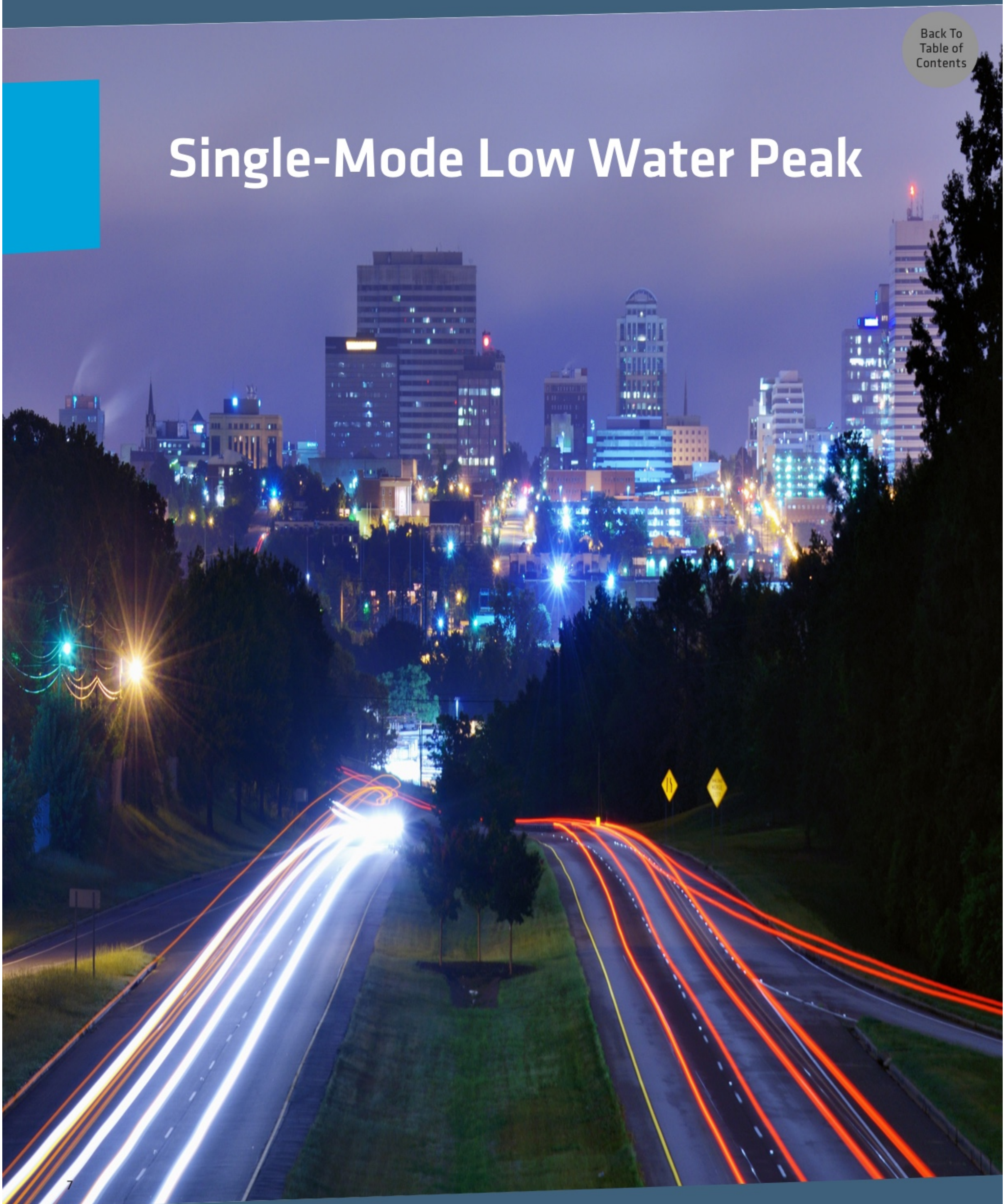
Single-Mode Low Water Peak



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Single-Mode Low Water Peak Fiber

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Corning® SMF-28® Ultra Optical Fiber

Product Information

CORNING

Corning® SMF-28® Ultra optical fiber is an ITU-T Recommendation G.652.D compliant optical fiber with Corning's enhanced low-loss and bend fiber technologies. This full-spectrum fiber has bend performance that exceeds the ITU-T Recommendation G.657.A1 standard and still splices the same as the installed base of standard single-mode fibers such as SMF-28e+ fiber. SMF-28 Ultra fiber offers industry-leading specifications for attenuation, macrobend loss, and polarization mode dispersion values, which provide a solid foundation for new network deployments as well as upgrades to existing networks. Since Corning brought the first fiber to market more than 40 years ago, Corning's leadership in single-mode fiber innovation has been unparalleled.

Optical Specifications

Maximum Attenuation

Wavelength (nm)	Maximum Value* (dB/km)
1310	≤ 0.32
1383**	≤ 0.32
1490	≤ 0.21
1550	≤ 0.18
1625	≤ 0.20

* Alternate attenuation offerings available upon request.
** Attenuation values at this wavelength represent post-hydrogen aging performance.

Attenuation vs. Wavelength

Range (nm)	Ref. λ (nm)	Max. α Difference (dB/km)
1285 – 1330	1310	0.03
1525 – 1575	1550	0.02

The attenuation in a given wavelength range does not exceed the attenuation of the reference wavelength (λ) by more than the value α.

Macrobend Loss

Mandrel Radius (mm)	Number of Turns	Wavelength (nm)	Induced Attenuation* (dB)
10	1	1550	≤ 0.50
10	1	1625	≤ 1.5
15	10	1550	≤ 0.05
15	10	1625	≤ 0.30
25	100	1310, 1550, 1625	≤ 0.01

*The induced attenuation due to fiber wrapped around a mandrel of a specified radius.

Point Discontinuity

Wavelength (nm)	Point Discontinuity (dB)
1310	≤ 0.05
1550	≤ 0.05

Cable Cutoff Wavelength (λ_{cc})

λ_{cc} ≤ 1260 nm

Mode-Field Diameter

Wavelength (nm)	MFD (µm)
1310	9.2 ± 0.4
1550	10.4 ± 0.5

Dispersion

Wavelength (nm)	Dispersion Value [ps/(nm·km)]
1550	≤ 18.0
1625	≤ 22.0

Zero Dispersion Wavelength (λ_0): 1304 nm ≤ λ_0 ≤ 1324 nm
Zero Dispersion Slope (S_0): S_0 ≤ 0.092 ps/(nm²·km)

Polarization Mode Dispersion (PMD)

	Value (ps/√km)
PMD Link Design Value	≤ 0.04*
Maximum Individual Fiber PMD	≤ 0.1

***Complies with IEC 60794-3: 2001, Section 5.5, Method 1, (m = 20, Q = 0.01%), September 2001.**

The PMD link design value is a term used to describe the PMD of concatenated lengths of fiber (also known as PMD_Q). This value represents a statistical upper limit for total link PMD. Individual PMD values may change when fiber is cabled.

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

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Corning® SMF-28® Ultra Optical Fiber

Dimensional Specifications

Glass Geometry

Fiber Curl	≥ 4.0 m radius of curvature
Cladding Diameter	125.0 ± 0.7 µm
Core-Clad Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7%

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 1310 nm, 1550 nm, and 1625 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.05
Temperature Humidity Cycling	-10°C to +85°C up to 98% RH	≤ 0.05
Water Immersion	23°C ± 2°C	≤ 0.05
Heat Aging	85°C ± 2°C	≤ 0.05
Damp Heat	85°C at 85% RH	≤ 0.05

*Reference temperature = +23ºC
Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa).*

*Higher proof test levels available.

Length

Fiber lengths available up to 63.0 km/spool.

Performance Characterizations

Characterized parameters are typical values.

Core Diameter	8.2 µm
Numerical Aperture	0.14 NA is measured at the one percent power level of a one-dimensional far-field scan at 1310 nm.
Effective Group Index of Refraction (N_{eff})	1310 nm: 1.4676 1550 nm: 1.4682
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (3N) Wet, 14-day room temperature: 0.6 lbs. (3N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1310 nm: -77 dB 1550 nm: -82 dB

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Corning® SMF-28e+® Optical Fiber
Product Information

CORNING

Corning® SMF-28e+® optical fiber is the industry leader in comprehensive single-mode fiber performance for metro and access networks. It is ITU-T Recommendation G.652.D-compliant and fully backward compatible with legacy standard single-mode fibers. SMF-28e+ fiber is built on Corning's solid foundation of quality and proven performance. Since Corning brought the first fiber to market more than 40 years ago, Corning's leadership in single-mode fiber innovation has been unparalleled.

Optical Specifications

Maximum Attenuation

Wavelength (nm)	Maximum Value* (dB/km)
1310	≤ 0.35
1383**	≤ 0.35
1490	≤ 0.24
1550	≤ 0.20
1625	≤ 0.23

* Alternate attenuation offerings available upon request.
** Attenuation values at this wavelength represent post-hydrogen aging performance.

Attenuation vs. Wavelength

Range (nm)	Ref. λ (nm)	Max. α Difference (dB/km)
1285 – 1330	1310	0.03
1525 – 1575	1550	0.02

The attenuation in a given wavelength range does not exceed the attenuation of the reference wavelength (λ) by more than the value α.

Macrobend Loss

Mandrel Diameter (mm)	Number of Turns	Wavelength (nm)	Induced Attenuation* (dB)
32	1	1550	≤ 0.03
50	100	1310	≤ 0.03
50	100	1550	≤ 0.03
60	100	1625	≤ 0.03

*The induced attenuation due to fiber wrapped around a mandrel of a specified diameter.

Point Discontinuity

Wavelength (nm)	Point Discontinuity (dB)
1310	≤ 0.05
1550	≤ 0.05

Cable Cutoff Wavelength (λ_{cc})

λ_{cc} ≤ 1260 nm

Mode-Field Diameter

Wavelength (nm)	MFD (µm)
1310	9.2 ± 0.4
1550	10.4 ± 0.5

Dispersion

Wavelength (nm)	Dispersion Value [ps/(nm•km)]
1550	≤ 18.0
1625	≤ 22.0

Zero Dispersion Wavelength (λ_0): 1304 nm ≤ λ_0 ≤ 1324 nm
Zero Dispersion Slope (S_0): ≤ 0.092 ps/(nm^2•km)

Polarization Mode Dispersion (PMD)

	Value (ps/√km)
PMD Link Design Value	≤ 0.06*
Maximum Individual Fiber PMD	≤ 0.1

*Complies with IEC 60794-3: 2001, Section 5.5, Method 1, (m = 20, Q = 0.01%), September 2001.

The PMD link design value is a term used to describe the PMD of concatenated lengths of fiber (also known as PMDQ). This value represents a statistical upper limit for total link PMD. Individual PMD values may change when fiber is cabled.

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

plus CORNING Optical Fiber

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SM-LWP

Corning® SMF-28e+® Optical Fiber

Dimensional Specifications

Glass Geometry

Fiber Curl	≥ 4.0 m radius of curvature
Cladding Diameter	125.0 ± 0.7 µm
Core-Clad Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7%

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 1310 nm, 1550 nm, and 1625 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.05
Temperature Humidity Cycling	-10°C to +85°C up to 98% RH	≤ 0.05
Water Immersion	23°C ± 2°C	≤ 0.05
Heat Aging	85°C ± 2°C	≤ 0.05
Damp Heat	85°C at 85% RH	≤ 0.05

*Reference temperature = +23ºC

Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa).*

*Higher proof test levels available.

Length

Fiber lengths available up to 63.0 km/spool.

Performance Characterizations

Characterized parameters are typical values.

Core Diameter	8.2 µm
Numerical Aperture	0.14 NA is measured at the one percent power level of a one-dimensional far-field scan at 1310 nm.
Effective Group Index of Refraction (N_{eff})	1310 nm: 1.4674 1550 nm: 1.4679
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (3N) Wet, 14-day room temperature: 0.6 lbs. (3N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1310 nm: -77 dB 1550 nm: -82 dB

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Draka

A brand of the Prysmian Group

Single-Mode Fiber

Enhanced Single-Mode Optical Fiber (ESMF)

Improved performance across the entire 1260 nm to 1625 nm wavelength spectrum

Draka's Enhanced Single-Mode Fiber (ESMF) was develped for telecom applications such as long-haul, metropolitian, FTTx, and Premise

Draka's Enhanced Single-Mode Fiber (ESMF) provides improved performance across the entire 1260 nm to 1625 nm wavelength spectrum. It has a low dispersion in the 1310 nm window and low attenuation in the 1383 nm water-peak region to allow use of the extended band (1360 nm to 1460 nm).

With its wide operating spectrum, ESMF expands the future growth capability of the fiber and allows flexible configuration of voice, data, and video services within the fiber. It can be used in all cable constructions, including loose tube, tight buffered, ribbon, and central tube designs.

The tighter geometrical, attenuation and PMD specifications of ESMF enable superior performance in long-haul, metropolitan, access and premises applications in telecommunications, CATV and utility networks. ESMF is completely interchangeable with standard single-mode fiber. Draka's Advanced Plasma Vapor Deposition (APVD™) manufacturing process ensures the highest quality and purity of fibers. Proprietary ColorLock™ coating process further enhances the performance, durability and reliability of the fiber, even in the harshest environments.

The fiber complies with or exceeds the ITU-T Recommendation G.652.D, the IEC International Standard 60793-2-50 type B.1.3 Optical Fiber Specification, Telcordia GR-20-CORE, ANSI/ICEA S-87-640 and RUS 7CFR 1755.900.

Features	Advantages
Low 1383 nm (water-peak) attenuation	• Provides expanded fiber capacity and cost savings through use of cheaper lasers in the entire 1260 to 1625 nm range, multiplexing filters and higher number of channels
Low hydrogen sensitivity	• Low attenuation in the 1383 nm region even as fiber ages, for improved performance and long life
Lower PMD of 0.06 ps/√km link design value	• Extends the PMD distance performance, reducing regeneration costs
Low 1460 nm attenuation (< 0.25 dB/km)	• Easy design of low cost laser and filter based systems over a wide wavelength range • Ensure efficient Raman pumping for C-band amplification
Proprietary PCVD and APVD™ manufacturing process	• Superior geometry, uniformity and purity
Revolutionary ColorLock-XS coating process	• Increased reliability, durability, and superior aging performance, resulting in lower maintenance and replacement costs. Makes color a component of the coating, thus enhancing fiber identification and colored fiber reliability. Consistent, vibrant color for easy-of-use and flexibility

Key Industry Leading Milestones

1998	2001	2008
ColorLock™world only lifetime guaranteeed colored fibers	Enhanced SMF more than two years in advance on international standards	ColorLock-XS™: extreme protection against microbendings

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Draka

A brand of the Prysmian Group

SM-LWP

Enhanced Single-Mode Optical Fiber (ESMF)

Optical Specifications (uncabled fiber)

Attenuation	
Attenuation @ 1310 nm	0.33 – 0.35 dB/km
Attenuation @ 1383 nm*	0.32 – 0.35 dB/km
Attenuation @ 1460 nm	0.25 dB/km
Attenuation @ 1550 nm	0.19 – 0.21 dB/km
Attenuation @ 1625 nm	0.20 – 0.23 dB/km

**Including H2-aging according to IEC 60793-2-50, type B.1.3*
Other values available on request

Attenuation vs. Wavelength

Maximum attenuation change over the window from reference

Wavelength range (nm)	Reference λ (nm)	(dB/km)
1285-1330	1310	≤ 0.03
1525-1575	1550	≤ 0.02
1460-1625	1550	≤ 0.04

Point Discontinuities

No point discontinuity greater than 0.05 dB at 1310 nm & 1550 nm.

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Induced Attenuation (dB)
100	25	1310	≤ 0.05
100	25	1550	≤ 0.05
100	30	1625	≤ 0.05

Cutoff Wavelength

Cable Cutoff Wavelength (λccf)	≤ 1260 nm

Mode Field Diameter

Wavelength (nm)	MFD (µm)
1310	8.8 to 9.6
1550	9.6 to 10.6

Chromatic Dispersion

Wavelength (nm)	Chromatic Dispersion (ps/[nm.km])
1285-1330	≤ |3|
1550	≤ 18.0
1625	≤ 22.0
Zero Dispersion Wavelength (λo):	1300-1322 nm
Slope (So) at λo:	≤ 0.090 ps/(nm^2.km)

Polarization Mode Dispersion (PMD)

PMD Link Design Value** (ps√km)	≤ 0.06
Max. Individual Fiber (ps√km)	≤ 0.1

*** According to IEC 60794-3, Ed 3 (Q=0.01%)*

Geometrical Specifications

Glass Geometry	
Cladding Diameter	125.0 ± 0.7 µm
Core/Cladding Concentricity Error	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7 %
Fiber Curl (Radius)	≥ 4 m

Coating Geometry	
Coating Diameter	242 ± 7 µm
Coating/Cladding Concentricity Error	≤ 12 µm
Coating Non-Circularity	< 5%
Length	Standard lengths up to 50.4 km

Mechanical Specifications

Proof Test

The entire length is subjected to a tensile proof stress > 0.7 GPa (100 kpsi) 1% strain equivalent

Tensile Strength

Dynamic tensile strength (0.5 meter gauge length):

Aged*** and unaged	Median > 3.8 GPa (550 kpsi)

**** Aging at 85°C, 85% RH, 30 days*

Dynamic and Static Fatigue

Dynamic fatigue unaged and aged***	$n_d > 20$
Static fatigue, aged***	$n_s > 23$

Coating Performance

Coating strip force unaged and aged****

- Average strip force:	1 N to 3 N
- Peak strip force:	1.2 N to 8.9 N

**** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C
- Wasp spray exposure (Telcordia)

Environmental Specifications

Attenuation

Environmental Test	Test Conditions	Induced attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling	- 60°C to 85°C	≤ 0.05
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.05
Water Immersion	14 days; 23°C	≤ 0.05
Dry Heat	30 days; 85°C	≤ 0.05
Damp Heat	30 days; 85°C, 85% RH	≤ 0.05

Typical Values

Miscellaneous	
Nominal Zero Dispersion Slope	0.085 ps/(nm^2.km)
Effective group index @ 1310 nm	1.467
Effective group index @ 1550 nm	1.468
Effective group index @ 1625 nm	1.468
Rayleigh Backscatter Coefficient for 1 ns pulse width:	
@ 1310 nm	-79.4 dB
@ 1550 nm	-81.7 dB
@ 1625 nm	-82.5 dB
Median Dynamic Tensile Strength	5.3 GPa (750 kpsi)
(Aged at 85°C, 85% RH, 30 days; 0,5 m gauge length)	

Prysmian Group

PRYSMIAN

Draka

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Prysmian OneSpec™
Premium Low Water Peak G.652.D Fiber

Overview

This specification applies to fiber cables with "G.652.D Single-Mode Low Water-Peak Fiber". The fiber is a Premium Grade Standard Single-Mode Fiber (SSMF) featuring low attenuation around the Water-Peak (1383nm). Due to its backward-compatible with older SSMF standards, Premium LWP Fiber can be used to extend legacy SSMF networks. It is particularly well suited to new networks designed to operate throughout the 1260-1625 nm range. Prysmian's Premium LWP Fiber specification meets or exceeds all applicable international standards and assures seamless interoperability with other top-tier SSMF designs.

Application Data

- Premium LWP fiber is fully compliant with ITU-T G.652 recommendations. G.652 fiber is the most widely deployed fiber category in the world today. It is also the category most widely supported by equipment manufacturers.
- Premium LWP fiber is also fully compliant with the ITU-T G.652.D attributes.
- Prysmian's Premium LWP fiber specification is performance-based to ensure the reliable operation of your network. It is a manufacturer-independent specification.
- Prysmian's Premium LWP fiber provides the industry's best specs for glass geometry and bending losses in a G.652 fiber. These features make it ideal for FTTx applications, where frequent access and splicing are required.

Features and Benefits

Low Water-Peak Attenuation

- Provides dramatically lower attenuation for wavelengths around 1383nm
- Permits system operation in the water-peak region
- Allows operation over the entire 1260-1625nm spectrum, thereby enabling FTTH, CWDM and/or DWDM on a single fiber.
- Fully compliant with all fiber categories in the ITU-T G.652 Recommendations (A through D)

Long-Term Attenuation Stability

- Attenuation at the water-peak remains low, even after hydrogen aging
- Provides steady performance across the full spectrum of transmission wavelengths

Precise Glass Geometry

- The industry's best geometry specs
- Consistent, low-loss splices and connectors
- High yields in mass fusion splicers and low-end hand-held fusion splicers

International Standards Compliance

- Compatible with all other G.652 fibers, regardless of their water-peak attenuation
- Compatible with all equipment designed for G.652 fibers
- Meets or exceeds the world's most stringent Low Water-Peak Standard (G.652.D)
- Fully compliant with IEC 60793-2 50 type B.1.3, Telecordia GR20, ANSI/ICEA640, and RUS 7 CFR 1755.900 fiber requirements
- Suitable for expansion of legacy networks
- Designed with future network expansions and upgrades in mind

World Class Performance

- Meets or exceeds all applicable standards
- Ensures the performance and stability of your network
- Maximizes returns on network investment, both today and into the future

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Prysmian Group

PRYSMIAN
Draka

SM-LWP

Prysmian OneSpec™
Premium Low Water Peak G.652.D Fiber

Performance Specifications

General Parameters	
Fiber Type	LWP Standard Single-Mode
Reference Standards	ITU G.652.D
Refractive Index Profile	Matched-Clad, Step-Index
Fiber Coating	Dual-Layer Acrylate
Minimum Proof Test	100 kpsi

Dimensional Parameters	
Outer Coating Diameter	242 ± 7 µm
Coating/Cladding Concentricity Error	≤ 12 µm
Cladding Diameter	125.0 ± 0.7 µm
Cladding Non-Circularity	≤ 0.7%
Core-Clad Concentricity	≤ 0.5 µm
Nominal Core Diameter	8.2 µm
Fiber Curl	≥ 4.0 m radius

Optical Parameters	
Mode Field Diameter @ 1310 nm	9.2 ± 0.4 mm
Mode Field Diameter @ 1550 nm	10.4 ± 0.5 mm
Cabled Cut-Off Wavelength	≤ 1260 nm
Zero Dispersion Wavelength (λ)	1302 nm to 1324 nm
Chromatic Dispersion	
1285-1330 nm	≤ 3 ps/(nm*km)
1550 nm	≤ 18.0 ps/(nm*km)
1625 nm	≤ 22.0 ps/(nm*km)
Zero Dispersion Slope	≤ 0.090 ps/(nm²*km)
Typical Zero Dispersion Slope	0.086 ps/(nm²*km)
Point Discontinuity (1310 & 1550 nm)	≤ 0.05 dB

Attenuation vs. Wavelength	
1285 nm to 1330 nm	= α_{1310} ± 0.03 dB/km
1525 nm to 1575 nm	= α_{1550} ± 0.02 dB/km
1383 nm (Post Hydrogen Aging)	0.31 - 0.35 dB/km

Environmental Performance	
Temperature Cycling (-60°C to +85°C)	≤ 0.05 dB/km
Temperature Humidity Cycling (-10°C to +85°C, up to 98% RH)	≤ 0.05 dB/km
Water Immersion (23°C ± 2°C)	≤ 0.05 dB/km
Accelerated Heat Aging (85°C ± 2°C)	≤ 0.05 dB/km

Macrobend Loss	
1 turn on a 32 mm mandrel	≤ 0.03 dB @ 1550 nm
100 turns on a 50 mm mandrel	≤ 0.03 dB @ 1310 nm
100 turns on a 50 mm mandrel	≤ 0.03 dB @ 1550 nm
100 turns on a 60 mm mandrel	≤ 0.03 dB @ 1625 nm

Polarization Mode Dispersion (PMD)	
Max. Value in uncabled fiber	≤ 0.1 ps/km$^{1/2}$
Link Design Value	≤ 0.06 ps/km$^{1/2}$

OTDR Settings	
IOR @ 1310 nm	1.467
IOR @ 1550 nm	1.468

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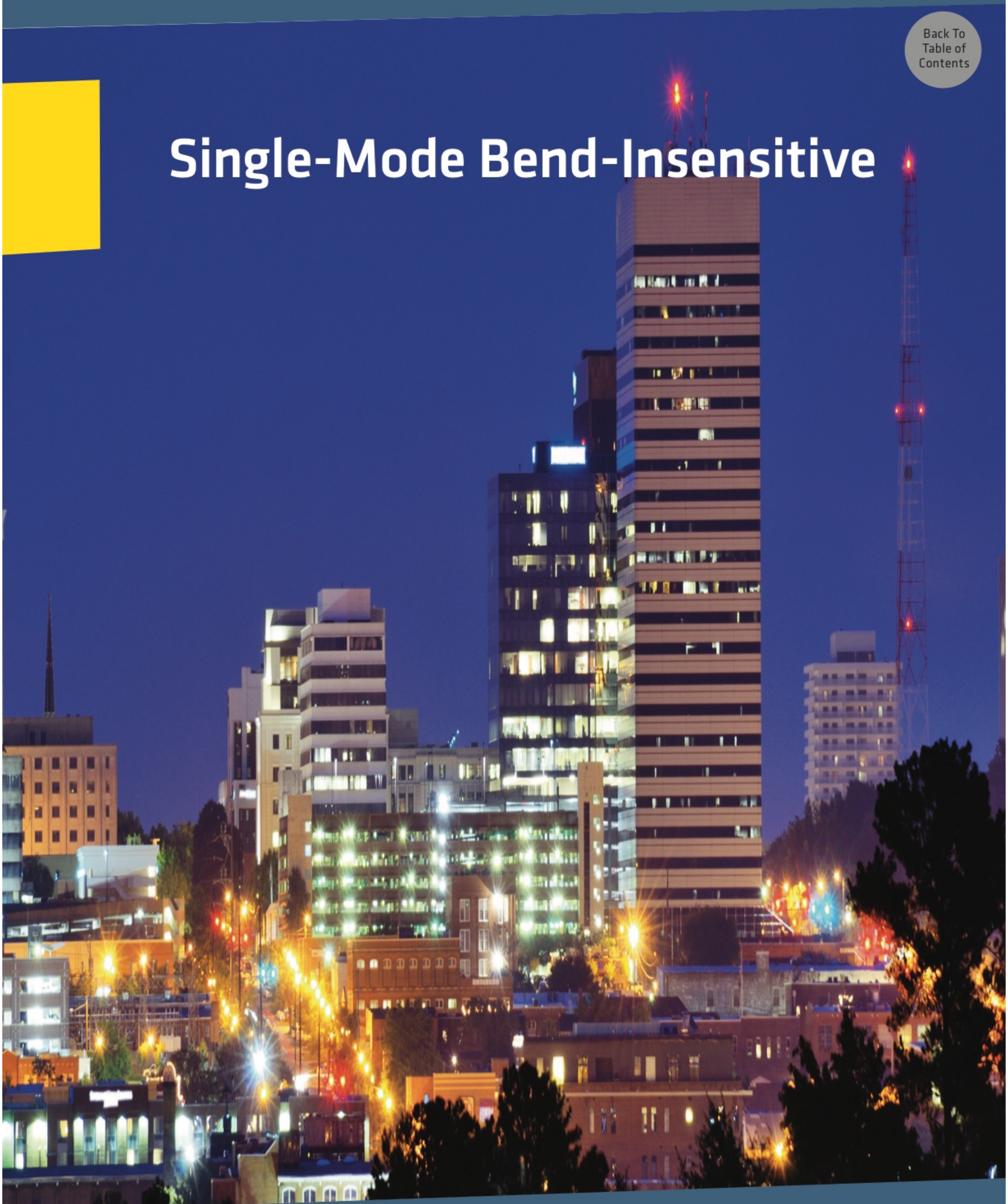
Single-Mode Bend-Insensitive



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Single-Mode Bend-Insensitive Fiber

Bend-Insensitive G.657.A1 & G.652.D (10 mm bend radius)

Bend-Insensitive G.657.A2 & G.652.D (7.5 mm bend radius)

Bend-Insensitive 200 micron

Bend-Insensitive G.657.B3 & G.652.D (5.0 mm bend radius)

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Corning® SMF-28® Ultra Optical Fiber

Product Information

CORNING

Corning® SMF-28® Ultra optical fiber is an ITU-T Recommendation G.652.D compliant optical fiber with Corning's enhanced low-loss and bend fiber technologies. This full-spectrum fiber has bend performance that exceeds the ITU-T Recommendation G.657.A1 standard and still splices the same as the installed base of standard single-mode fibers such as SMF-28e+ fiber. SMF-28 Ultra fiber offers industry-leading specifications for attenuation, macrobend loss, and polarization mode dispersion values, which provide a solid foundation for new network deployments as well as upgrades to existing networks. Since Corning brought the first fiber to market more than 40 years ago, Corning's leadership in single-mode fiber innovation has been unparalleled.

Optical Specifications

Maximum Attenuation

Wavelength (nm)	Maximum Value* (dB/km)
1310	≤ 0.32
1383**	≤ 0.32
1490	≤ 0.21
1550	≤ 0.18
1625	≤ 0.20

* Alternate attenuation offerings available upon request.
** Attenuation values at this wavelength represent post-hydrogen aging performance.

Attenuation vs. Wavelength

Range (nm)	Ref. λ (nm)	Max. α Difference (dB/km)
1285 – 1330	1310	0.03
1525 – 1575	1550	0.02

The attenuation in a given wavelength range does not exceed the attenuation of the reference wavelength (λ) by more than the value α.

Macrobend Loss

Mandrel Radius (mm)	Number of Turns	Wavelength (nm)	Induced Attenuation* (dB)
10	1	1550	≤ 0.50
10	1	1625	≤ 1.5
15	10	1550	≤ 0.05
15	10	1625	≤ 0.30
25	100	1310, 1550, 1625	≤ 0.01

*The induced attenuation due to fiber wrapped around a mandrel of a specified radius.

Point Discontinuity

Wavelength (nm)	Point Discontinuity (dB)
1310	≤ 0.05
1550	≤ 0.05

Cable Cutoff Wavelength (λ_{cc})

$\lambda_{cc} \leq 1260$ nm

Mode-Field Diameter

Wavelength (nm)	MFD (µm)
1310	9.2 ± 0.4
1550	10.4 ± 0.5

Dispersion

Wavelength (nm)	Dispersion Value [ps/(nm·km)]
1550	≤ 18.0
1625	≤ 22.0

Zero Dispersion Wavelength (λ_0): 1304 nm $\leq \lambda_0 \leq$ 1324 nm
Zero Dispersion Slope (S_0): $S_0 \leq$ 0.092 ps/(nm^2·km)

Polarization Mode Dispersion (PMD)

	Value (ps/√km)
PMD Link Design Value	≤ 0.04*
Maximum Individual Fiber PMD	≤ 0.1

***Complies with IEC 60794-3: 2001, Section 5.5, Method 1, (m = 20, Q = 0.01%), September 2001.**

The PMD link design value is a term used to describe the PMD of concatenated lengths of fiber (also known as PMD_Q). This value represents a statistical upper limit for total link PMD. Individual PMD values may change when fiber is cabled.

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

plus CORNING Optical Fiber

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Corning® SMF-28® Ultra Optical Fiber

Dimensional Specifications

Glass Geometry

Fiber Curl	≥ 4.0 m radius of curvature
Cladding Diameter	125.0 ± 0.7 µm
Core-Clad Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7%

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 1310 nm, 1550 nm, and 1625 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.05
Temperature Humidity Cycling	-10°C to +85°C up to 98% RH	≤ 0.05
Water Immersion	23°C ± 2°C	≤ 0.05
Heat Aging	85°C ± 2°C	≤ 0.05
Damp Heat	85°C at 85% RH	≤ 0.05

*Reference temperature = +23ºC

Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa).*

*Higher proof test levels available.

Length

Fiber lengths available up to 63.0 km/spool.

Performance Characterizations

Characterized parameters are typical values.

Core Diameter	8.2 µm
Numerical Aperture	0.14 NA is measured at the one percent power level of a one-dimensional far-field scan at 1310 nm.
Effective Group Index of Refraction (N_{eff})	1310 nm: 1.4676 1550 nm: 1.4682
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (3N) Wet, 14-day room temperature: 0.6 lbs. (3N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1310 nm: -77 dB 1550 nm: -82 dB

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Draka

A brand of the Prysmian Group

Single-Mode Fiber

BendBright™ Single-Mode Optical Fiber

Low micro-bending sensitive, low water peak fiber

Draka BendBright™ fiber encompasses all the feature of Enhanced Single-Mode ESMF fiber and provides high resistance to additional losses due to macro-bending, particularly in the 1600 nm wavelength region.

This fiber can be used in all cable constructions, including loose tube, tight buffered, ribbon, and central tube designs. It supports long-haul, metropolitan and in particular access and premises (FTTH) applications in telecommunications, CATV, utility and intelligent traffic networks.

Opening the transmission window up to the highest wavelength region in the L-band has challenged traditional fiber macro-bending performance. BendBright™ meets and exceeds the challenge.

Draka fibers are further enhanced with the proprietary ColorLock-XS™ coating. This coating enables optimum fiber performance, reliability and durability, even in harsh environments.

The fiber complies with or exceeds the ITU-T Recommendation G.652.D and G.657.A1, the IEC International Standard 60793-2-50 type B.1.3 and B.6.A Optical Fiber Specification, Telcordia GR-20-CORE, ANSI/ICEA S-87-640 and RUS 7CFR 1755.900.

Features	Advantages
Lower PMD of 0.06 ps/√km link design value	• Extends the PMD distance performance, reducing regeneration costs
Improved geometrical parameters	• Low splice loss and high splice yield
Proprietary APVD™ manufacturing process	• Superior geometry, uniformity and purity
Revolutionary ColorLock-XS coating process	• Increased reliability, durability, and superior aging performance, resulting in lower maintenance and replacement costs. Makes color a component of the coating, thus enhancing fiber identification and colored fiber reliability. Consistent, vibrant color for easy-of-use and flexibility

Key Industry Leading Milestones

- **1996** – ColorLock™
- **2002** – BendBright G.652.B
- **2005** – BendBrightG.652.D
- **2005** – At&T technical innovations award for BendBright

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Draka

A brand of the Prysmian Group

SM -BIF

BendBright™ Single-Mode Optical Fiber

Optical Specifications

Attenuation	
Attenuation @ 1310 nm	0.33 – 0.35 dB/km
Attenuation @ 1383 nm*	0.32 – 0.35 dB/km
Attenuation @ 1460 nm	0.25 dB/km
Attenuation @ 1550 nm	0.19 – 0.21 dB/km
Attenuation @ 1625 nm	0.20 – 0.23 dB/km

**Including H2-aging according to IEC 60793-2-50, type B.1.3*
Other values available on request

Attenuation vs. Wavelength

Maximum attenuation change over the window from reference

Wavelength range (nm)	Reference λ (nm)	(dB/km)
1285-1330	1310	≤ 0.03
1525-1575	1550	≤ 0.02
1460-1625	1550	≤ 0.04

Point Discontinuities

No point discontinuity greater than 0.05 dB at 1310 nm & 1550 nm.

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Induced Attenuation (dB)
1	10	1550	≤ 0.75
1	10	1625	≤ 1.5
10	15	1550	≤ 0.25
10	15	1625	≤ 1.0

Cutoff Wavelength	
Cable Cutoff Wavelength (λccf)	≤ 1260 nm

Mode Field Diameter	
Wavelength (nm)	MFD (μm)
1310	9.0 ± 0.4
1550	10.1 ± 0.5

Chromatic Dispersion	
Wavelength (nm)	Chromatic Dispersion (ps/[nm.km])
1285-1330	≤ |3|
1550	≤ 18.0
1625	≤ 22.0
Zero Dispersion Wavelength (λo):	1300-1322 nm
Slope (So) at λo:	≤ 0.090 ps/(nm².km)

Polarization Mode Dispersion (PMD)	
PMD Link Design Value** (ps√km)	≤ 0.06
Max. Individual Fiber (ps√km)	< 0.1

*** According to IEC 60794-3, Ed 3 (Q=0.01%)*

Geometrical Specifications

Glass Geometry	
Cladding Diameter	125.0 ± 0.7 μm
Core/Cladding Concentricity Error	≤ 0.5 μm
Cladding Non-Circularity	≤ 0.7 %
Fiber Curl (Radius)	≥ 4 m

Coating Geometry	
Coating Diameter	242 ± 7 μm
Coating/Cladding Concentricity Error	≤ 12 μm
Coating Non-Circularity	≤ 5%
Length	Standard lengths up to 50.4 km

Mechanical Specifications

Proof Test

The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent

Tensile Strength

Dynamic tensile strength (0.5 meter gauge length):

Aged*** and unaged	Median > 3.8 GPa (550 kpsi)

**** Aging at 85°C, 85% RH, 30 days*

Dynamic and Static Fatigue	
Dynamic fatigue unaged and aged***	$n_d \geq 20$
Static fatigue, aged***	$n_s \geq 23$

Coating Performance	
Coating strip force unaged and aged****	
- Average strip force:	1 N to 3 N
- Peak strip force:	1.2 N to 8.9 N

**** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C
- Wasp spray exposure (Telcordia)

Environmental Specifications

Attenuation

Environmental Test	Test Conditions	Induced attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling	- 60°C to 85°C	≤ 0.05
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.05
Water Immersion	14 days; 23°C	≤ 0.05
Dry Heat	30 days; 85°C	≤ 0.05
Damp Heat	30 days; 85°C, 85% RH	≤ 0.05

Typical Values

Miscellaneous	
Nominal Zero Dispersion Slope	0.085 ps/(nm².km)
Effective group index @ 1310 nm	1.467
Effective group index @ 1550 nm	1.468
Effective group index @ 1625 nm	1.468
Rayleigh Backscatter Coefficient for 1 ns pulse width:	
@ 1310 nm	-79.4 dB
@ 1550 nm	-81.7 dB
@ 1625 nm	-82.5 dB
Median Dynamic Tensile Strength	5.3 GPa (750 kpsi)
(Aged at 85°C, 85% RH, 30 days; 0,5 m gauge length)	

Prysmian Group

PRYSMIAN

Draka

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Prysmian OneSpec™
Single-Mode Bend-Insensitive Fiber – ITU G.657.A1 & G.652.D
(10.0 mm Bend Radius)

Overview

This specification applies to fiber cables with "ITU G.657.A1 Bend-Insensitive Single-Mode Fiber (BIF)". This is a premium grade full spectrum fiber that provides lower bending loss performance while maintaining full backward compatibility and compliance with the ITU G.652.D low water peak single-mode fibers and specifications. This fiber provides low bending loss performance down to a bend radius of 10.0 mm.

Application Data

- Ideally suited for premise and fiber-to-the-home applications where cables or fibers can be exposed to tighter bends.

Features and Benefits

Low bending losses

- Up to 1/10th the bending loss of standard single-mode fiber provides improved system performance.
- Low bending loss at 15 mm bend radius; 10 turn loss ≤ 0.03 dB.
- Specified down to a 10 mm bend radius; 1 turn loss ≤ 0.75 dB.
- Allows a smaller bend radius with small diameter cables such as patch cords and distribution cables.
- Improperly installed small diameter bends result in lower attenuation impacts on systems.
- Allow the use of smaller splice trays or closures.
- Provides lower bending losses at higher wavelengths such as 1625 nm which future proofs the network.
- Improves temperature cycling and mid-span express tube routing loss performance providing long-term attenuation stability.

Full industry standards compliance

- Fully compliant to both ITU G.657.A1 BIF and G.652.D SMF industry standards.
- Fully compliant to both IEC 60793-2-50 B.6A BIF and B1.3 SMF fiber standards.
- Fully compliant with Telcordia GR20 & GR409.
- Fully compliant with all ICEA fiber cable standards including ICEA 640, 696, & 596.
- Compliant with RUS 7 CFR 1755.900 fiber requirements.

Full backward ITU G.652.D SMF compatibility

- Compliant with ITU G.652.D and IEC 60793-2-50 B.1.3 low water peak SMF specifications.
- Compatible with equipment designed for G.652 fibers; fully transparent from a transmission perspective.
- Splice compatible with ITU G.652 SMF using standard single-mode fiber machine settings.
- Full 1260-1625 nm low water peak compliance.

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Prysmian Group

PRYSMIAN Draka

Prysmian OneSpec™
Single-Mode Bend-Insensitive Fiber – ITU G.657.A1 & G.652.D (10.0 mm Bend Radius)

Performance Specifications

Optical Parameters	
Mode Field Diameter @ 1310 nm	9.2 ± 0.4 µm
Mode Field Diameter @ 1550 nm	10.1 or 10.4 ± 0.5 µm
Cabled Cut-Off Wavelength	≤ 1260 nm
Zero Dispersion Wavelength (λ)	1300 nm to 1324 nm
Chromatic Dispersion	
1550 nm	≤ 18.0 ps/(nm*km)
1625 nm	≤ 22.0 ps/(nm*km)
Zero Dispersion Slope	≤ 0.092 ps/(nm²*km)
Point Discontinuity (1310 & 1550 nm)	≤ 0.05 dB

Attenuation vs. Wavelength	
1285 nm to 1330 nm	= α_{1310} ± 0.03 dB/km
1525 nm to 1575 nm	= α_{1550} ± 0.02 dB/km
1383 nm (Post Hydrogen Aging)	0.31 - 0.35 dB/km

Polarization Mode Dispersion (PMD)	
Max. Value In Uncabled Fiber	≤ 0.1 ps/km$^{1/2}$
Link Design Value	≤ 0.06 ps/km$^{1/2}$

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Attenuation (dB)
10	15	1550	≤ 0.25
10	15	1625	≤ 1.0
1	10	1550	≤ 0.75
1	10	1625	≤ 1.5

Dimensional Parameters	
Outer Coating Diameter	242 ± 7 µm
Coating/Cladding Concentricity Error	≤ 12 µm
Cladding Diameter	125.0 ± 0.7 µm
Cladding Non-Circularity	≤ 0.7%
Core-Clad Concentricity	≤ 0.5 µm
Fiber Curl	≥ 4.0 m radius

Mechanical Performance	
Minimum Proof Test	100 Kpsi (0.7 GPa); 1% strain equivalent

Environmental Performance

Environmental Test	Induced Attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling (-60°C to +85°C)	≤ 0.05
Temperature Humidity Cycling (-10°C to +85°C, up to 98% RH)	≤ 0.05
Water Immersion (23°C ± 2°C)	≤ 0.05
Accelerated Heat Aging (85°C ± 2°C)	≤ 0.05
Damp Heat (85°C, 85% RH)	≤ 0.05

Performance Characterization	
Effective Group Index Of Refraction	@ 1310 nm 1.4676 @ 1550 nm 1.4682
Fatigue Resistance Parameter (n_d)	20
Rayleigh Backscatter	@ 1310 nm -77 dB
Coefficient (1 ns = pulse width)	@ 1550 nm -82 dB

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Corning® ClearCurve® LBL Optical Fiber

Product Information

CORNING

Corning® ClearCurve® LBL optical fiber is a full-spectrum fiber with enhanced macrobend performance compared to traditional bend-improved single-mode fibers. ClearCurve LBL fiber exceeds the ITU-T Recommendation G.657.A2/B2 and remains fully compliant with ITU-T Recommendation G.652.D. ClearCurve LBL fiber is compatible with the installed base of Corning® SMF-28e® and SMF-28e+® fibers.

Optical Specifications

Maximum Attenuation

Wavelength (nm)	Maximum Value* (dB/km)
1310	≤ 0.35
1383**	≤ 0.35
1490	≤ 0.24
1550	≤ 0.20
1625	≤ 0.23

* Alternate attenuation offerings available upon request.
** Attenuation values at this wavelength represent post-hydrogen aging performance.

Attenuation vs. Wavelength

Range (nm)	Ref. λ (nm)	Max. α Difference (dB/km)
1285 – 1330	1310	0.03
1525 – 1575	1550	0.02

The attenuation in a given wavelength range does not exceed the attenuation of the reference wavelength (λ) by more than the value α.

Macrobend Loss

Mandrel Radius (mm)	Number of Turns	Wavelength (nm)	Induced Attenuation* (dB)
7.5	1	1550	≤ 0.4
7.5	1	1625	≤ 0.8

*The induced attenuation due to fiber wrapped around a mandrel of a specified diameter.

Point Discontinuity

Wavelength (nm)	Point Discontinuity (dB)
1310	≤ 0.05
1550	≤ 0.05

Cable Cutoff Wavelength (λ_{cc})

$\lambda_{cc} \leq 1260$ nm

Mode-Field Diameter

Wavelength (nm)	MFD (µm)
1310	8.6 ± 0.4
1550	9.6 ± 0.5

Dispersion

Wavelength (nm)	Dispersion Value [ps/(nm·km)]
1550	≤ 18.0
1625	≤ 23.0

Zero Dispersion Wavelength (λ_0): 1304 nm $\leq \lambda_0 \leq$ 1324 nm

Zero Dispersion Slope (S_0): ≤ 0.092 ps/(nm²•km)

Polarization Mode Dispersion (PMD)

	Value (ps/√km)
PMD Link Design Value	≤ 0.06*
Maximum Individual Fiber PMD	≤ 0.2

*Complies with IEC 60794-3: 2001, Section 5.5, Method 1, (m = 20, Q = 0.01%), September 2001.

The link design value is a term used to describe the PMD of concatenated lengths of fiber (also known as PMDQ). This value represents a statistical upper limit for total link PMD. Individual PMD values may change when fiber is cabled.

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

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Corning® ClearCurve® LBL Optical Fiber

Dimensional Specifications

Glass Geometry

Fiber Curl	≥ 4.0 m radius of curvature
Cladding Diameter	125.0 ± 0.7 µm
Core-Clad Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7%

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 1310 nm, 1550 nm, and1625 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.05
Temperature Humidity Cycling	-10°C to +85°C up to 98% RH	≤ 0.05
Water Immersion	23°C ± 2°C	≤ 0.05
Heat Aging	85°C ± 2°C	≤ 0.05
Damp Heat	85°C at 85% RH	≤ 0.05

*Reference temperature = +23ºC
Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa).*

*Higher proof test levels available.

Length

Fiber lengths available up to 50.4 km/spool.

Performance Characterizations

Characterized parameters are typical values.

Numerical Aperture	1310 nm: 0.14
Effective Group Index of Refraction (N_{eff})	1310 nm: 1.4670 1550 nm: 1.4677
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (3N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1310 nm: -77 dB 1550 nm: -82 dB

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Draka

A brand of the Prysmian Group

Single-Mode Fiber

BendBright-XS™ Single-Mode Optical Fiber

Truly bend-insensitive fiber, fully backwards compatible

Draka BendBright-XS™ fiber combines two attractive features: excellent low macro-bending sensitivity and low water peak level. Together they allow unlimited use of the whole telecom wavelength window for a great variety of applications. This next generation behavior has been obtained by adding a trench with a lowered refractive index in the cladding area, preventing the optical field to escape, avoiding compromises effecting the main transmission parameters.

Apart from its use in office installations, as patch cords and/or interconnection cables, the use of the BendBright-XS in Fiber-to-the-Home (and even longer distance) networks offers significant added value to the network installers. Bend radii in fiber guidance ports can be reduced as well as minimum bend radii in wall and corner mountings. As the fiber is very forgiving for installation errors, reduced demands for the skills of the installation engineers may further reduce the costs. Its enhanced macro-bending behavior further guarantees that all transmissions bands up to 1625 nm (L-band) will be available for future use in this hungry bandwidth environment. BendBright-XS™ guarantees future proof end-to-end FTTH roll outs.

Draka's Advanced Plasma and Vapor Deposition (PCVD and APVD™) manufacturing process ensures the highest quality and purity of fibers. Proprietary ColorLock™ coating process further enhances the performance, durability and reliability of the fiber, even in the harshest environments.

The fiber fully complies with or exceeds the ITU-T Recommendations G.657.A2, G.657.B2 and G.652.D, the IEC International Standard 60793-2-50 type B.1.3 and B.6.A&B Optical Fiber Specification and is backwards compatible with all other G.652 fiber used in current optical networks.

Features	Advantages
Low macro-bending loss at very low radii (≤ 15 mm)	• Allows shorter radius storage of fiber over-length leading to more compact installations • Is more forgiving for installation errors in fiber management systems and or splice protection devices
Compatibility with other G.652 single-mode fiber installations	• The BendBright-XS™ can be spliced with similar settings of the fusion splice program as applied for other G.652 fibers • Low loss splicing of BendBright-XS™ to other G.652 fibers can be done with standard fusion splicers
Low bending at partial bends in the mm bend	• Allows for tight in-building installations • Allows for small volume patch panel installations • Prevents fiber coating degradation in case high power systems are used in up-grading scenarios
Low micro-bending loss	• Allows for highly demanding cable designs including ribbons

Key Industry Leading Milestones

- 1996 — ColorLock™
- 2002 — BendBright 1st bend improved SMF
- 2005 — AT&T Innovation Award
- 2006 — BendBright-XS 1st truly bend-insensitive SMF
- 2009 — BendBright-XS recognized asG.657.A2 subcategory

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Draka

A brand of the Prysmian Group

BendBright-XS™ Single-Mode Optical Fiber

Optical Specifications

Attenuation	
Attenuation @ 1310 nm	0.33 – 0.35 dB/km
Attenuation @ 1383 nm*	0.32 – 0.35 dB/km
Attenuation @ 1460 nm	0.25 dB/km
Attenuation @ 1550 nm	0.19 – 0.20 dB/km
Attenuation @ 1625 nm	0.20 – 0.21 dB/km

**Including H2-aging according to IEC 60793-2-50, type B.1.3*
Other values available on request

Attenuation vs. Wavelength

Maximum attenuation change over the window from reference

Wavelength range (nm)	Reference λ (nm)	(dB/km)
1285-1330	1310	≤ 0.03
1525-1575	1550	≤ 0.02
1460-1625	1550	≤ 0.04

Point Discontinuities

No point discontinuity greater than 0.05 dB at 1310 nm & 1550 nm.

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Induced Attenuation (dB)
10	15	1550	≤ 0.03
10	15	1625	≤ 0.1
1	10	1550	≤ 0.1
1	10	1625	≤ 0.2
1	7.5	1550	≤ 0.5
1	7.5	1625	≤ 1.0

Cutoff Wavelength	
Cable Cutoff Wavelength (λccf)	≤ 1260 nm

Mode Field Diameter	
Wavelength (nm)	MFD (µm)
1310	8.8 ± 0.4
1550	9.8 ± 0.5

Chromatic Dispersion	
Wavelength (nm)	Chromatic Dispersion (ps/[nm.km])
Zero Dispersion Wavelength (λo):	1300-1324 nm
Slope (So) at λo:	≤ 0.092 ps/(nm².km)

Polarization Mode Dispersion (PMD)	
PMD Link Design Value** (ps√km)	≤ 0.06
Max. Individual Fiber (ps√km)	≤ 0.1

*** According to IEC 60794-3, Ed 3 (Q=0.01%)*

Geometrical Specifications

Glass Geometry	
Cladding Diameter	125.0 ± 0.7 µm
Core/Cladding Concentricity Error	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7 %
Fiber Curl (Radius)	≥ 4 m
Coating Geometry	
Coating Diameter	242 ± 7 µm
Coating/Cladding Concentricity Error	≤ 12 µm
Coating Non-Circularity	≤ 5%
Length	Standard lengths up to 25.2 km

Mechanical Specifications

Proof Test

The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent

Tensile Strength

Dynamic tensile strength (0.5 meter gauge length):

Aged*** and unaged	Median > 3.8 GPa (550 kpsi)

**** Aging at 85°C, 85% RH, 30 days*

Dynamic and Static Fatigue	
Dynamic fatigue unaged and aged***	$n_d \geq 20$
Static fatigue, aged***	$n_s \geq 23$

Coating Performance

Coating strip force unaged and aged****

- Average strip force:	1 N to 3 N
- Peak strip force:	1.2 N to 8.9 N

**** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C
- Wasp spray exposure (Telcordia)

Environmental Specifications

Attenuation

Environmental Test	Test Conditions	Induced attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling	- 60°C to 85°C	≤ 0.05
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.05
Water Immersion	14 days; 23°C	≤ 0.05
Dry Heat	30 days; 85°C	≤ 0.05
Damp Heat	30 days; 85°C, 85% RH	≤ 0.05

Typical Values

Miscellaneous	
Nominal Zero Dispersion Slope	0.088 ps/(nm².km)
Effective group index @ 1310 nm	1.467
Effective group index @ 1550 nm	1.467
Effective group index @ 1625 nm	1.468
Rayleigh Backscatter Coefficient for 1 ns pulse width:	
@ 1310 nm	-79.1 dB
@ 1550 nm	-81.4 dB
@ 1625 nm	-82.2 dB
Median Dynamic Tensile Strength	5.3 GPa (750 kpsi)
(Aged at 85°C, 85% RH, 30 days; 0,5 m gauge length)	

Prysmian Group

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PRYSMIAN
Draka

Prysmian OneSpec™
Single-Mode Bend-Insensitive Fiber – ITU G.657.A2 & G.652.D
(7.5 mm Bend Radius)

Overview

This specification applies to fiber cables with "ITU G.657.A2 Bend-Insensitive Single-Mode Fiber (BIF)". This is a premium grade full spectrum fiber that provides extremely low bending loss performance while maintaining full backward compatibility and compliance with the ITU G.652.D low water peak single-mode fibers and specifications. This fiber provides low bending loss performance down to a bend radius of 7.5 mm.

Application Data

- Ideally suited for premise and fiber-to-the-home applications where cables or fibers can be exposed to tighter bends.

Features and Benefits

Low bending losses

- Up to 1/100th the bending loss of standard single-mode fiber provides improved system performance.
- Very low loss at 15 mm bend radius; 10 turn loss ≤ 0.03 dB.
- Specified down to a 7.5 mm bend radius; 1 turn loss ≤ 1.0 dB.
- Allows a smaller bend radius with small diameter cables such as patch cords and distribution cables.
- Improperly installed small diameter bends result in lower attenuation impacts on systems.
- Allow the use of smaller splice trays or closures.
- Permits the use of smaller diameter cable designs such as Prysmian's LT2.0.
- Provides lower bending losses at higher wavelengths such as 1625 nm which future proofs the network.
- Significantly improves temperature cycling & mid-span express tube routing loss performance providing long-term attenuation stability.

Full industry standards compliance

- Fully compliant to both ITU G.657.A2 BIF and G.652.D SMF industry standards.
- Fully compliant to both IEC 60793-2-50 B.6A & B BIF and B1.3 SMF fiber standards.
- Fully compliant with Telcordia GR20 and GR409.
- Fully compliant with all ICEA fiber cable standards including ICEA 640, 696, and 596.
- Compliant with RUS 7 CFR 1755.900 fiber requirements.

Full backward ITU G.652.D SMF compatibility

- Compliant with ITU G.652.D and IEC 60793-2-50 B.1.3 low water peak SMF specifications.
- Compatible with equipment designed for G.652 fibers; fully transparent from a transmission perspective.
- Splice compatible with ITU G.652 SMF using BIF program settings.
- Full 1260-1625 nm low water peak compliance.

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Prysmian Group

PRYSMIAN
Draka

Prysmian OneSpec™
Single-Mode Bend-Insensitive Fiber – ITU G.657.A2 & G.652.D (7.5 mm Bend Radius)

Performance Specifications

Optical Parameters	
Mode Field Diameter @ 1310 nm	8.6 or 8.9 ± 0.4 µm
Mode Field Diameter @ 1550 nm	9.65 or 9.9 ± 0.5 µm
Cabled Cut-Off Wavelength	≤ 1260 nm
Zero Dispersion Wavelength (λ)	1300 nm to 1324 nm
Chromatic Dispersion	
1550 nm	≤ 18.0 ps/(nm*km)
1625 nm	≤ 23.0 ps/(nm*km)
Zero Dispersion Slope	≤ 0.092 ps/(nm²*km)
Point Discontinuity (1310 nm & 1550 nm)	≤ 0.05 dB

Attenuation vs. Wavelength	
1285 nm to 1330 nm	= α_{1310} ± 0.03 dB/km
1525 nm to 1575 nm	= α_{1550} ± 0.02 dB/km
1383 nm (Post Hydrogen Aging)	0.31 - 0.35 dB/km

Polarization Mode Dispersion (PMD)	
Max. Value In Uncabled Fiber	≤ 0.2 ps/km$^{1/2}$
Link Design Value	≤ 0.06 ps/km$^{1/2}$

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Attenuation (dB)
10	15	1550	≤ 0.03
10	15	1625	≤ 0.1
1	10	1550	≤ 0.1
1	10	1625	≤ 0.2
1	7.5	1550	≤ 0.5
1	7.5	1625	≤ 1.0

Dimensional Parameters	
Outer Coating Diameter	242 ± 7 µm
Coating/Cladding Concentricity Error	≤ 12 µm
Cladding Diameter	125.0 ± 0.7 µm
Cladding Non-Circularity	≤ 0.7%
Core-Clad Concentricity	≤ 0.5 µm
Fiber Curl	≥ 4.0 m radius

Mechanical Performance	
Minimum Proof Test	100 Kpsi (0.7 GPa); 1% strain equivalent

Environmental Performance

Environmental Test	Induced Attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling (-60°C to +85°C)	≤ 0.05
Temperature Humidity Cycling (-10°C to +85°C, up to 98% RH)	≤ 0.05
Water Immersion (23°C ± 2°C)	≤ 0.05
Accelerated Heat Aging (85°C ± 2°C)	≤ 0.05
Damp Heat (85°C, 85% RH)	≤ 0.05

Performance Characterization	
Effective Group Index Of Refraction	@ 1310 nm 1.467 @ 1550 nm 1.467
Fatigue Resistance Parameter (n_d)	20

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Corning® SMF-28® Ultra 200 Optical Fiber

Product Information

CORNING

Leveraging Corning® SMF-28® Ultra optical fiber technology, Corning® SMF-28® Ultra 200 optical fiber is a full-spectrum fiber with a reduced coating diameter of 200 microns and enhanced optical bending performance compared to legacy single-mode fiber. This fiber features low attenuation, a 9.2 micron nominal mode-field diameter at 1310 nm, and is intended for use in miniaturized cabling applications. SMF-28® Ultra 200 fiber surpasses the requirements of ITU-T Recommendations G.657.A1 and G.652.D and is fully backwards compatible with legacy G.652 compliant fiber types.

Optical Specifications

Maximum Attenuation

Wavelength (nm)	Maximum Value* (dB/km)
1310	≤ 0.32
1383**	≤ 0.32
1490	≤ 0.21
1550	≤ 0.18
1625	≤ 0.20

* Alternate attenuation offerings available upon request.
** Attenuation values at this wavelength represent post-hydrogen aging performance.

Attenuation vs. Wavelength

Range (nm)	Ref. λ (nm)	Max. α Difference (dB/km)
1285 – 1330	1310	0.03
1525 – 1575	1550	0.02

The attenuation in a given wavelength range does not exceed the attenuation of the reference wavelength (λ) by more than the value α.

Macrobend Loss

Mandrel Radius (mm)	Number of Turns	Wavelength (nm)	Induced Attenuation* (dB)
10	1	1550	≤ 0.50
10	1	1625	≤ 1.5
15	10	1550	≤ 0.05
15	10	1625	≤ 0.30
25	100	1310, 1550, 1625	≤ 0.01

*The induced attenuation due to fiber wrapped around a mandrel of a specified radius.

Point Discontinuity

Wavelength (nm)	Point Discontinuity (dB)
1310	≤ 0.05
1550	≤ 0.05

Cable Cutoff Wavelength (λ_{cc})

$\lambda_{cc} \leq 1260$ nm

Mode-Field Diameter

Wavelength (nm)	MFD (µm)
1310	9.2 ± 0.4
1550	10.4 ± 0.5

Dispersion

Wavelength (nm)	Dispersion Value [ps/(nm•km)]
1550	≤ 18.0
1625	≤ 22.0

Zero Dispersion Wavelength (λ_0): 1304 nm ≤ λ_0 ≤ 1324 nm
Zero Dispersion Slope (S_0): $S_0 \leq 0.092$ ps/(nm^2•km)

Polarization Mode Dispersion (PMD)

	Value (ps/√km)
PMD Link Design Value	≤ 0.04*
Maximum Individual Fiber PMD	≤ 0.1

*Complies with IEC 60794-3: 2001, Section 5.5, Method 1, (m = 20, Q = 0.01%), September 2001.

The PMD link design value is a term used to describe the PMD of concatenated lengths of fiber (also known as PMD_Q). This value represents a statistical upper limit for total link PMD. Individual PMD values may change when fiber is cabled.

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

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Corning® SMF-28® Ultra 200 Optical Fiber

SM -BIF

Dimensional Specifications

Glass Geometry

Fiber Curl	≥ 4.0 m radius of curvature
Cladding Diameter	125.0 ± 0.7 µm
Core-Clad Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7%

Coating Geometry

Coating Diameter	200 ± 5 µm
Coating-Cladding Concentricity	≤ 10 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 1310 nm, 1550 nm, and 1625 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.05
Temperature Humidity Cycling	-10°C to +85°C up to 98% RH	≤ 0.05
Water Immersion	23°C ± 2°C	≤ 0.05
Heat Aging	85°C ± 2°C	≤ 0.05
Damp Heat	85°C at 85% RH	≤ 0.05

*Reference temperature = +23ºC
Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa).*

*Higher proof test levels available.

Length

Fiber lengths available up to 50.4 km/spool.

Performance Characterizations

Characterized parameters are typical values.

Core Diameter	8.2 µm
Numerical Aperature	0.14 NA is measured at the one percent power level of a one-dimensional far-field scan at 1310 nm
Zero Dispersion Slope (S_0)	0.088 ps/(nm²*km)
Effective Group Index of Refraction (N_{eff})	1310 nm: 1.4676 1550 nm: 1.4682
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.5 lbs. (2N) Wet, 14-day room temperature: 0.5 lbs. (2N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1310 nm: -77dB 1550 nm: -82dB

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A brand of the Prysmian Group

Single-Mode Fiber

BendBright-XS™ 200 µm Single-Mode Optical Fiber

Truly bend-insensitive SMF for compact cables and small connectivities foot print

Draka BendBright-XS™ 200 µm allows cable designers to drastically reduce cable diameters for most OSP cable designs. This feature not only increases fiber density in ducts, it reduces size & weight of aerial cables and it allows designers to increase fiber density in OPGW.

Draka BendBright-XS™ fiber combines attractive features: excellent low macro-bending sensitivity, low water peak level and G.657.A2 + G.652.D compliance. Together they allow unlimited use of the whole telecom wavelength window (1260nm to 1650nm) for a great variety of applications. BendBright-XS™ 200 µm offers in addition a reduced outside diameter for drastic reduction of cables and fiber management systems footprints and weight. It can dramatically reduce the total cost of ownership of a networks while limiting the environmental impact of its deployment. Reduction of civil works, possibility to reuse existing ducts, lower costs of pathways fees are immediate benefits.

BendBright-XS™ 200 µm is similar in its optical and glass parts to the standard BendBright-XS™. Size reduction has been obtained by reducing the coating diameter. Thanks to the quality of modern coatings, no compromise had to be made to the overall quality of the fiber and to its performances. Notably Draka has carried exhaustive tests that proved its compatibility with the most popular installation tools and backward compatibility with legacy fibers.

BendBright-XS™ 200 µm fully complies with or exceeds the ITU-T Recommendations G.657.A1, G.657.A2, G.657.B2 and G.652.D. It satisfies all IEC testing requirements for dimensional, transmission, mechanical and environmental performances, except for a slightly reduced coating strip force. BendBright-XS™ 200 µm has been demonstrated to be fully appropriate for cable manufacturing and field installation.

Features	Advantages
Reduced coating diameter (200 µm)	• Reduction of cable diameter • Reduction of fiber management systems footprint • Reduction of the total cost of ownership and of the environmental impact of network deployments
Same glass diameter than conventional fiber (125 µm) and similar mode field diameter	• Compatible with standard cleaving and stripping tools • Can be spliced with similar settings of the fusion splice program as applied for other G.652 fibers • Low loss splicing of BendBright-XS™ to other G.652 fibers
Full compliance with G.652.D and truly bend- insensitive up to the highest wavelength	• All bands utilization, from O- to L-Band • Future systems evolutions proof (10G-PON, WDM-PON and beyond)

Key Industry Leading Milestones

1996	2002	2006	2007	2009	2010
ColorLock™	BendBright 1st bend improved SMF	BendBright-XS 1st truly bend-insensitive SMF	ColorLock-XS™	BendBright-XS recognized as G.657.A2 subcategory	BendBright-XS 200 µm

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Draka

A brand of the Prysmian Group

SM -BIF

BendBright-XS™ 200 µm Single-Mode Optical Fiber

Optical Specifications

Attenuation	
Attenuation @ 1310 nm	0.33 – 0.35 dB/km
Attenuation @ 1383 nm*	0.32 – 0.35 dB/km
Attenuation @ 1460 nm	0.25 dB/km
Attenuation @ 1550 nm	0.19 – 0.20 dB/km
Attenuation @ 1625 nm	0.20 – 0.21 dB/km

**Including H2-aging according to IEC 60793-2-50, type B.1.3*
Other values available on request

Attenuation vs. Wavelength

Maximum attenuation change over the window from reference

Wavelength range (nm)	Reference λ (nm)	(dB/km)
1285-1330	1310	≤ 0.03
1525-1575	1550	≤ 0.02
1460-1625	1550	≤ 0.04

Point Discontinuities

No point discontinuity greater than 0.05 dB at 1310 nm & 1550 nm.

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Induced Attenuation (dB)
10	15	1550	≤ 0.03
10	15	1625	≤ 0.1
1	10	1550	≤ 0.1
1	10	1625	≤ 0.2
1	7.5	1550	≤ 0.5
1	7.5	1625	≤ 1.0

Cutoff Wavelength	
Cable Cutoff Wavelength (λccf)	≤ 1260 nm

Mode Field Diameter	
Wavelength (nm)	MFD (µm)
1310	8.8 ± 0.4
1550	9.8 ± 0.5

Chromatic Dispersion	
Wavelength (nm)	Chromatic Dispersion (ps/[nm.km])
Zero Dispersion Wavelength (λo):	1300-1324 nm
Slope (So) at λo:	≤ 0.092 ps/(nm².km)

Polarization Mode Dispersion (PMD)	
PMD Link Design Value** (ps√km)	≤ 0.06
Max. Individual Fiber (ps√km)	≤ 0.1

*** According to IEC 60794-3, Ed 3 (Q=0.01%)*

Geometrical Specifications

Glass Geometry	
Cladding Diameter	125.0 ± 0.7 µm
Core/Cladding Concentricity Error	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7 %
Fiber Curl (Radius)	≥ 4 m

Coating Geometry	
Coating Diameter	200 ± 10 µm
Coating/Cladding Concentricity Error	≤ 12 µm
Coating Non-Circularity	≤ 5%
Length	Standard lengths up to 25.2 km

Mechanical Specifications

Proof Test

The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent

Tensile Strength

Dynamic tensile strength (0.5 meter gauge length):

Aged*** and unaged	Median > 3.8 GPa (550 kpsi)

**** Aging at 85°C, 85% RH, 30 days*

Dynamic and Static Fatigue	
Dynamic fatigue unaged and aged***	$n_d \geq 20$
Static fatigue, aged***	$n_s \geq 23$

Coating Performance

Coating strip force unaged and aged****

- Average strip force:	0.8 N to 3 N
- Peak strip force:	1.0 N to 8.9 N

**** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C
- Wasp spray exposure (Telcordia)

Environmental Specifications

Attenuation

Environmental Test	Test Conditions	Induced attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling	- 60°C to 85°C	≤ 0.05
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.05
Water Immersion	14 days; 23°C	≤ 0.05
Dry Heat	30 days; 85°C	≤ 0.05
Damp Heat	30 days; 85°C, 85% RH	≤ 0.05

Typical Values

Miscellaneous	
Nominal Zero Dispersion Slope	0.088 ps/(nm².km)
Effective group index @ 1310 nm	1.467
Effective group index @ 1550 nm	1.467
Effective group index @ 1625 nm	1.468
Rayleigh Backscatter Coefficient for 1 ns pulse width:	
@ 1310 nm	-79.1 dB
@ 1550 nm	-81.4 dB
@ 1625 nm	-82.2 dB
Median Dynamic Tensile Strength	5.3 GPa (750 kpsi)
(Aged at 85°C, 85% RH, 30 days; 0,5 m gauge length)	

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Corning® ClearCurve® ZBL Optical Fiber

Product Information

CORNING

Bend Performance and Compatibility

Corning® ClearCurve® ZBL optical fiber delivers the best macrobending performance in the industry while maintaining compatibility with current optical fibers, equipment, practices and procedures. This full-spectrum single-mode optical fiber, when subjected to smaller radii bends, experiences virtually no signal loss. ClearCurve ZBL fiber exceeds the most stringent bend performance requirements of ITU-T Recommendation G.652.D and the installed base of SMF-28e® and SMF-28e+® fibers. Now network planners and designers are able to design optical fiber into much more challenging installations and environments; cable designers can offer optical cables with an unmatched ruggedness for easier installation and handling.

Optical Specifications

Maximum Attenuation

Wavelength (nm)	Maximum Value* (dB/km)
1310	≤ 0.35
1383**	≤ 0.35
1490	≤ 0.24
1550	≤ 0.20
1625	≤ 0.23

* Alternate attenuation offerings available upon request.

** Attenuation values at this wavelength represent post-hydrogen aging performance.

Attenuation vs. Wavelength

Range (nm)	Ref. λ (nm)	Max. α Difference (dB/km)
1285 – 1330	1310	0.03
1525 – 1575	1550	0.02

The attenuation in a given wavelength range does not exceed the attenuation of the reference wavelength (λ) by more than the value α.

Macrobend Loss

Mandrel Radius (mm)	Number of Turns	Wavelength (nm)	Induced Attenuation* (dB)
5	1	1550	≤ 0.10
5	1	1625	≤ 0.30

*The induced attenuation due to fiber wrapped around a mandrel of a specified diameter.

Point Discontinuity

Wavelength (nm)	Point Discontinuity (dB)
1310	≤ 0.05
1550	≤ 0.05

Cable Cutoff Wavelength (λ_{cc})

λ_{cc} ≤ 1260 nm

Mode-Field Diameter

Wavelength (nm)	MFD (µm)
1310	8.6 ± 0.4
1550	9.65 ± 0.5

Dispersion

Wavelength (nm)	Dispersion Value [ps/(nm•km)]
1550	≤ 18.0
1625	≤ 23.0

Zero Dispersion Wavelength (λ_0): 1304 nm ≤ λ_0 ≤ 1324 nm

Zero Dispersion Slope (S_0): ≤ 0.092 ps/(nm²•km)

Polarization Mode Dispersion (PMD)

	Value (ps/√km)
PMD Link Design Value	≤ 0.06*
Maximum Individual Fiber PMD	≤ 0.2

*Complies with IEC 60794-3: 2001, Section 5.5, Method 1, (m = 20, Q = 0.01%), September 2001.

The link design value is a term used to describe the PMD of concatenated lengths of fiber (also known as PMD_Q). This value represents a statistical upper limit for total link PMD. Individual PMD values may change when fiber is cabled.

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

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Corning® ClearCurve® ZBL Optical Fiber

Dimensional Specifications

Glass Geometry

Fiber Curl	≥ 4.0 m radius of curvature
Cladding Diameter	125.0 ± 0.7 µm
Core-Clad Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7%

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 1310 nm, 1550 nm, and 1625 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.05
Temperature Humidity Cycling	-10°C to +85°C up to 98% RH	≤ 0.05
Water Immersion	23°C ± 2°C	≤ 0.05
Heat Aging	85°C ± 2°C	≤ 0.05
Damp Heat	85°C at 85% RH	≤ 0.05

*Reference temperature = +23ºC
Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa).*

*Higher proof test levels available.

Length

Fiber lengths available up to 25.2 km/spool.

Performance Characterizations

Characterized parameters are typical values.

Numerical Aperture	1310 nm: 0.14
Effective Group Index of Refraction (N_{eff})	1310 nm: 1.4670 1550 nm: 1.4677
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (3N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1310 nm: -77 dB 1550 nm: -82 dB

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A brand of the Prysmian Group

Draka

Specialty Fiber

BendBright-Elite™ Fiber for Components

Ultra bend-insensitive SMF - Guaranteed for very low radii

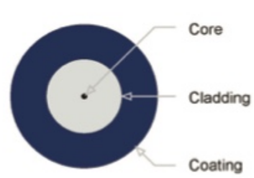
Since 2002, Draka's BendBright™ fibers family has set the standard of single-mode fibers for applications particularly demanding in terms of bending resistance, notably Access and FTTX telecom networks. Based on the Draka's proprietary manufacturing technologies and the Draka's patented trench-assisted design BendBright-Elite™ offers full backward compatibility while meeting or exceeding the newest standards for telecom applications.

BendBright-Elite™ further extends these technologies to enhance the bending performance at very low radii at all wavelengths. With bend losses less than 0.1 dB for 1 turn at 5 mm at 1550 nm, Draka's BendBright-Elite™ offers unmatched value to customers that need to reduce the size of their components or to those who wants to introduce the fiber in customer's home. Its tight geometry is guaranteed over the entire length of the fiber, a pre-requisite for automated inter-connectorization practices. Thanks to its high proof test stress level and its extreme insensitivity to optical bending loss, Draka's BendBright-Elite is able to endure repeated very tight bending.

While offering unparalleled performance, Draka's BendBright-Elite™ is still based on conventional technology. It is an all solid silica fibers, without voids or other hole structures. It can be easily fusion spliced by any commercial splicer and requires no specific connectorization procedure. Because it's manufactured using Draka's Plasma Chemical Vapor Deposition process, BendBright-Elite™ has perfect control of all its characteristics both along the length of the fiber and in any radial direction. The fiber fully complies with or exceeds the ITU-T Recommendation G.652.D, and the IEC 60793-2-50 type B.1.3. Optical Fiber Specification and is backwards compatible with all other G.652 fiber used in current optical networks. In addition the fiber fully complies with ITU-T Recommendation G.657.B3 and the IEC 60793-2-50 type B.6.A&B.

Features	Advantages
Excellent macro-bend performance at very low radii (down to 5 mm)	• Allows miniaturization of optical components • Permits high power in compact components
Low macro-bending loss and high proof test stress (200 kpsi)	• Guaranteed high strength • Able to cope with non professional, do-it-your-self installation practice in home environment
Solid silica structure	• No special connectorization procedures • No special mechanical splice procedures • Easy to fusion splice with any commercial machine
Tight cladding diameter 125.0 ± 0.4 µm	• Guarantees easy, fully automated connectorization
Tight cladding non-circularity ≤ 0.3 %	• Guarantees easy connectorization
Tight core/cladding concentricity ≤ 0.3 µm	• Offers low connector loss
DLPC9 coating	• Guarantees easy strip-ability

DrakaElite



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Draka

A brand of the Prysmian Group

BendBright-Elite™ Fiber for Components

Optical Specifications

Attenuation	
Attenuation @ 1310 nm	≤ 0.35 dB/km
Attenuation @ 1383 nm*	≤ 0.35 dB/km
Attenuation @ 1550 nm	≤ 0.22 dB/km
Attenuation @ 1625 nm	≤ 0.24 dB/km

**Including H2-aging according to IEC 60793-2-50, type B.1.3*
Other values available on request

Attenuation vs. Wavelength

Maximum attenuation change over the window from reference

Wavelength range (nm)	Reference λ (nm)	(dB/km)
1285-1330	1310	≤ 0.03
1525-1575	1550	≤ 0.02
1460-1625	1550	≤ 0.04

Point Discontinuities

No point discontinuity greater than 0.05 dB at 1310 nm & 1550 nm.

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Induced Attenuation (dB)
1	10	1550	≤ 0.03
1	10	1625	≤ 0.1
1	7.5	1550	≤ 0.08
1	7.5	1625	≤ 0.25
1	5.0	1550	≤ 0.15
1	5.0	1625	≤ 0.45

Cutoff Wavelength	
Cable Cutoff Wavelength (λccf)	≤ 1260 nm

Mode Field Diameter	
Wavelength (nm)	MFD (µm)
1310	8.8 ± 0.4
1550	9.8 ± 0.5

Chromatic Dispersion	
Wavelength (nm)	Chromatic Dispersion (ps/[nm.km])
Zero Dispersion Wavelength (λo):	1300-1324 nm
Slope (So) at λo:	< 0.092 ps/(nm².km)

Polarization Mode Dispersion (PMD)	
PMD Link Design Value** (ps√km)	≤ 0.06
Max. Individual Fiber (ps√km)	≤ 0.1

*** According to IEC 60794-3, Ed 3 (Q=0.01%)*

Geometrical Specifications

Glass Geometry	
Cladding Diameter	125.0 ± 0.4 µm
Core/Cladding Concentricity Error	≤ 0.3 µm
Cladding Non-Circularity	≤ 0.3 %
Fiber Curl (Radius)	≥ 4 m
Coating Geometry	
Coating Diameter	242 ± 5 µm
Coating/Cladding Concentricity Error	≤ 12 µm
Coating Non-Circularity	≤ 5.0%
Length	Standard lengths up to 25.2 km

Mechanical Specifications

Proof Test

The entire length is subjected to a tensile proof stress ≥ 1.4 GPa (200 kpsi) 2% strain equivalent

Tensile Strength

Dynamic tensile strength (0.5 meter gauge length):

Aged*** and unaged	Median > 3.8 GPa (550 kpsi)

**** Aging at 85°C, 85% RH, 30 days*

Dynamic and Static Fatigue	
Dynamic fatigue unaged and aged***	n_d ≥ 20
Static fatigue, aged***	n_s ≥ 23

Coating Performance

Coating strip force unaged and aged****

- Average strip force:	1 N to 3 N
- Peak strip force:	1.2 N to 8.9 N

**** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C
- Wasp spray exposure (Telcordia)

Environmental Specifications

Attenuation

Environmental Test	Test Conditions	Induced attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling	- 60°C to 85°C	≤ 0.05
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.05
Water Immersion	14 days; 23°C	≤ 0.05
Dry Heat	30 days; 85°C	≤ 0.05
Damp Heat	30 days; 85°C, 85% RH	≤ 0.05

Typical Values

Miscellaneous	
Nominal Zero Dispersion Slope	0.089 ps/(nm².km)
Effective group index @ 1310 nm	1.467
Effective group index @ 1550 nm	1.467
Effective group index @ 1625 nm	1.468
Rayleigh Backscatter Coefficient for 1 ns pulse width:	
@ 1310 nm	-79.0 dB
@ 1550 nm	-81.3 dB
@ 1625 nm	-82.0 dB
Median Dynamic Tensile Strength****	5.3 GPa (750 kpsi)
****(Aged at 85°C, 85% RH, 30 days; 0,5 m gauge length)	

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Prysmian OneSpec™
Single-Mode Bend-Insensitive Fiber – ITU G.657.B3 & G.652.D
(5.0 mm Bend Radius)

Overview

This specification applies to fiber cables with "ITU G.657.B3 Bend-Insensitive Single-Mode Fiber (BIF)". This is a premium grade full spectrum fiber that provides the ultimate in extremely low bending loss performance while maintaining full backward compatibility and compliance with the ITU G.652.D low water peak single mode fibers and specifications. This fiber provides low bending loss performance down to a bend radius of 5 mm.

Application Data

- Ideally suited for premise and fiber-to-the-home applications where cables or fibers can be exposed to tighter bends.

Features and Benefits

Low bending losses

- Up to 1/300th the bending loss of standard single mode fiber provides improved system performance.
- Very low loss at 5 mm bend radius; 1 turn loss ≤ 0.15 dB @ 1550 nm.
- Allows a smaller bend radius with small diameter cables such as patch cords and distribution cables.
- Improperly installed small diameter bends result in lower attenuation impacts on systems.
- Allow the use of smaller splice trays or closures.
- Permits the use of smaller diameter cable designs such as Prysmian's LT2.0.
- Provides lower bending losses at higher wavelengths such as 1625 nm which future proofs the network.
- Significantly improves temperature cycling and mid-span express tube routing loss performance providing long-term attenuation stability.

Full industry standards compliance

- Fully compliant to both ITU G.657.B3 BIF and G.652.D SMF industry standards.
- Fully compliant to both IEC 60793-2-50 B.6.B3 BIF and B1.3 SMF fiber standards.
- Fully compliant with Telcordia GR20 & GR409.
- Fully compliant with all ICEA fiber cable standards including ICEA 640, 696, & 596.
- Compliant with RUS 7 CFR 1755.900 fiber requirements.

Full backward ITU G.652.D SMF compatibility

- Compliant with ITU G.652.D and IEC 60793-2-50 B.1.3 low water peak SMF specifications.
- Compatible with equipment designed for G.652 fibers; fully transparent from a transmission perspective.
- Splice compatible with ITU G.652 SMF using BIF program settings.
- Full 1260-1625 nm low water peak compliance.

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SM -BIF

Prysmian OneSpec™
Single-Mode Bend-Insensitive Fiber – ITU G.657.B3 & G.652.D
(5.0 mm Bend Radius)

Performance Specifications

Optical Parameters	
Mode Field Diameter @ 1310 nm	8.6 or 8.8 ± 0.4 µm
Mode Field Diameter @ 1550 nm	9.65 or 9.8 ± 0.5 µm
Cabled Cut-Off Wavelength	≤ 1260 nm
Zero Dispersion Wavelength (λ)	1300 nm to 1324 nm
Chromatic Dispersion	
1550 nm	≤ 18.0 ps/(nm*km)
1625 nm	≤ 23.0 ps/(nm*km)
Zero Dispersion Slope	≤ 0.092 ps/(nm²*km)
Point Discontinuity (1310 & 1550 nm)	≤ 0.05 dB

Attenuation vs. Wavelength	
1285 nm to 1330 nm	= α_{1310} ± 0.03 dB/km
1525 nm to 1575 nm	= α_{1550} ± 0.02 dB/km
1383 nm (Post Hydrogen Aging)	0.31 - 0.35 dB/km

Polarization Mode Dispersion (PMD)	
Max. Value In Uncabled Fiber	≤ 0.2 ps/km$^{1/2}$
Link Design Value	≤ 0.06 ps/km$^{1/2}$

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Attenuation (dB)
1	10	1550	≤ 0.03
1	10	1625	≤ 0.1
1	7.5	1550	≤ 0.08
1	7.5	1625	≤ 0.25
1	5	1550	≤ 0.15
1	5	1625	≤ 0.45

Dimensional Parameters	
Outer Coating Diameter	242 ± 5 µm
Coating/Cladding Concentricity Error	≤ 12 µm
Cladding Diameter	125.0 ± 0.7 µm
Cladding Non-Circularity	≤ 0.7%
Core-Clad Concentricity	≤ 0.5 µm
Fiber Curl	≥ 4.0 m radius

Mechanical Performance	
Minimum Proof Test	100 Kpsi (0.7 GPa); 1% strain equivalent

Environmental Performance

Environmental Test	Induced Attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling (-60°C to +85°C)	≤ 0.05
Temperature Humidity Cycling (-10°C to +85°C, up to 98% RH)	≤ 0.05
Water Immersion (23°C ± 2°C)	≤ 0.05
Accelerated Heat Aging (85°C ± 2°C)	≤ 0.05
Damp Heat (85°C, 85% RH)	≤ 0.05

Performance Characterization	
Effective Group Index Of Refraction	@ 1310 nm 1.467 @ 1550 nm 1.467
Fatigue Resistance Parameter (n_d)	20

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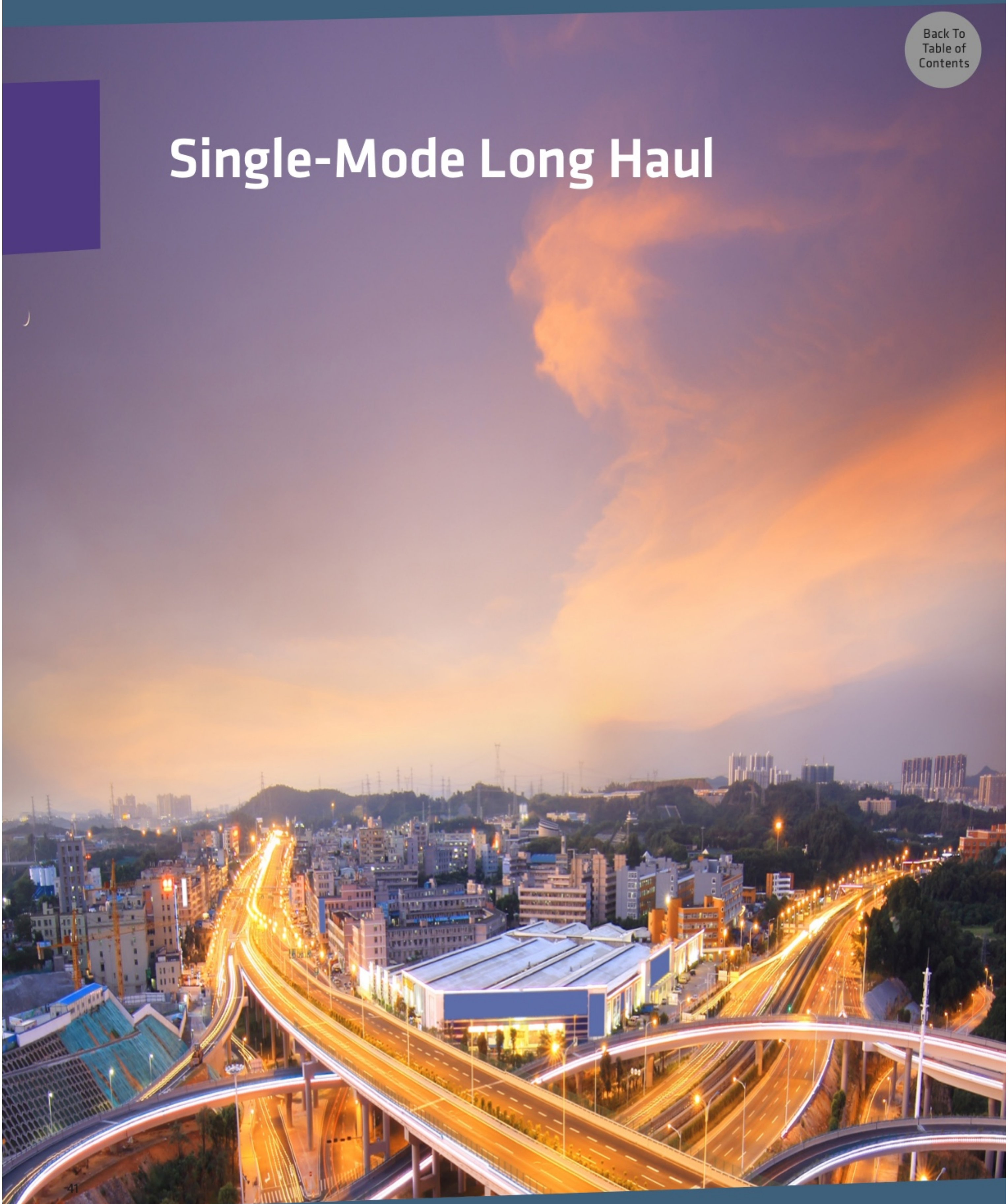
Single-Mode Long Haul



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Single-Mode Long Haul Fiber

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Corning® LEAF® Optical Fiber

Product Information

CORNING

In the race to satisfy the global demand for bandwidth, Corning® LEAF® optical fiber is the clear winner as the world's most widely deployed non-zero dispersion-shifted fiber (NZDSF). Optimized for long-haul and metro networks, LEAF fiber is a technically advanced product that provides high capacity, broad system flexibility, and superior performance. Additionally LEAF fiber is the industry leader in polarization mode dispersion (PMD) specifications and has the lowest attenuation of any NZDSF on the market today, enabling networks to evolve from the current 10G and 40G and 100G systems of the future.

Optical Specifications

Maximum Attenuation

Wavelength (nm)	Maximum Value (dB/km)
1383	≤ 0.4
1410	≤ 0.32
1450	≤ 0.26
1550	≤ 0.19
1625	≤ 0.21

Attenuation vs. Wavelength

Range (nm)	Ref. λ (nm)	Max. α Difference (dB/km)
1525 – 1575	1550	0.02
1550 – 1625	1550	0.03

The attenuation in a given wavelength range does not exceed the attenuation of the reference wavelength (λ) by more than the value α.

Macrobend Loss

Mandrel Diameter (mm)	Number of Turns	Wavelength (nm)	Induced Attenuation* (dB)
32	1	1550 & 1625	≤ 0.50
60	100	1550 & 1625	≤ 0.05

***The induced attenuation due to fiber wrapped around a mandrel of a specified diameter.**

Point Discontinuity

Wavelength (nm)	Point Discontinuity (dB)
1550	≤ 0.05

Mode-Field Diameter

Wavelength (nm)	MFD (μm)
1550	9.6 ± 0.4

Dispersion

Wavelength (nm)	Dispersion Value [ps/(nm•km)]
1530	2.0–5.5
1565	4.5–6.0
1625	5.8–11.2

Polarization Mode Dispersion (PMD)

	Value (ps/√km)
PMD Link Design Value	≤ 0.04*
Maximum Individual Fiber PMD	≤ 0.1

***Complies with IEC** 60794-3: 2001, **Section** 5.5, **Method** 1, **(m =** 20, **Q =** 0.01%**), September** 2001.

The PMD link design value is a term used to describe the PMD of concatenated lengths of fiber (also known as PMD_Q). This value represents a statistical upper limit for total link PMD. Individual PMD values may change when fiber is cabled.

Standards Compliance

- ITU-T G.655 (Tables A, B, C, D)
- IEC Specifications 60793-2-50 Type B4
- TIA/EIA 492-EA00
- Telcordia's GR-20

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

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Corning® LEAF® Optical Fiber

Dimensional Specifications

Glass Geometry

Fiber Curl	≥ 4.0 m radius of curvature
Cladding Diameter	125.0 ± 0.7 µm
Core-Clad Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 1550 nm and 1625 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.05
Temperature Humidity Cycling	-10°C to +85°C up to 98% RH	≤ 0.05
Water Immersion	23°C ± 2°C	≤ 0.05
Heat Aging	85°C ± 2°C	≤ 0.05
Damp Heat	85°C at 85% RH	≤ 0.05

*Reference temperature = +23ºC   Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa).*

*Higher proof test levels available

Length

Fiber lengths available up to 25.2 km/spool.

Performance Characterizations

Characterized parameters are typical values.

Numerical Aperture	0.14 NA is measured at the one percent power level of a one-dimensional far-field scan at 1550 nm.
Effective Area (A_{eff})	1550 nm: 72 µm²
Effective Group Index of Refraction (N_{eff})	1550 nm: 1.4693
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (3N) Wet, 14-day room temperature: 0.6 lbs. (3N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1550 nm: -81 dB 1625 nm: -82 dB
Chromatic Dispersion	1550 nm at 4 ps/(nm•km) 1625 nm at 10 ps/(nm•km)

Formulas

Dispersion

$$\text{Dispersion} = D(\lambda) := \left(\frac{D(1565\text{ nm}) - D(1530\text{ nm})}{35} \cdot (\lambda - 1565)\right) + D(1565\text{ nm})$$

λ = Operating Wavelength up to 1565 nm

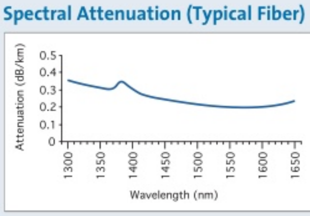
$$\text{Dispersion} = D(\lambda) := \left(\frac{D(1625\text{ nm}) - D(1565\text{ nm})}{60} \cdot (\lambda - 1625)\right) + D(1625\text{ nm})$$

λ = Operating Wavelength from 1565 nm – 1625 nm

Cladding Non-Circularity

$$\text{Cladding Non-Circularity} = \left[1 - \frac{\text{Min. Cladding Diameter}}{\text{Max. Cladding Diameter}}\right] \times 100$$

Spectral Attenuation (Typical Fiber)



Wavelength (nm)	Attenuation (dB/km)
1383	0.34
1410	0.28
1450	0.24
1550	0.19
1625	0.20

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Draka

A brand of the Prysmian Group

Single-Mode Fiber

TeraLight™ Ultra Optical Fiber

Optimized for long haul and ultra long haul

Draka's TeraLight™ Non-zero Dispersion Shifted Fiber (NZDSF) has set the standard for high bit-rate, multi-wavelength transmission. Its unique optimization of effective area, chromatic dispersion and dispersion slope enables excellent distorsion management cost effective operation at 10 and 40 Gbps, tight channel spacing in C- and L-bands, compatibility with the future S-band.

TeraLight™ Ultra is further optimized for long-haul and ultra-long-haul applications. Its typical chromatic dispersion of 8 ps/nm.km at 1550 nm is optimized to be half that of standard single mode fiber resulting in lower costs for dispersion compensation, but high enough to counter cross-channel non-linearities. Guaranteed PMD link design value of 0.04 ps/km keeps distorsions within tolerable limits, permitting 3 to 5 times longer distances without regeneration at 40 Gbps than fibers with higher PMD values, resulting in cost savings. Low attenuation in the 1450 nm region ensures maximum efficiency of distributed Raman amplification systems. Channel spacing as low as 25 GHz at 10 Gbps in C- and L- bands allows future capacity expansion. Commercially available dispersion compensationg devices provide near 100% chromatic dispersion and dispersion slope compensation.

The fiber complies with or exceeds the ITU-T Recommendations G.655.E/G656, the IEC International Standard 60793-2-50 type B4/B5 and can be used in all cable constructions, including loose tube, tight buffered, ribbon and central tube designs. Draka's Advanced Plasma and Vapor deposition (APVD™) manufacturing process and proprietary ColorLock-XS™ coating process further enhance fiber purity, reliability, and durability.

Features	Advantages
10 Gbps, 40 Gbps and higher data rates PMD link design value 0.04 ps/km	• Future capacity increase; future-proof • Three to five times longer distance without regeneration at 40 Gbps than fibers with higher PMD values
Low attenuation, optimized effective area	• Improve the optical signal-to-noise ratio, extending the link distance
More flat dispersion slope provides near 100% end-to-end compensation with commercially available dispersion compensation devices	• Potential cost savings from avoidance of costly channel-by-channel compensation at long distances or higher bit rates (contact Draka for availability)
More than 160 channels in C-band alone at 10 Gbps	• Maximizing C-band utilization defers costly L-band deployment, providing significant cost savings
320 channels in C-, L- and S-bands at 10 Gbps	• Higher capacity and more efficient bandwidth use

Key Industry Leading Milestones

1999	2002	2003	2005
Introduced TeraLight™	World Record: 6.4 Tbps over 2100 km	World Record: 6000 km 80 channels ay 10 Gbps	World Record: 4000 km 40 channels at 40 Gbps (EDFA Only)

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TeraLight™ Ultra Optical Fiber

Optical Specifications (uncabled fiber)

Attenuation	
Attenuation @ 1310 nm	0.40 dB/km
Attenuation @ 1450 nm	0.25 dB/km
Attenuation @ 1550 nm	0.21 dB/km
Attenuation @ 1625 nm	0.24 dB/km
Attenuation @ 1383 nm*	0.7 dB/km

**Including H2-aging according to IEC 60793-2-50, type B.1.3*

Attenuation vs. Wavelength

Maximum attenuation change over the window from reference

Wavelength range (nm)	Reference λ (nm)	(dB/km)
1525-1575	1550	≤ 0.03
1550-1625	1550	≤ 0.05
1440-1550	1550	≤ 0.1

Point Discontinuities

No point discontinuity greater than 0.05 dB at 1310 nm & 1550 nm.

Attenuation with Bending

Number of Turns	Mandrel Radius (mm)	Wavelength (nm)	Induced Attenuation (dB)
1	16	1550	≤ 0.5
100	25	1550	≤ 0.05
100	25	1625	≤ 0.05

Cutoff Wavelength	
Cable Cutoff Wavelength (λccf)	≤ 1260 nm

Mode Field Diameter	
Wavelength (nm)	MFD (µm)
1550	9.2 ± 0.5

Chromatic Dispersion	
Wavelength (nm)	Chromatic Dispersion (ps/[nm.km])
1310	-10 to -3.0
1440	> 0.1
1530-1565	5.5 to 10
1565-1625	7.5 to 13.8
Zero Dispersion Wavelength (λ0):	≤ 1425 nm

Polarization Mode Dispersion (PMD)	
PMD Link Design Value** (ps√km)	≤ 0.04
Max. Individual Fiber (ps√km)	≤ 0.08

*** According to IEC 60794-3, Ed 3 (Q=0.01%)*

Geometrical Specifications

Glass Geometry	
Cladding Diameter	125.0 ± 0.7 µm
Core/Cladding Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7 %
Fiber Curl (Radius)	≥ 4 m

Coating Geometry	
Coating Diameter	242 ± 7 µm
Coating/Cladding Concentricity	≤ 12 µm
Coating Non-Circularity	≤ 5%
Length	Standard lengths up to 25.2 km

Mechanical Specifications

Proof Test

The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent

Tensile Strength

Dynamic tensile strength (0.5 meter gauge length):

Aged*** and unaged	Median > 3.8 GPa (550 kpsi)

**** Aging at 85°C, 85% RH, 30 days*

Dynamic and Static Fatigue	
Dynamic fatigue unaged and aged***	$n_d \geq 20$
Static fatigue, aged***	$n_s \geq 23$

Coating Performance

Coating strip force unaged and aged****

- Average strip force:	1 N to 3 N
- Peak strip force:	1.2 N to 8.9 N

**** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C
- Wasp spray exposure (Telcordia)

Environmental Specifications

Attenuation

Environmental Test	Test Conditions	Induced attenuation at 1310, 1550 nm (dB/km)
Temperature Cycling	- 60°C to 85°C	≤ 0.05
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.05
Water Immersion	14 days; 23°C	≤ 0.05
Dry Heat	30 days; 85°C	≤ 0.05
Damp Heat	30 days; 85°C, 85% RH	≤ 0.05

Typical Characterisation Values

Miscellaneous	
Dispersion at 1440 nm	2 ps/(nm.km)
Dispersion at 1550 nm	8 ps/(nm.km)
Dispersion at 1625 nm	12 ps/(nm.km)
Dispersion Slope at 1550 nm	0.052 ps/(nm².km)
Effective Area	63 µm
Effective group index @ 1550 nm	1.4683
Effective group index @ 1625 nm	1.4685
Rayleigh Backscatter Coefficient for 1 ns pulse width	
@ 1550 nm	-80.4 dB
@ 1625 nm	-81.3 dB

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Corning® SMF-28® ULL Optical Fiber

Product Information

CORNING

Corning® SMF-28® ULL optical fiber has the lowest loss of any terrestrial-grade, single-mode fiber with a maximum attenuation of 0.17 dB/km at 1550 nm. SMF-28 ULL fiber has been deployed around the world in some of the most challenging network applications, where ultra-low attenuation can be leveraged to extend network span lengths, skip amplification sites, upgrade to faster bit rates, add network components for improved flexibility, or lengthen the distances between regenerators. As a result, long-haul and regional networks are scalable for the higher capacities required to meet the ever-increasing global demand for bandwidth without the need to sacrifice backwards compatibility with an existing ITU-T Recommendation G.652 installed base of fibers. SMF-28 ULL fiber complies with ITU-T Recommendation G.652.B and G.654.C.

Optical Specifications

Maximum Attenuation

Wavelength (nm)	Maximum Value* (dB/km)
1310	≤ 0.31
1550	≤ 0.17
1625	≤ 0.20

*Alternate attenuation offerings available upon request.

Attenuation vs. Wavelength

Range (nm)	Ref. λ (nm)	Max. α Difference (dB/km)
1285 – 1330	1310	0.03
1525 – 1575	1550	0.02
1550 – 1625	1550	0.03

The attenuation in a given wavelength range does not exceed the attenuation of the reference wavelength (λ) by more than the value α.

Macrobend Loss

Mandrel Diameter (mm)	Number of Turns	Wavelength (nm)	Induced Attenuation* (dB)
32	1	1550	≤ 0.1
50	100	1310	≤ 0.05
50	100	1550	≤ 0.05
60	100	1625	≤ 0.05

*The induced attenuation due to fiber wrapped around a mandrel of a specified diameter.

Point Discontinuity

Wavelength (nm)	Point Discontinuity (dB)
1310	≤ 0.05
1550	≤ 0.05

Cable Cutoff Wavelength (λ_{cc})

λ_{cc} ≤ 1260 nm

Mode-Field Diameter

Wavelength (nm)	MFD (μm)
1310	9.2 ± 0.5
1550	10.5 ± 0.5

Dispersion

Wavelength (nm)	Dispersion Value [ps/(nm·km)]
1550	≤ 18.0
1625	≤ 22.0

Zero Dispersion Wavelength (λ_0): 1304 nm ≤ λ_0 ≤ 1324 nm

Zero Dispersion Slope (S_0): ≤ 0.092 ps/(nm²·km)

Polarization Mode Dispersion (PMD)

	Value (ps/√km)
PMD Link Design Value	≤ 0.04*
Maximum Individual Fiber PMD	≤ 0.1

*Complies with IEC 60794-3: 2001, Section 5.5, Method 1, (m = 20, Q = 0.01), September 2001.

The PMD link design value is a term used to describe the PMD of concatenated lengths of fiber (also known as PMD_Q). This value represents a statistical upper limit for total link PMD. Individual PMD values may change when fiber is cabled.

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

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Long Haul

Corning® SMF-28® ULL Optical Fiber

Dimensional Specifications

Glass Geometry

Fiber Curl	≥ 4.0 m radius of curvature
Cladding Diameter	125.0 ± 0.7 µm
Core-Clad Concentricity	≤ 0.5 µm
Cladding Non-Circularity	≤ 0.7%

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 1310 nm, 1550 nm & 1625 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.05
Temperature Humidity Cycling	-10°C to +85°C up to 98% RH	≤ 0.05
Water Immersion	23°C ± 2°C	≤ 0.05
Heat Aging	85°C ± 2°C	≤ 0.05
Damp Heat	85°C at 85% RH	≤ 0.05

*Reference temperature = +23ºC

Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa).*

*Higher proof test levels available.

Length

Fiber lengths available up to 25.2 km/spool.

Performance Characterization Specification

Characterized parameters are typical values.

Core Diameter	8.2 µm
Numerical Aperture	0.14 NA is measured at the one percent power level of a one-dimensional far-field scan at 1310 nm.
Effective Group Index of Refraction (N_{eff})	1310 nm: 1.4606 1550 nm: 1.4620
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (3N) Wet, 14-day room temperature: 0.6 lbs. (3N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	1310 nm: -77 dB 1550 nm: -82 dB

PI1470 | Issued: July 2014 Supersedes: May 2014 | TL9000/ISO9001 Certified

Multimode Fiber

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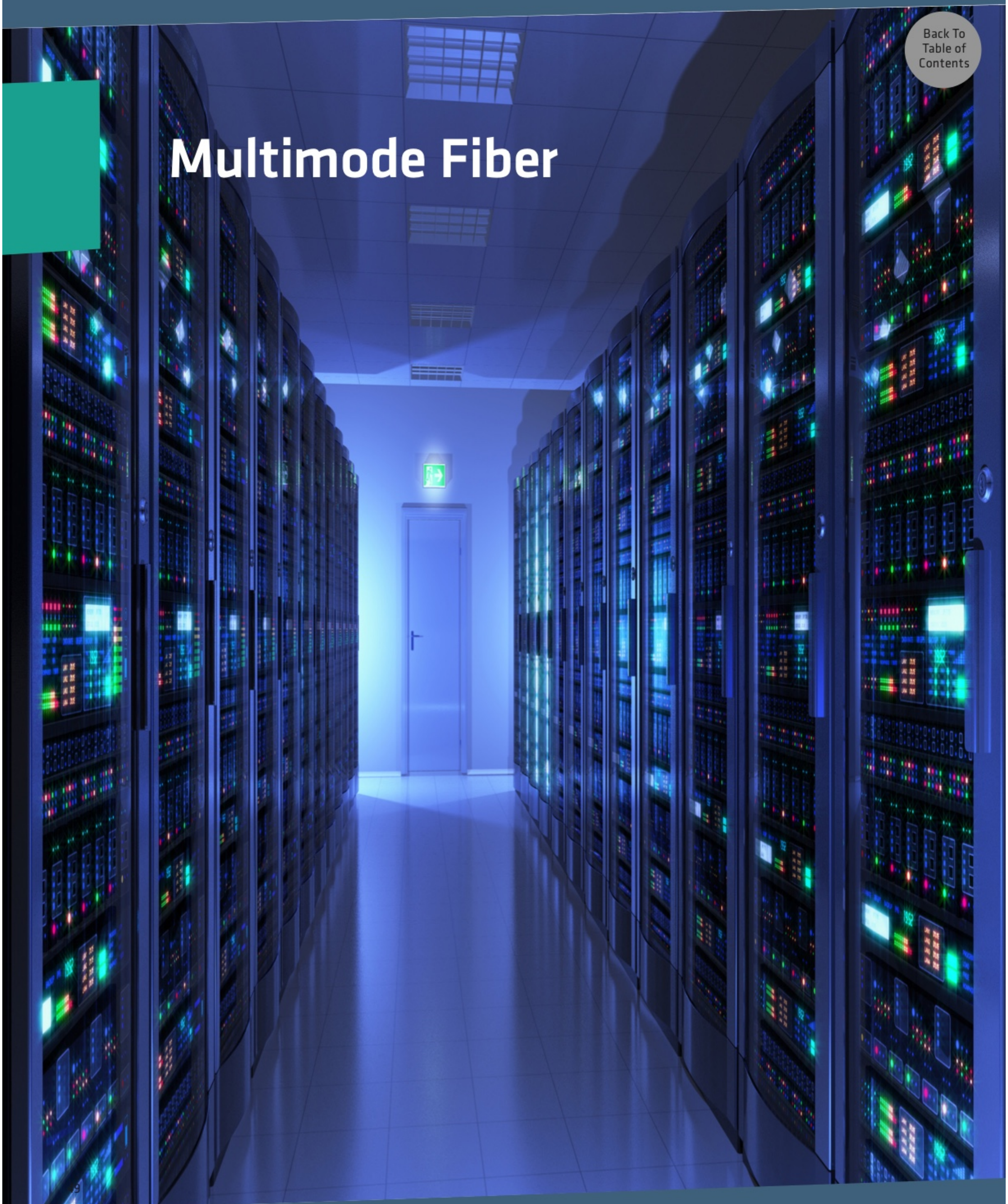

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Multimode Fiber

ISO/IEC 11801 MMF Class OM1 -62.5 µm

ISO/IEC 11801 MMF Class OM2, OM3, & OM4 - 50 µm

ISO/IEC 11801 MMF Class OM4 Plus & OM5 High Performance - 50 µm

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Prysmian OneSpec™
62.5 µm Multimode Fiber – OM1

Overview

62.5 µm multimode fiber is a legacy laser optimized OM1 optical fiber with a 62.5 µm core and a 125 µm cladding.

Applications

The fiber is optimized for low cost deployment in shorter distance Local Area Networks and premise applications with video, data and/or voice services using LED, VCSEL, or laser sources. The fiber is optimized for 1300 nm applications but is suitable for 850 nm operation.

Features and Benefits

- Fully compatibility with legacy systems like Fast Ethernet, FDDI, ATM, Fiber Channel and 1 Gb/s Ethernet.
- Greater distance capability at data rates up to 1 Gb/s at either 850 nm or 1300 nm windows.
- Optimized for 1 Gb/s transmission to 300 m at 850 nm and 500 m at 1300 nm.
- Optimized performance in tight buffer cable applications.

Fully Compliant to Industry Standards

- ISO/IEC 11801 OM1 industry standards
- IEC60793-2-10 Type A1b fiber standards
- ITU G651.1 standard
- TIA/EIA 492AAAA standards
- Telcordia GR20 and GR409
- All ICEA fiber cable standards including ICEA 640 696 and 596

REV 11-16 SUPERSEDES 6-15

Prysmian Group

PRYSMIAN Draka

Multimode Specification	OM1
International Standard	IEC 60793-2-10 type A1b TIA/EIA-492AAAA ISO/IEC 11801 OM-1
Optical Characteristics	
Attenuation (dB/km) 850 nm and 1300 nm	See Cable Data Sheet
Overfilled Modal Bandwidth (MHz*km)	
850 nm	≥ 200
1300 nm	≥ 500
System Capacity - 1Gb/s Ethernet @ 850 nm/1300nm Distance Capability	300/500 m
Zero Dispersion Wavelength (nm)	1320 - 1365
Dispersion Slope, 1295 nm to 1310 nm	< 0.11
Bending Loss, 100 Turns, R = 37.5 mm Mandrel, 850 nm/1300 nm (dB)	< 0.5/0.5
Point Discontinuity @ 850 nm and 1310 nm (dB)	≤ 0.2
Group Index of Refraction (typical)	
850 nm	1.496
1300 nm	1.491
Geometrical Specifications	
Numerical Aperture	0.275 ± 0.015
Core Diameter (µm)	62.5 ± 2.5
Core Non-Circularity (%)	≤ 5
Core/Cladding Concentricity Error (µm)	≤ 1.5
Cladding Diameter (µm)	125.0 ± 2.0
Cladding Non-Circularity (%)	1.0
Coating Diameter (µm)	242 ± 5
Coating Cladding Concentricity (µm)	< 12
Mechanical Specifications	
Coating Strip Force, Aged and Unaged (N)	2.7 (typical)
Proof Test	100 kpsi
Fatigue Parameter (Typical) Aged and Unaged	> 20
Environmental Specifications	
-60 to + 85°C (dB/km) @ 850 nm, 1300 nm	< 0.1
-10 to + 85°C, 4-98% RH, (dB/km) @ 850 nm, 1300 nm	< 0.1
Water Immersion 30 days @ 23°C (dB/km) @ 850 nm, 1300 nm	< 0.2
Damp Heat (85°C, 85% RH, 30 days) (dB/km) @ 850 nm, 1300 nm	< 0.2
Dry Heat 30 days 85°C, (dB/km) @ 850 nm, 1300 nm	< 0.2

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Draka

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Multimode Fiber

Legacy OM1 Graded-Index Multimode Fiber

62.5 /125 µm (1300 nm bandwidth optimized)

Legacy 850 nm Laser-Optimized OM1 62.5 µm Multimode Fiber.

This graded-index multimode fiber has a 62.5 µm core diameter and a 125 µm cladding diameter. The fiber is designed for use at 1300 nm and can also be used at 850 nm and is suitable for use in premises cabling applications, like Local Area Networks (including backbone, riser and horizontal) with video, data and/or voice services using LED, VCSEL and Fabry-Perot laser sources at 850 nm or 1300 nm.

This multimode fiber assures full compatibility with legacy systems, like Fast Ethernet, FDDI, ATM, Fiber Channel and 1Gb/s Ethernet. Because of the nature of the Plasma-Activated Chemical Vapor Deposition (PCVD and APVD™) manufacturing process, this fiber offers the highest bandwidth available in the market. OM1 and even OM2 fiber selections are available.

Standards references: The fiber complies with or exceeds IEC 60793-2-10 type A1b Optical Fiber Specification, TIA/EIA-492AAAA detail specification and Telcordia GR-20-CORE and GR-409-CORE specifications.

Features	Advantages
Produced by the PCVD and APVD™ processes, the ultimate processes for graded- index multimode fibers	• Superior geometry, uniformity and purity of glass • CVD and APVD™ produced multimode fibres show excellent modal bandwidth performance PMD values
Coated with the dual layer UV Acrylate	• Optimized performance in tight-buffer cable applications • High resistance to micro-bending • Stable performance over a wide range of environmental conditions • Improved an easier strippability of tight buffer coatings

Key Industry Leading Milestones

1999	2003	2006	2010	2012
First shipment of what became OM3 fiber in 2002	First OM3 fiber with 10Gb/s over 550 m: MaxCap-OM4 fiber	First Bend-Insensitive Single-mode fiber: BendBright-XS	Bend-Insensitive OM2/OM2+/OM3/OM4 fiber: MaxCap-BB-OMx	Bend-Insensitive Chromatic Dispersion Compensating fiber: MaxCap-BB-OM4+

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Draka

A brand of the Prysmian Group

Legacy OM1 Graded-Index Multimode Fiber

Optical Specifications (uncabled fiber)

Attenuation	
Attenuation Coefficient @ 850 nm	≤ 2.6 to ≤ 2.7 dB/km
Attenuation Coefficient @ 1300 nm	≤ 0.5 to ≤ 0.6 dB/km
Aperture	
Numerical Aperture	0.275 ± 0.015
Chromatic Dispersion	
Zero Dispersion Wavelength (λ_O)	1320 nm ≤ λ_O ≤ 1365 nm
Zero Dispersion Slope (S_O)	
1320 nm ≤ λ_O ≤ 1348 nm	≤ 0.11 ps/(nm²·km)
1348 nm ≤ λ_O ≤ 1365 nm	≤ 0.001 (1458- λ_O) ps/(nm²·km)
Overfilled Modal Bamdwidth[1]	
850 nm	≤ 160 MHz.km
1300 nm	≤ 500 MHz.km
Bending Loss	
100 turns, D=75 mm; 850 nm / 1300 nm	≤ 0.05 dB
Backscatter Characteristics[2]	
Point Discontinuity[3] 850 nm, 1300 nm	≤ 0.1 dB
Irregularities over fiber length 850 nm, 1300 nm	≤ 0.1 dB
Reflections	Not Allowed
Group Index of Refraction (Typical) 850 nm 1300 nm	 1.496 1.491

[1] *The model bandwith is linearly normalized to 1 km, according to IEC 60793-2-10*

[2] *OTDR measurement 0.5 µs pulse width*

[3] *mean of bi-directional measurement*

Geometrical Specifications

Glass Geometry	
Core Diameter	62.5 ± 2.5 µm
Core Non-Circularity	≤ 5 %
Core/Cladding Concentricity Error	≤ 1 µm
Cladding Diameter	125.0 ± 1.0 µm
Cladding Non-Circularity	≤ 0.7 %
Coating Geometry	
Coating Diameter	242 ± 5 µm
Coating Non-Circularity	≤ 5%
Coating/Cladding Concentricity Error	≤ 10 µm
Length	Standard lengths up to 26.4 km
Other lengths available on request	

Mechanical Specifications

Proof Test	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged[4] and unaged	Median > 3.8 GPa (550 kpsi)
[4] *Aging at 85°C, 85% RH, 30 days*	
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged[4]	n_d > 25
Coating Performance	
Coating strip force unaged and aged[5]	
- Average strip force:	1 N to 3 N
- Peak strip force:	1.3 N to 8.9 N
[5] Aging: • 0°C and 45°C • 30 days at 85°C and 85% RH • 14 days water immersion at 23°C	

Environmental Specifications

Attenuation		
Environmental Test	**Test Conditions**	**Induced attenuation at 850, 1300 nm (dB/km)**
Temperature Cycling	- 60°C to 85°C	≤ 0.1
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.1
Water Immersion	30 days; 23°C	≤ 0.1
Dry Heat	30 days; 85°C	≤ 0.1
Damp Heat	30 days; 85°C, 85% RH	≤ 0.1

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Corning® InfiniCor® 300 62.5 µm Optical Fiber

Product Information

How Do You Measure Trust? Gb/s Works for Us.

In today's enterprise networks, bandwidth demands are growing – rapidly. That's because end-user productivity is increasingly dependent on instant accessibility and high throughput of information. Narrow bandwidth constricts your capacity to succeed. Corning's InfiniCor® 300 fiber, the world's first laser-optimized™ 62.5 µm multimode fiber, will help you to stay ahead of escalating network demands with:

- Greater distance capability at data rates up to 1 Gb/s in both the 850 and 1300 nm windows
- Higher data aggregation in the backbone, riser and horizontal, compared with non-laser-optimized fibers
- Full compatibility with the broad range of laser-based and legacy protocols and applications
- Superior measurement technology and manufacturing control
- Industry-leading CPC® coating for superior microbend and environmental performance

Optimized Data Rate over Distance	1 Gb/s over 300 m at 850 nm 1 Gb/s over 550 m at 1300 nm
Standards Compliance*	
ISO/IEC 11801	type OM1 fiber
IEC 60793-2-10	type A1b fiber
TIA/EIA	492AAAA-A

*meets or exceed standards requirements for the fiber specifications listed.

Optical Specifications

Bandwidth

Intermediate Performance EMB* (MHz•km)	Legacy Performance EMB** (MHz•km)	
850 nm Only	850 nm	1300 nm
220	200	500

*RML BW, per TIA/EIA 455-204 and IEC 60793-1-41, for intermediate performance laser-based systems (typically up to 1 Gb/s).

**OFL BW, per TIA/EIA 455-204 and IEC 60793-1-41, for legacy and LED-based systems (typically up to 100 Mb/s).

Attenuation

Wavelength (nm)	Maximum Value (dB/km)
850	≤ 2.9
1300	≤ 0.6

No point discontinuity greater than 0.2 dB. Attenuation at 1380 nm does not exceed the attenuation at 1300 nm by more than 1.0 dB/km.

Induced attenuation from 100 turns around a 75 mm mandrel shall be ≤ 0.5 dB at 850 nm and 1300 nm.

Numerical Aperture

0.275 ± 0.015

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

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Corning® InfiniCor® 300 62.5 µm Optical Fiber

Dimensional Specifications

Glass Geometry

Core Diameter	62.5 ± 2.5 µm
Cladding Diameter	125.0 ± 2.0 µm
Core-Clad Concentricity	≤ 1.5 µm
Cladding Non-Circularity	≤ 1.0%
Core Non-Circularity	≤ 5%

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 850 and 1300 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤ 0.10
Temperature Humidity Cycling	-10°C to +85°C and 4% to 98% RH	≤ 0.10
Water Immersion	23°± 2°C	≤ 0.20
Heat Aging	85°± 2°C	≤ 0.20
Damp Heat	85°C at 85% RH	≤ 0.20

*Operating Temperature Range: -60ºC to +85ºC

Mechanical Specifications

Proof Test

The entire fiber length is subjected to a tensile stress ≥ 100 kpsi (0.69 GPa)*.

*Higher proof test levels available.

Length

Fiber lengths available up to 17.6 km/spool.

Performance Characterizations

Refractive Index Difference	2%
Effective Group Index of Refraction (N_{eff})	850 nm: 1.496 1300 nm:1.491

N_{eff} was empirically derived to the third decimal place using a specific commercially available OTDR.

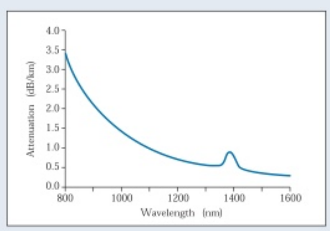
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs. (2.7N) Wet, 14 days in 23ºC water soak: 0.6 lbs. (2.7N)
Rayleigh Backscatter Coefficient (for 1 ns Pulse Width)	850 nm: -68 dB 1300 nm: -76 dB

Chromatic Dispersion

Zero Dispersion Wavelength (λ_0): 1332 nm ≤ λ_0 ≤1354 nm

Zero Dispersion Slope (S_0): ≤ 0.097 ps/(nm²•km)

Spectral Attenuation (Typical Fiber)



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Prysmian OneSpec™
50 µm Multimode Fiber – OM2/OM3/OM4

Overview

Prysmian offers a full range of multimode fibers that are 850 nm laser optimized for different performance classes: OM2, OM3, & OM4. This laser optimization, combined with a bend-insensitive fiber design provides superior performance for 10, 40 and 100 Gb/s applications.

Applications

50 µm multimode fiber is optimized for low cost deployment in shorter distance applications such as Local Area Networks (LAN) up to 550 m (10G BASE-SX) and in data centers up to 150 m at 40G/100G data rates (40G BASE-SR4 and 100G BASE-SR10).

Features and Benefits

- Low bending loss at a 15 mm or even 7.5 mm radius significantly improves system performance.
- Allows a smaller bend radius with small diameter cables such as patch cords and distribution cables.
- Improperly installed small diameter bends from challenging installations result in lower attenuation impacts on systems.
- Allows use of smaller high density fiber management systems.
- Improved micro and macro bending performance provides improves cabling performance.

Fully Compliant to Industry Standards

- ISO/IEC 11801 OM2, OM3, OM4 industry standards
- IEC60793-2-10 type A1a.1, A1a.2, or A1a.3 fiber standards
- ITU G651.1 standard
- TIA/EIA 492AAAB, 492AAAC, or 492AAAD standards
- Telcordia GR20 and GR409
- All ICEA fiber cable standards including ICEA 640, 696, & 596
- Fully backwards compatible with legacy 50 µm fibers

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Prysmian Group

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Multimode Specification	OM2	OM3	OM4	OM4 PLUS
International Standard	IEC 60793-2-10 type A1a.1 TIA/EIA-492AAAB ITU G.651.1 ISO/IEC 11801 OM-2	IEC 60793-2-10 type A1a.2 TIA/EIA-492AAAC ITU G.651.1 ISO/IEC 11801 OM-3	IEC 60793-2-10 type A1a.3 TIA/EIA-492AAAD ITU G.651.1 ISO/IEC 11801 OM-4	IEC 60793-2-10b type A1a.3 TIA/EIA-492AAAD ITU G.651.1 ISO/IEC 11801 OM-4
Optical Characteristics				
Attenuation (dB/km)	See Cable Data Sheet	See Cable Data Sheet	See Cable Data Sheet	See Cable Data Sheet
Overfilled Modal Bandwidth (MHz*km)				
850 nm	≥ 700	≥ 1500	≥ 3500	≥ 3500
1300 nm	≥ 500	≥ 500	≥ 500	≥ 500
Effective Modal Bandwidth (MHz*km) @ 850 nm	≥ 950	≥ 2000	≥ 4700	≥ 4700
Effective Bandwidth (MH*km) @ 850 nm	---	---	---	≥ 5000
System Capacity				
10Gb/s Ethernet IEEE 802.3ae	150 m	300 m	550 m	550 m
40/100Gb/s Ethernet IEEE 802.3ba	NA	100 m	150 m	150 m
Zero Dispersion Wavelength (nm)	1295-1340	1295-1340	1295-1340	1295-1340
Dispersion Slope 1295 nm ≤1310 nm (ps/nm²km)	< 0.105	< 0.105	< 0.105	< 0.105
Bending Loss				
100 Turns, R=37.5 mm @ 850 nm/1300 nm (dB)	≤ 0.5/0.5	≤ 0.05/0.15	≤ 0.05/0.15	≤ 0.05/0.15
2 Turns, R=15 mm @ 850 nm/1300 nm (dB)	≤ 0.1/0.3	≤ 0.1/0.3	≤ 0.1/0.3	≤ 0.1/0.3
2 Turns, R=7.5 mm @ 850 nm/1300 nm (dB)	≤ 0.2/0.5	≤ 0.2/0.5	≤ 0.2/0.5	≤ 0.2/0.5
Backscatter Characteristics				
Point Discontinuity @ 850 nm & 1310 nm (dB)	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1
Irregularities over fiber length (dB)	≤ 0.1	≤ 0.1	≤ 0.1	≤ 0.1
Reflections	not allowed	not allowed	not allowed	not allowed
Group Index of Refraction (typical)				
850 nm	1.48	1.48	1.48	1.48
1300 nm	1.479	1.479	1.479	1.479
Geometrical Specifications				
Numerical Aperture	0.200 ± 0.015	0.200 ± 0.015	0.200 ± 0.015	0.200 ± 0.015
Core Diameter (µm)	50 ± 2.5	50 ± 2.5	50 ± 2.5	50 ± 2.5
Core Non-Circularity	≤ 5%	≤ 5%	≤ 5%	≤ 5%
Core/Cladding Concentricity Error (µm)	≤ 1.5	≤ 1.5	≤ 1.5	≤ 1.5
Cladding Diameter (µm)	125.0 ± 1.0	125.0 ± 1.0	125.0 ± 1.0	125.0 ± 1.0
Cladding Non-Circularity (%)	1.0%	1.0%	1.0%	1.0%
Coating Diameter (µm)	242 ± 5	242 ± 5	242 ± 5	242 ± 5
Coating cladding Concentricity (µm)	< 12	< 12	< 12	< 12
Mechanical Specifications				
Coating Strip Force, Aged and Unaged (N)	2.7 (typical)	2.7 (typical)	2.7 (typical)	2.7 (typical)
Proof Test	100 kpsi	100 kpsi	100 kpsi	100 kpsi
Fatigue Parameter (Typical) Aged and Unaged	>20	>20	>20	>20
Environmental Specifications				
-60 to + 85°C (dB/km) @ 850 nm, 1300 nm	< 0.1	< 0.1	< 0.1	< 0.1
-10 to + 85°C, 4-98% RH, (dB/km) @ 850 nm, 1300 nm	< 0.1	< 0.1	< 0.1	< 0.1
Water Immersion 30 days @ 23°C (dB/km) @ 850 nm, 1300 nm	< 0.2	< 0.2	< 0.2	< 0.2
Damp Heat (85°C, 85%RH, 30 days) (dB/km) @ 850 nm, 1300 nm	< 0.2	< 0.2	< 0.2	< 0.2
Dry Heat 30 days 85°C, (dB/km) @ 850 nm, 1300 nm	< 0.2	< 0.2	< 0.2	< 0.2

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Draka

A brand of the Prysmian Group

Multimode Fiber

MaxCap-BB-OM2 / OM2+ / OM3 / OM4 Multimode Fiber

Bend-Insensitive 10, 40, 100 Gb/s

Bend-Insensitive 850 nm Laser-Optimized 50 µm MaxCap-BB-OM2 / OM2+ / OM3 / OM4 multimode fiber for 10, 40 and 100 Gb/s applications.

Draka 850 nm laser-optimized 50 µm bend-insensitive multimode fiber (MaxCap-BB-OMx) has been designed in quality classes OM2, OM2+, OM3 and OM4 fiber. The outstanding bending performance of this fiber combines improved fiber and cable management with superior bandwidth (low DMD) for 10, 40 and 100 Gb/s system applications. The eminent bending performance of robust MaxCap-BB-OMx fibers is based on the large know how built up developing Draka world-acclaimed bend-insensitive single-mode fibers BendBright-XS™ and BendBright-Elite™. BendBright™ technology is referred to in the title of this product by the abbreviation BB.

MaxCap-BB-OMx fibers support compact cable management and allow more easily MACs (Moves, Adds, Changes) applied in Local Area Networks (LAN) backbones up to 550 m (10GBASE-SX) and in Data Centers up to 150 m at 40G/100G bit rates (40GBASE-SR4 and 100GBASE-SR10). The MaxCap-BB-OMx multimode fibers are produced by the proprietary Plasma-Activated Chemical Vapor Deposition process (PCVD), acknowledged worldwide as offering the best core profile accuracy for multimode fibers.

Standards references: The MaxCap-BB-OM2 and OM2+ and MaxCap-BB-OM3 / OM4 multimode fibers types entirely comply with or exceed IEC 60793-2-10 type A1a.1 / A1a.2 / A1a.3 Optical Fiber Specification, ISO/IEC 11801 OM2 / OM3 / OM4 specification, TIA/EIA-492AAAB / 492AAAC / 492AAAD detail specification and Telcordia GR-20-CORE and GR-409-CORE specifications.

Features	Advantages
MaxCap-BB-OM2 / OM2+ / OM3 / OM4 high bandwidth capability is combined with extremely low bending sensitivity	• Margins in 10 Gb/s (and beyond) systems, supported by high bandwidth OM2 / OM2+ / OM3 / OM4 are further improved by additional low bending loss, offering more relaxed and easier installations and MACs (Moves, Adds, Changes)
MaxCap-BB-OM2 / OM2+ / OM3 / OM4 low bending sensitivity	• Allows use of smaller, high density fiber management systems, as key issue in limited space data centers, computer rooms and LANs. Overall system network reliability (uptime) is improved thanks to the reduction of system impairments due to tight bends introduced by human mistakes
MaxCap-BB-OM2+ / OM3 / OM4 fulfill both EMB and DMD requirements; also a tighter inner-DMD mask (0–18 µm) is used	• Compared to the standards (and competitors) Draka's MaxCap-BB-OMx fibers ultimately offer additional robustness in 10Gb/s and beyond systems
Coated with the dual layer UV Acrylate	• MaxCap-BB-OMx multimode fibers show excellent micro-bending behavior, resulting in easy cabling and installation, supporting a max. cabled attenuation of 3.0 dB/km at 850 nm

Key Industry Leading Milestones

1999	2003	2006	2010	2012
First shipment of what became OM3 fiber in 2002	First OM3 fiber with 10Gb/s over 550 m: MaxCap-OM4 fiber	First Bend-Insensitive Single-mode fiber: BendBright-XS	Bend-Insensitive OM2/OM2+/OM3/OM4 fiber: MaxCap-BB-OMx	Bend-Insensitive Chromatic Dispersion Compensating fiber: MaxCap-BB-OM4+

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MaxCap-BB-OM2 / OM2+ / OM3 / OM4 Multimode Fiber

Optical Specifications (uncabled fiber)

Attenuation				
Attenuation Coefficient @ 850 nm	≤ 2.3 to ≤ 2.4 dB/km			
Attenuation Coefficient @ 1300 nm	≤ 0.5 to ≤ 0.6 dB/km			
Aperture				
Numerical Aperture	0.200 ± 0.015			
Chromatic Dispersion				
Zero Dispersion Wavelength (λ_0)	1295 nm ≤ λ_0 ≤ 1340 nm			
Zero Dispersion Slope (S_0)				
1295 nm ≤ λ_0 ≤ 1310 nm	≤ 0.105 ps/(nm^2.km)			
1310 nm ≤ λ_0 ≤ 1340 nm	≤ 0.000375 (1590- λ_0) ps/(nm^2.km)			
Fiber Capacity				
	OM2	**OM2+**	**OM3**	**OM4**
40G BASE-SR4 /100G BASE-SR10	--	--	140 m[1]	170 m[1]
10G BASE-SR	83 m	150 m	300 m	550 m[1]
1G BASE-SR	600 m	750 m	1000 m	1100 m
Overfilled Modal Bandwidth (min.)				
850 nm	500 MHz.km	700 MHz.km	1500 MHz.km	3500 MHz.km
1300 nm	500 MHz.km	500 MHz.km	500 MHz.km	500 MHz.km
Effective Modal Bandwidth (EMB)(min.)				
10G BASE-SR	--	950 MHz.km	2000 MHz.km	4700 MHz.km
DMD				
See Note 2				
Bending Loss				
2 turns, Radius = 7.5 mm; 850 nm/ 1300 nm	≤ 0.2 / ≤ 0.5 dB			
2 turns, Radius = 15 mm; 850 nm/ 1300 nm	≤ 0.1 / ≤ 0.3 dB			
Backscatter Characteristics[3]				
Point Discontinuity[4] 850 nm, 1300 nm	≤ 0.1 dB			
Irregularities over fiber length 850 nm, 1300 nm	≤ 0.1 dB			
Reflections	Not Allowed			
Group Index of Refraction (Typical) 850 nm / 1300 nm	1.482 / 1.477			

[3] *OTDR measurement 0.5* µs pulse width
[4] *Mean of bi-directional measurement*

Geometrical Specifications

Glass Geometry	
Core Diameter	50 ± 2.5 µm
Core Non-Circularity	≤ 5 %
Core/Cladding Concentricity Error	≤ 1 µm
Cladding Diameter	125.0 ± 1.0 µm
Cladding Non-Circularity	≤ 0.7 %
Coating Geometry	
Coating Diameter	242 ± 5 µm
Coating Non-Circularity	≤ 5%
Coating/Cladding Concentricity Error	≤ 10 µm
Length	Standard lengths up to 8.8 km

Other lengths available on request

Mechanical Specifications

Proof Test (off line)	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged[5] and unaged	Median > 3.8 GPa (550 kpsi)
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged[5]	n_d > 25
Coating Performance	
Coating strip force unaged and aged[6]	
- Average strip force:	1 N to 3 N
- Peak strip force:	1.3 N to 8.9 N

[5] *Aging at 85°C, 85% RH, 30 days*

[6] Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C

Environmental Specifications

Environmental Test	Test Conditions	Induced attenuation at 850, 1300 nm (dB/km)
Attenuation		
Temperature Cycling	- 60°C to 85°C	≤ 0.1
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.1
Water Immersion	30 days; 23°C	≤ 0.1
Dry Heat	30 days; 85°C	≤ 0.1
Damp Heat	30 days; 85°C, 85% RH	≤ 0.1

1. Maximum cabled fiber attenuation 3.0 dB/km at 850 nm, maximum total connector loss of 1.0 dB and VCSELs maximum RMS spectral width of 0.29 nm (according to IEEE 10GbE model: http://grouper.ieee.org/groups/802/3/ae/public/adhoc/serial_pmd/documents/10GEPBud3_1_16a.xls).

2. DMD specifications are compliant with and more stringent than the requirements of IEC 60793-2-10 (type A1a.2 for OM3 and type A1a.3 for OM4), TIA-492AAAC (OM3) and 492AAAD (OM4).

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Corning® ClearCurve® Multimode Optical Fiber

Product Information

Bend Performance and Compatibility

Corning® ClearCurve® ultra-bendable, laser-optimized™ multimode optical fiber delivers enhanced macrobending performance while maintaining compatibility with current optical fibers, equipment, practices and procedures. ClearCurve® OM_2, OM_3 and OM_4 multimode fiber is designed to withstand tight bends and challenging cabling routes with substantially less signal loss than conventional multimode fiber.

Standards Compliance	ClearCurve® OM_4 fiber	ClearCurve® OM_3 fiber	ClearCurve® OM_2 fiber
ISO/IEC 11801	Type OM_4 fiber	Type OM_3 fiber	Type OM_2 fiber
IEC 60793-2-10	Type A1a.3 fiber	Type A1a.2 fiber	Type A1a.1 fiber
TIA/EIA	492AAAD	492AAAC-B	492AAAB-A
ITU	ITU G651.1	ITU G651.1	ITU G651.1

Optical Specifications

Bandwidth

	High Performance EMB* (MHz.km)	Overfilled Modal Bandwidth** (MHz.km)	
Corning Optical Fiber	**850 nm only**	**850 nm**	**1300 nm**
ClearCurve® OM_4 fiber	4700	3500	500
ClearCurve® OM_3 fiber	2000	1500	500
ClearCurve® OM_2 fiber	950	700	500

*Ensured via minEMBc, per ITA/EIA 455-220A and IEC 60793-1-49, for high performance laser-based systems.

** OFL BW, per TIA/EIA 455-204 and IEC 60793-1-41.

Attenuation

Wavelength (nm)	Maximum Value (dB/km)
850	≤2.3
1300	≤0.6

Macrobend Loss

Mandrel Radius (mm)	Number of Turns	Induced Attenuation (dB) 850 nm	1300 nm
15	2	≤0.1	≤0.3
7.5	2	≤0.2	≤0.5

No point discontinuity greater than 0.2 dB. Attenuation at 1380 nm does not exceed the attenuation at 1300 nm by more than 3.0 dB/km.

Numerical Aperture

0.200 ± 0.015

Dimensional Specifications

Glass Geometry

Core Diameter	50.0 ± 2.5 µm
Cladding Diameter	125.0 ± 1.0 µm
Core-Clad Concentricity	≤1.5 µm
Cladding Non-Circularity	≤1.0%
Core Non-Circularity	≤5%

Coating Geometry

Coating Diameter	242 ± 5 µm
Coating-Cladding Concentricity	< 12 µm

How to Order

Contact your sales representative, or call the Optical Fiber Customer Service Department.

Please specify the fiber type, attenuation, and quantity when ordering.

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Corning® ClearCurve® Multimode Optical Fiber

Environmental Specifications

Environmental Test	Test Condition	Induced Attenuation 850 & 1300 nm (dB/km)
Temperature Dependence	-60°C to +85°C*	≤0.10
Temperature Humidity Cycling	-10°C to +85°C and 4% to 98% RH	≤0.10
Water Immersion	23°C ± 2°C	≤0.20
Heat Aging	85°C ± 2°C	≤0.20
Damp Heat	85°C at 85% RH	≤0.20

*Reference temperature = +23ºC
Operating Temperature Range: -60ºC to +85ºC

Mechanical Specification

Proof Test

The entire fiber length is subjected to a tensile stress ≥100 kpsi (0.69 GPa).*

*Higher proof test levels available

Length

Fiber lengths available up to 17.6 km/spool.

Performance Characterizations

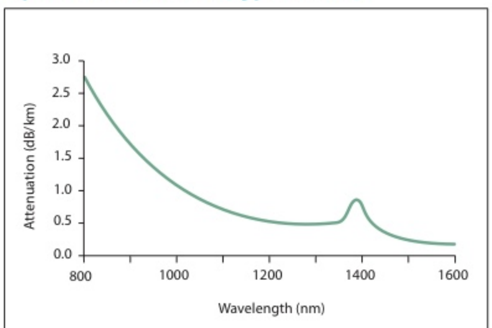
Characterized parameters are typical values.

Refractive Index Difference	1%
Effective Group Index of Refraction (N_{eff})	850 nm: 1.482 1300 nm: 1.477
Fatigue Resistance Parameter (N_d)	20
Coating Strip Force	Dry: 0.6 lbs (2.7 N) Wet, 14 days in 23°C water soak: 0.6 lbs (2.7 N)

Chromatic Dispersion

Zero Dispersion Wavelength (λ_0): 1295 nm ≤ λ_0 ≤ 1315 nm
Zero Dispersion Slope (S_0): ≤ 0.101 ps/(nm^2*km)

Spectral Attenuation (Typical Fiber)



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Draka

A brand of the Prysmian Group

Multimode Fiber

MaxCap-BB-OM4 Plus Multimode Fiber

Bend-Insensitive 40 &100 Gb/s (Chromatic Dispersion Compensating (CDC) Fiber)

Bend-insensitive 850 nm laser-optimized 50 µm MaxCap-OM4-Plus multimode fiber for 40 and 100 Gb/s applications.

A new Draka 850 nm laser-optimized 50 µm bend-insensitive MaxCap-OM4-Plus multimode fiber has been designed on top of Draka's already robust OM4 multimode fiber family. This fiber further optimizes the overall dispersion in VCSEL launched multimode fiber systems, not only taking care of traditional modal dispersion, but also compensating chromatic dispersion introduced by selective coupling of transverse VCSEL modes (operating at different wavelength) into fiber modes. So far IEEE does not take care of this Modal and Chromatic Dispersion Interaction (MCDI), but with increasing line speeds (e.g. to 25 Gb/s) and longer distances (>150m), this interaction cannot be ignored anymore. The overall dispersion behavior of this new fiber is defined by a new parameter: EB (Effective Bandwidth), a combination of modal bandwidth (EMB) and chromatic bandwidth, see: D. Molin, et al., "Chromatic Dispersion Compensated Multimode Fibers for Data Communications", ECOC 2011.

The outstanding bending performance of this bend-insensitive fiber combines improved fiber & cable management with superior bandwidth for 40 Gb/s and (future) 100 Gb/s system applications (e.g. 25 Gb/s line speeds) for extended reach.

Standards references : The MaxCap-BB-OM4-Plus multimode fibers entirely comply with or exceed IEC 60793-2-10 type A1a.3 Optical Fiber Specification, ISO/IEC 11801 OM4 specification, TIA/EIA-492AAAD detail specification and Telcordia GR-20-CORE and GR-409-CORE specifications.

Features	Advantages
MaxCap-BB-OM4-Plus multimode fibers optimize both modal as well as chromatic dispersion	• For higher bit rate & longer distances chromatic dispersion cannot be ignored anymore. MaxCap-BB-OM4-Plus multimode fibers offer the unique advantage in optimizing modal and chromatic dispersion influences when used with typical 850nm VCSEL sources
MaxCap-BB-OM4-Plus multimode fibers show very low bending sensitivity	• MaxCap-BB-OM4-Plus multimode fibers allow the use of smaller, high density fiber management systems in space limited data centres, computer rooms and LANs, improving overall system network reliability (uptime)
MaxCap-BB-OM4-Plus multimode fibers are characterized by the well known EMB parameter for modal dispersion and a new EB parameter for combined chromatic and modal dispersion	• MaxCap-BB-OM4-Plus multimode fibers offer increased robustness for higher speed links (e.g. 25 Gb/s) and longer reach (e.g. increasing the max. distance with several tens of meters)
MaxCap-BB-OM4-Plus multimode fibers are coated with the dual layer UV Acrylate	• MaxCap-BB-OM4-Plus multimode fibers show excellent micro-bending behaviour, which results in easy cabling and and installation, supporting a max. cabled attenuation of 3.0 dB/km at 850 nm

Key Industry Leading Milestones

1999 — First shipment of what became OM3 fiber in 2002

2003 — First OM3 fiber with 10Gb/s over 550 m: MaxCap-OM4 fiber

2006 — First Bend-Insensitive Single-mode fiber: BendBright-XS

2010 — Bend-Insensitive OM2/OM2+/OM3/OM4 fiber: MaxCap-BB-OMx

2012 — Bend-Insensitive Chromatic Dispersion Compensating fiber: MaxCap-BB-OM4+

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A brand of the Prysmian Group

MaxCap-BB-OM4 Plus Multimode Fiber

Optical Specifications (uncabled fiber)

Attenuation	
Attenuation Coefficient @ 850 nm	≤ 2.3 to ≤ 2.4 dB/km
Attenuation Coefficient @ 1300 nm	≤ 0.5 to ≤ 0.6 dB/km
Aperture	
Numerical Aperture	0.200 ± 0.015
Chromatic Dispersion	
Zero Dispersion Wavelength (λ_0)	1295 nm ≤ λ_0 ≤ 1340 nm
Zero Dispersion Slope (S_0)	
1295 nm ≤ λ_0 ≤ 1310 nm	≤ 0.105 ps/(nm^2.km)
1310 nm ≤ λ_0 ≤ 1340 nm	≤ 0.000375 (1590- λ_0) ps/(nm^2.km)
Fiber Capacity	
40G BASE-SR4 /100G BASE-SR10	200 m [1, 2]
10G BASE-SR	600 m [1, 2]
1G BASE-SR	1200 m [2]
Overfilled Modal Bandwidth (min.)	
850 nm	3500 MHz.km
1300 nm	500 MHz.km
Effective Modal Bandwidth (EMB)(min.)	
850 nm	4700 MHz.km
Effective Bandwidth (EB[3])(min.)	
850 nm	5000 MHz.km
Bending Loss	
2 turns, Radius = 7.5 mm; 850 nm, 1300 nm	≤ 0.2 / ≤ 0.5 dB
2 turns, Radius = 15 mm; 850 nm, 1300 nm	≤ 0.1 / ≤ 0.3 dB
Backscatter Characteristics[2]	
Point Discontinuity[3] 850 nm, 1300 nm	≤ 0.1 dB
Irregularities over fiber length 850 nm, 1300 nm	≤ 0.1 dB
Reflections	Not Allowed
Group Index of Refraction (Typical)	
850 nm	1.482
1300 nm	1.477

Geometrical Specifications

Glass Geometry	
Core Diameter	50 ± 2.5 µm
Core Non-Circularity	≤ 5 %
Core/Cladding Concentricity Error	≤ 1 µm
Cladding Diameter	125.0 ± 1.0 µm
Cladding Non-Circularity	≤ 0.7 %
Coating Geometry	
Coating Diameter	242 ± 5 µm
Coating Non-Circularity	≤ 5%
Coating/Cladding Concentricity Error	≤ 10 µm
Length	Standard lengths up to 8.8 km
Other lengths available on request	

Mechanical Specifications

Proof Test (off line)	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged[5] and unaged	Median > 3.8 GPa (550 kpsi)
[5]Aging at 85°C, 85% RH, 30 days	
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged[5]	n_d > 25
Coating Performance	
Coating strip force unaged and aged[4]	
- Average strip force:	1 N to 3 N
- Peak strip force:	1.3 N to 8.9 N

[4]Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C

Environmental Specifications

Environmental Test	Test Conditions	Induced attenuation at 850, 1300 nm (dB/km)
Attenuation		
Temperature Cycling	- 60°C to 85°C	≤ 0.1
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.1
Water Immersion	30 days; 23°C	≤ 0.1
Dry Heat	30 days; 85°C	≤ 0.1
Damp Heat	30 days; 85°C, 85% RH	≤ 0.1

1). The modal bandwidth is linearly normalized to 1 km, according to IEC 60793-2-10.

2). OTDR measurement with 0.5)s pulse width.

3). Mean of bi-directional measurement.

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A brand of the Prysmian Group

Multimode Fiber

WideCap-OM5 Multimode Fiber

Fiber optimized for multi-wavelength systems

Bend insensitive Laser-Optimized 50 µm WideCap-OM5 Multimode Fiber for multi-wavelength systems.

WideCap-OM5 multimode fiber delivers OM5 performance in the 850-950 nm window while maintaining compatibility with current multimode fibers. Traditional OM4 fibers offer high bandwidth in a narrow band centred at 850nm. To satisfy the exponentially increasing information demand in Data Centers, the capacity of WideCap-OM5 has been extended to longer wavelengths up to 950 nm. WideCap-OM5 and multi-wavelength transceivers are a viable solution for future 100 and 400 Gbps multi-wavelength systems. WideCap-OM5 incorporates BendBright® technology to withstand tight bends and cabling challenges in the data center.

Standards references :
WideCap-OM5 comply with or exceed IEC 60793-2-10 type A1a.3 Optical Fiber Specification, ISO/IEC 11801 OM5 specification, TIA/EIA-492AAAD detail specification and Telcordia GR-20-CORE and GR-409-CORE specifications.

Features	Advantages
WideCap-OM5 multimode fiber optimized for z multi-wavelength systems	• WideCap-OM5 has been designed for high performance data centers, and future-proof the advent of multi-wavelength transceivers at 40/100/400 Gbps
WideCap-OM5 offers OM4 capacity in the 850-950 nm window	• WideCap-OM5 offers OM4 quality performance at 850 nm and longer wavelengths, supporting up to four 25 Gbps channels in the 850-950 window
WideCap-OM5 with BendBright® technology to deliver enhanced macrobending performance	• WideCap-OM5 allows the use of smaller, high density fiber management systems in space limited data centers, computer rooms and LANs, improving overall system network reliability

Key Industry Leading Milestones

1999	2003	2010	2012	2014
Introduction of MaxCap150 (now MaxCap-OM3)	Prysmian group drives the advacement of MMF and introduces MaxCap550 (now MaxCap-OM4	Introduction of Bend-Insensitive OM2/OM3/OM4 fiber: MaxCap-BB-OMx	Introduction of MaxCap-BB-OM4+ optimized for data centers and offering extended reach	WideCap-OM4 First OM4 optimized for multi-wavelength systems

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Draka

A brand of the Prysmian Group

WideCap-OM5 Multimode Fiber

Optical Specifications

Attenuation	
Attenuation Coefficient @ 850 nm	≤ 2.3 to ≤ 2.4 dB/km
Attenuation Coefficient @ 1300 nm	≤ 0.5 to ≤ 0.6 dB/km
Aperture	
Numerical Aperture	0.200 ± 0.015
Chromatic Dispersion	
Zero Dispersion Wavelength (λ_0)	1295 nm ≤ λ_0 ≤ 1340 nm
Zero Dispersion Slope (S_0)	
1295 nm ≤ λ_0 ≤ 1310 nm	≤ 0.105 ps/(nm²·km)
1310 nm ≤ λ_0 ≤ 1340 nm	≤ 0.000375 (1590- λ_0) ps/(nm²·km)
Fiber Capacity	
40 Gbps Multi-Wavelegth Transceivers	150 m [1]
10G BASE-SR4 / 100 G BASE-SR10	200 m [1]
10G BASE-SR	600 m [1]
Overfilled Modal Bandwidth	
850 nm	3500 MHz.km
1300 nm	500 MHz.km
Effective Modal Bandwidth (EMB)	
850 nm	4700 MHz.km
Effective Modal Bandwidth Equivalent[2]	
875 nm, 900 nm, 925 nm, & 950 nm	4700 MHz.km
Bending Loss	
2 turns, Radius = 7.5 mm; 850 nm, 1300 nm	≤ 0.2 / ≤ 0.5 dB
2 turns, Radius = 15 mm; 850 nm, 1300 nm	≤ 0.1 / ≤ 0.3 dB
Backscatter Characteristics[3]	
Point Discontinuity[4] 850 nm, 1300 nm	≤ 0.1 dB
Irregularities over fiber length 850 nm, 1300 nm	≤ 0.1 dB
Reflections	Not Allowed
Group Index of Refraction (Typical) 850 nm / 1300 nm	1.482 / 1.477

Geometrical Specifications

Glass Geometry	
Core Diameter	50 ± 2.5 µm
Core Non-Circularity	≤ 5 %
Core/Cladding Concentricity Error	≤ 1 µm
Cladding Diameter	125.0 ± 1.0 µm
Cladding Non-Circularity	≤ 0.7 %
Coating Geometry	
Coating Diameter	242 ± 5 µm
Coating Non-Circularity	≤ 5%
Coating/Cladding Concentricity Error	≤ 10 µm
Length	Standard lengths up to 8.8 km
Other lengths available on request	

Mechanical Specifications

Proof Test	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged[5] and unaged	Median > 3.8 GPa (550 kpsi)
[5]Aging at 85°C, 85% RH, 30 days	
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged[5]	n_d > 25
Coating Performance	
Coating strip force unaged and aged[6]	
- Average strip force:	1 N to 3 N
- Peak strip force:	1.3 N to 8.9 N
[6]Aging:	• 0°C and 45°C • 30 days at 85°C and 85% RH • 14 days water immersion at 23°C

Environmental Specifications

Attenuation		
Environmental Test	**Test Conditions**	**Induced attenuation at 850, 1300 nm (dB/km)**
Temperature Cycling	- 60°C to 85°C	≤ 0.1
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.1
Water Immersion	30 days; 23°C	≤ 0.1
Dry Heat	30 days; 85°C	≤ 0.1
Damp Heat	30 days; 85°C, 85% RH	≤ 0.1

1) For maximum cabled fiber attenuation of 3.0 dB/km at 850 nm, a maximum total connector loss of 1.0 dB

2) EMB equivalent has been defined to meet equivalent 850 nm OM4 performance at the wavelengths listed on the table. Takes into account the effect of chromatic dispersion on bandwidth at longer wavelengths

3) OTDR measurement with 0.5 µs pulse width

4) Mean of bi-directional measurement

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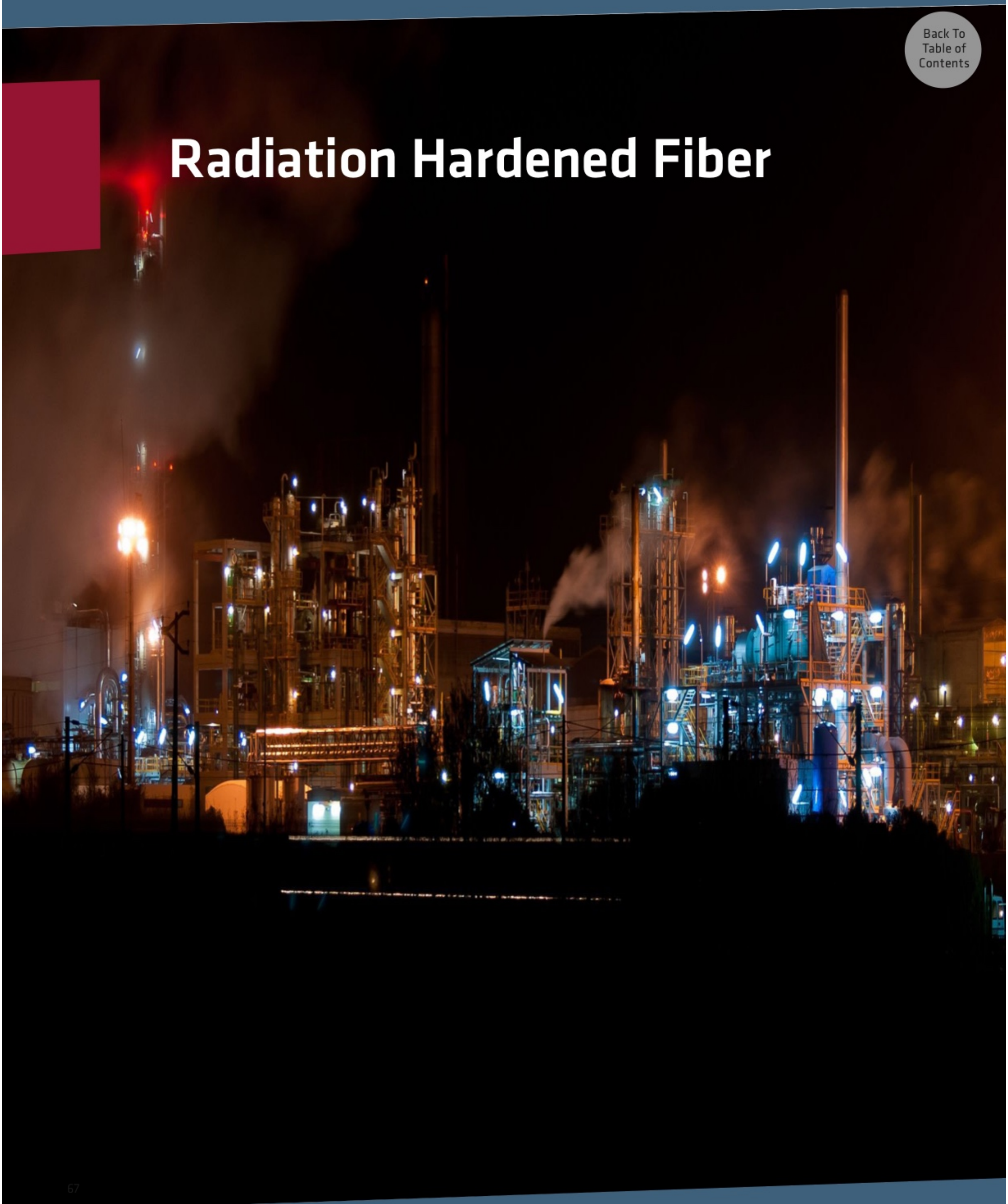
Radiation Hardened Fiber



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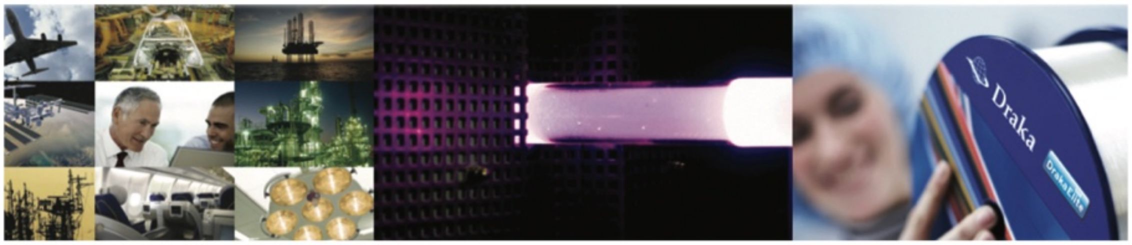
Radiation Hardened Fiber

A brand of the Prysmian Group

Single-Mode Fiber

RadHard Single-Mode Fiber (MIL-PRF-49291-7)

Radiation hardened SMF for irradiative environments



This DrakaElite™ RadHard Single-Mode Fiber (SMF) can be used for high irradiative environments (e.g. gamma rays, X-flash, neutrons protons) up to a dose of about 10 kGy. For extreme irradiative environments (some MGy dose) DrakaElite™ Super RadHard SMF is recommended.
Note: 1 Gy = 100 Rad.

This Germanium-doped RadHard SMF has been qualified and approved by the U.S. Defense Supply Center, Columbus (DSCC) in accordance with the U.S. Military MIL-PRF-49291/7 specification. (Note: 500 µm coating is not qualified).

Because Radiation Induced Attenuation (RIA) is a strong function of time after dose, dose rate, temperature, system operational wavelength, and system operational power, assessing the RIA performance of fibers should be conducted as close to conditions in the final application as possible.

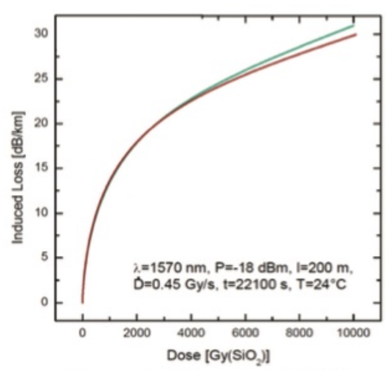
The DrakaElite™ RadHard SMF can be used in all cable constructions, including loose tube, tight buffered, ribbon and central tube designs. This fiber complies with or exceeds ITU-T Recommendation G.652.D, IEC 60793-2-50 category B1.3 Optical Fiber Specification and Telcordia GR-20-Core.

Prysmian Group' fiber plant Draka Comteq Fiber B.V. in Eindhoven, Netherlands, is MIL-STD-790 certified.

Features	Advantages
RadHard behavior	• Suitable for medium irradiative environments
Coated with the dual layer UV Acrylate	• Optimized performance in tight-buffer cable applications

Steady state gamma irradiation test conditions – MIL 49291-7		
Temperature	Dose Rate	Total Dose
- 28°C / 25°C / 85°C	0.50 Gy/s (SiO2)	Classified

Irradiation test requirements – MIL 49291-7		
Max. Induced Attenuation @1310nm	Attenuation At Specified Recovery Time	Specified Recovery Time
< 50 dB/km (Total dose classified)	< 15 @ -28 °C < 5 @ 25 °C < 5 @ 85 °C	1000 s



RIA reproducibility for Draka RH-SMFs (5 years difference in production date at 1570 nm; dose rate 0.45 Gy/s

DrakaElite

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Draka

A brand of the Prysmian Group

RadHard Single-Mode Fiber (MIL-PRF-49291-7)

Optical Specifications (uncabled Fiber)

Attenuation	
Attenuation Coefficient @ 1310 nm	≤ 0, 4 dB/km
Attenuation Coefficient @ 1385 nm	≤ 0, 4 dB/km
Attenuation Coefficient @ 1550 nm	≤ 0.3 dB/km
Backscatter Characteristics	
Point Discontinuity	
850 nm, 1300 nm	≤ 0.05 dB
Bending Loss	
100 turns, Radius = 38 mm; 1310 nm	≤ 0.1 dB
100 turns, Radius = 38 mm; 1550 nm	≤ 1.0 dB
Cutoff Wavelength	
Cable Cutoff Wavelength (λccf)	≤ 1260 nm
Mode Field Diameter	
Wavelength (nm)	MFD (μm)
1310 nm	9.0 ± 0.4
1550 nm	10.1 ± 0.5
Chromatic Dispersion	
1310 nm	< 3.2 ps/(nm.km)
1550 nm	< 22 ps/(nm.km)
Group Index of Refraction (Typical)	
1310 nm	1.467
1550 nm	1.468

Geometrical Specifications

Glass Geometry	
Cladding Diameter	125.0 ± 1.0 μm
Core/Cladding Concentricity Error	≤ 0.6 μm
Cladding Non-Circularity	≤ 1.0 %
Coating Geometry	
Coating Diameter	M49291/7-01 | 242 ± 10 μm M49291/7-02 | 500 ± 15 μm
Coating Non-Circularity	M49291/7-01 | ≤ 5 % M49291/7-02 | ≤ 5 %
Coating/Cladding Concentricity Error	M49291/7-01 | ≤ 10 μm M49291/7-02 | ≤ 20 μm
Standard Length	M49291/7-01 | 2.2 - 8.8 km M49291/7-02 | 1.1 - 6.6 km

Mechanical Specifications

Proof Test (offline)	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged** and unaged	Median > 3.8 GPa (550 kpsi)
*** Aging at 85°C, 85% RH, 30 days*	
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged**	$n_d > 18$
Coating Performance	
Coating strip force unaged and aged***	
- Average strip force:	M49291/7-01 | 1 N to 3 N M49291/7-02 | Not Spec.
- Peak strip force:	M49291/7-01 | 1.8 N to 13.2 N M49291/7-02 | 1.8 N to 20 N
*** Aging:	• 0°C and 45°C • 30 days at 85°C and 85% RH • 14 days water immersion at 23°C

Environmental Specifications

Environmental Test	Test Conditions	Induced attenuation at 850, 1300 nm (dB/km)
Attenuation		
Temperature Cycling	- 60°C to 85°C	≤ 0.05
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.05
Water Immersion	30 days; 23°C	≤ 0.05
Dry Heat	30 days; 85°C	≤ 0.05
Damp Heat	30 days; 85°C, 85% RH	≤ 0.05
Operating Temperature Range		-46°C to +85°C
Non-Operating Temperature + Storage Temperature Range		-55°C to +85°C

Typical Radiation Induced Attenuation (RIA)

Radiation Induced Attenuation	Dose: 10 KGy; Dose rate: 0.45 Gy/s; T=24°C; 1570 nm	~3 dB/100 m

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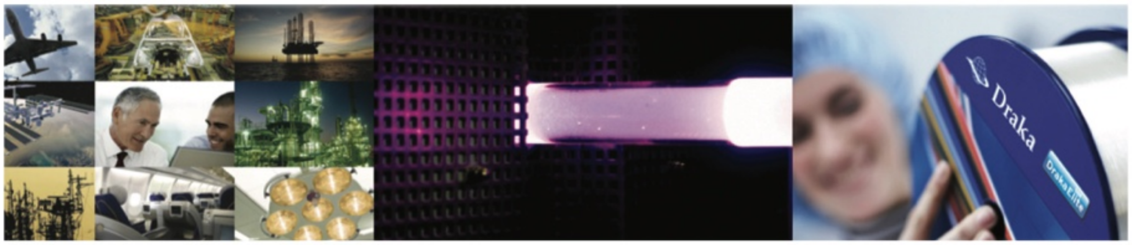
A brand of the Prysmian Group

Draka

Multimode Fiber

RadHard 62.5/125 µm Multimode Fiber (MIL-PRF-49291/6)

Radiation hardened 62.5 µm MMF for irradiative environments



This DrakaElite™ RadHard 62.5 µm core diameter multimode fiber (MMF) can be used for high irradiative environments (e.g. gamma rays, X-flash, neutrons protons) up to a dose of about 10 kGy. For extreme irradiative environments (some MGy dose) DrakaElite™ Super RadHard 50 µm core diameter MMF is recommended.

Note: 1 Gy = 100 Rad.

This Germanium-doped 62.5 µm core diameter RadHard MMF has been qualified and approved by the U.S. Defense Supply Center, Columbus (DSCC) in accordance with the U.S. Military MIL-PRF-49291/6 specification.

Because Radiation Induced Attenuation (RIA) is a strong function of time after dose, dose rate, temperature, system operational wavelength, and system operational power, assessing the RIA performance of fibers should be conducted as close to conditions in the final application as possible.

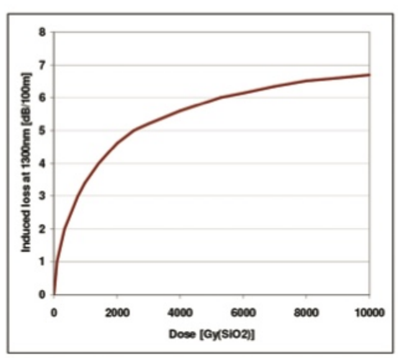
The DrakaElite™ 62.5 µm core diameter RadHard MMF can be used in all cable constructions, including loose tube, tight buffered, ribbon and central tube designs. This fiber complies with or exceeds IEC 60793-2-10 category A1b Optical Fiber Specification, TIA-492AAAA and Telcordia GR-20-Core.

Prysmian Group' fiber plant Draka Comteq Fibre B.V. in Eindhoven, Netherlands, is MIL-STD-790 certified.

Features	Advantages
RadHard behavior	• Suitable for medium irradiative environments
Coated with the dual layer UV Acrylate	• Optimized performance in tight-buffer cable applications

Steady state gamma irradiation test conditions – MIL 49291-6		
Temperature	**Dose Rate**	**Total Dose**
- 28°C / 25°C / 85°C	0.50 Gy/s (SiO2)	Classified

Irradiation test requirements – MIL 49291-6		
Max. Induced Attenuation @1310nm	**Attenuation At Specified Recovery Time**	**Specified Recovery Time**
< 50 dB/km (Total dose classified)	< 15 @ -28 °C < 5 @ 25 °C < 5 @ 85 °C	1000 s



Typical RIA for Draka RH 62.5 µm MMF at 1300nm; dose rate 1.67Gy/s, T=28 C

DrakaElite

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Draka

A brand of the Prysmian Group

RadHard 62.5/125 µm Multimode Fiber (MIL-PRF-49291/6)

Optical Specifications (uncabled Fiber)

Attenuation	
Attenuation Coefficient @ 850 nm	≤ 3.0 dB/km
Attenuation Coefficient @ 1300 nm	≤ 0.7 dB/km
Overfilled Modal Bandwidth (min.)[1]	
850 nm	300 MHz.km
1300 nm	600 MHz.km
RML Bandwidth (min.)[1]	
850 nm	385 MHz.km
1300 nm	700 MHz.km
Aperture	
Numerical Aperture	0.275 ± 0.015
Chromatic Dispersion	
Zero Dispersion Wavelength (λ_0)	1320 nm ≤ λ_0 ≤ 1365 nm
Zero Dispersion Slope (S_0)	
1320 nm ≤ λ_0 ≤ 1348 nm	≤ 0.11 ps/(nm².km)
1348 nm ≤ λ_0 ≤ 1365 nm	≤ 0.001 (1458- λ_0) ps/(nm².km)
Bending Loss	
100 turns, Radius = 75 mm; 1300 nm	≤ 0.5 dB
Backscatter Characteristics**	
Point Discontinuity*** 850 nm, 1300 nm	≤ 0.1 dB
Irregularities Over Fiber Length 850 nm, 1300 nm	≤ 0.1 dB
Reflections	Not Allowed
Group Index of Refraction (Typical) 850 nm 1300 nm	 1.496 1.491

*** OTDR measurement 0.5 µs pulse width*
**** mean of bi-directional measurement*

Geometrical Specifications

Glass Geometry	
Core Diameter	62.5 ± 2.5 µm
Core Non-Circularity	≤ 5 %
Core/Cladding Concentricity Error	≤ 1 µm
Cladding Diameter	125.0 ± 1.0 µm
Cladding Non-Circularity	≤ 0.7 %
Coating Geometry	
Coating Diameter	M49291/6-03 | 242 ± 10 µm M49291/6-05 | 500 ± 15 µm
Coating Non-Circularity	M49291/6-03 | ≤ 5 % M49291/6-05 | ≤ 5 %
Coating/Cladding Concentricity Error	M49291/6-03 | ≤ 10 µm M49291/6-05 | ≤ 20 µm
Standard Length	M49291/6-03 | 2.2 - 8.8 km M49291/6-05 | 1.1 - 6.6 km

Mechanical Specifications

Proof Test (offline)	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged** and unaged	Median > 3.8 GPa (550 kpsi)
*** Aging at 85°C, 85% RH, 30 days*	
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged**	n_d > 18
Coating Performance	
Coating strip force unaged and aged***	
- Average strip force:	M49291/6-03 | 1 N to 3 N M49291/6-05 | Not Spec.
- Peak strip force:	M49291/6-03 | 1.8 N to 13.2 N M49291/6-05 | 1.8 N to 20 N

*** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C

Environmental Specifications

Environmental Test	Test Conditions	Induced attenuation at 850, 1300 nm (dB/km)
Attenuation		
Temperature Cycling	- 60°C to 85°C	≤ 0.2
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.2
Water Immersion	30 days; 23°C	≤ 0.2
Dry Heat	30 days; 85°C	≤ 0.2
Damp Heat	30 days; 85°C, 85% RH	≤ 0.2
Operating Temperature Range		-55°C to +85°C
Non-Operating Temperature + Storage Temperature Range		-62°C to +85°C

Typical Radiation Induced Attenuation (RIA)

Radiation Induced Attenuation	Dose: 10 KGy; Dose rate: 1.67 Gy/s; T=28°C; 1300 nm	~7 dB/100 m

1). The modal bandwidth is linearly normalized to 1 km, according to IEC 60793-2-10.

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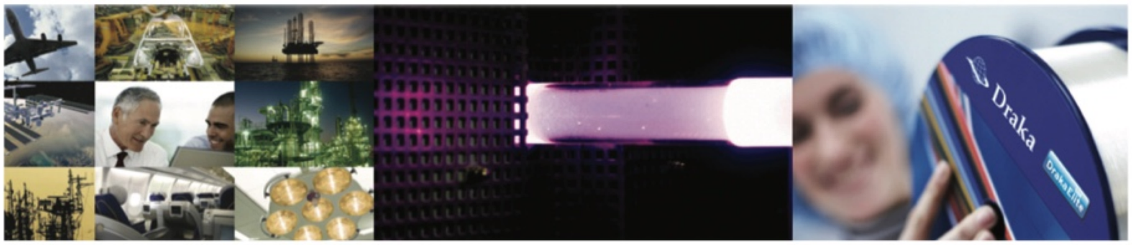
A brand of the Prysmian Group

Multimode Fiber

RadHard 62.5/125 µm Multimode Fiber (Non-MIL-Qualified)

Radiation hardened 62.5 µm MMF for irradiative environments



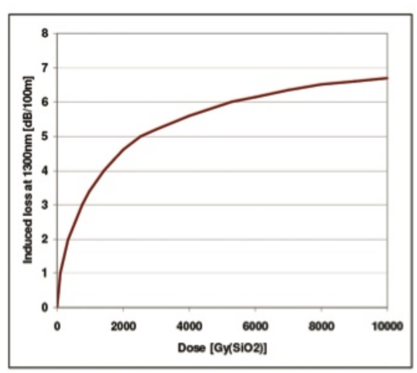
This DrakaElite™ RadHard 62.5 µm core diameter multimode fiber (MMF) can be used for high irradiative environments (e.g. gamma rays, X-flash, neutrons protons) up to a dose of about 10 kGy. For extreme irradiative environments (some MGy dose) DrakaElite™ Super RadHard 50 µm core diameter MMF is recommended.

Note: 1 Gy = 100 Rad.

Because Radiation Induced Attenuation (RIA) is a strong function of time after dose, dose rate, temperature, system operational wavelength, and system operational power, assessing the RIA performance of fibers should be conducted as close to conditions in the final application as possible.

The DrakaElite™ 62.5 µm core diameter RadHard MMF can be used in all cable constructions, including loose tube, tight buffered, ribbon and central tube designs. This fiber complies with or exceeds IEC 60793-2-10 category A1b Optical Fiber Specification, TIA-492AAAA and Telcordia GR-20-Core.

Features	Advantages
RadHard behavior	• Suitable for medium irradiative environments
Coated with the dual layer UV Acrylate	• Optimized performance in tight-buffer cable applications



Typical RIA for Draka RH 62.5 µm MMF at 1300 nm; dose rate 1.67 Gy/s, T=28 C

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RadHard 62.5/125 μm Multimode Fiber (Non-MIL-Qualified)

Optical Specifications (uncabled Fiber)

Attenuation	
Attenuation Coefficient @ 850 nm	≤ 3.0 dB/km
Attenuation Coefficient @ 1300 nm	≤ 0.7 dB/km
Overfilled Modal Bandwidth (min.)[1]	
850 nm	200 MHz.km
1300 nm	600 MHz.km
Aperture	
Numerical Aperture	0.275 ± 0.015
Chromatic Dispersion	
Zero Dispersion Wavelength (λ_0)	1320 nm ≤ λ_0 ≤ 1365 nm
Zero Dispersion Slope (S_0)	
1320 nm ≤ λ_0 ≤ 1348 nm	≤ 0.11 ps/(nm^2.km)
1348 nm ≤ λ_0 ≤ 1365 nm	≤ 0.001 (1458- λ_0) ps/(nm^2.km)
Bending Loss	
100 turns, Radius = 75 mm; 850 nm / 1300 nm	≤ 0.5 dB
Backscatter Characteristics**	
Point Discontinuity***	
850 nm, 1300 nm	≤ 0.1 dB
Irregularities Over Fiber Length 850 nm, 1300 nm	≤ 0.1 dB
Reflections	Not Allowed
Group Index of Refraction (Typical) 850 nm 1300 nm	 1.496 1.491

*** OTDR measurement 0.5 μs pulse width*
**** mean of bi-directional measurement*

Geometrical Specifications

Glass Geometry	
Core Diameter	62.5 ± 2.5 μm
Core Non-Circularity	≤ 5 %
Core/Cladding Concentricity Error	≤ 1 μm
Cladding Diameter	125.0 ± 1.0 μm
Cladding Non-Circularity	≤ 0.7 %
Coating Geometry	
Coating Diameter	242 ± 10 μm
Coating Non-Circularity	≤ 5 %
Coating/Cladding Concentricity Error	≤ 10 μm
Standard Length	2.2 - 8.8 km

Mechanical Specifications

Proof Test (offline)	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged** and unaged	Median > 3.8 GPa (550 kpsi)
*** Aging at 85°C, 85% RH, 30 days*	
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged**	n_d > 18
Coating Performance	
Coating strip force unaged and aged***	
- Average strip force:	1 N to 3 N
- Peak strip force:	1.2 N to 8.9 N

*** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C

Environmental Specifications

Environmental Test	Test Conditions	Induced attenuation at 850, 1300 nm (dB/km)
Attenuation		
Temperature Cycling	- 60°C to 85°C	≤ 0.2
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.2
Water Immersion	30 days; 23°C	≤ 0.2
Dry Heat	30 days; 85°C	≤ 0.2
Damp Heat	30 days; 85°C, 85% RH	≤ 0.2
Operating Temperature Range		-55°C to +85°C
Non-Operating Temperature + Storage Temperature Range		-62°C to +85°C

Typical Radiation Induced Attenuation (RIA)

Radiation Induced Attenuation	Dose: 10 KGy; Dose rate: 1.67 Gy/s; T=28°C; 1300 nm	~7 dB/100 m

1). The modal bandwidth is linearly normalized to 1 km, according to IEC 60793-2-10.

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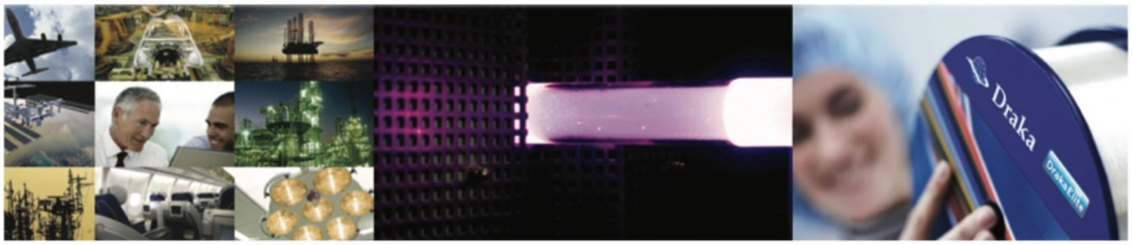
A brand of the Prysmian Group

Multimode Fiber

RadHard 50 µm OM2 Multimode Fiber (MIL-PRF-49291/1)

Radiation hardened 50 µm MMF for irradiative environments



This DrakaElite™ RadHard 50 µm core diameter multimode fiber (MMF) can be used for high irradiative environments (e.g. gamma rays, X-flash, neutrons protons) up to a dose of about 10 kGy. For extreme irradiative environments (some MGy dose) DrakaElite™ RadHard 50 µm core diameter MMF is recommended.

Note: 1 Gy = 100 Rad.

This Germanium-doped 50 µm core diameter RadHard MMF has been qualified and approved by the U.S. Defense Supply Center, Columbus (DSCC) in accordance with the U.S. Military MIL-PRF-49291/1.

Because Radiation Induced Attenuation (RIA) is a strong function of time after dose, dose rate, temperature, system operational wavelength, and system operational power, assessing the RIA performance of different fibers should be conducted as close to conditions in the final application as possible.

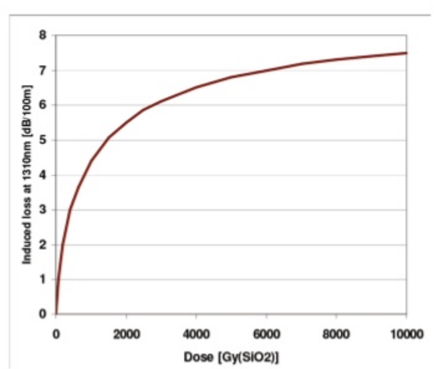
The DrakaElite™ 50 µm core diameter RadHard MMF can be used in all cable constructions, including loose tube, tight buffered, ribbon and central tube designs. This fibre complies with or exceeds IEC 60793-2-10 category A1a.1 Optical Fiber Specification, TIA-492AAAB and Telcordia GR-20-Core.

Prysmian Group' fiber plant Draka Comteq Fibre B.V. in Eindhoven , Netherlands, is MIL-STD-790 certified.

Features	Advantages
RadHard behavior	• Suitable for medium irradiative environments
Coated with the dual layer UV Acrylate	• Optimized performance in tight-buffer cable applications

Steady state gamma irradiation test conditions – MIL 49291-1		
Temperature	Dose Rate	Total Dose
- 28°C / 25°C / 85°C	0.50 Gy/s (SiO2)	Classified

Irradiation test requirements – MIL 49291-1		
Max. Induced Attenuation @1310nm	Attenuation At Specified Recovery Time	Specified Recovery Time
< 50 dB/km (Total dose classified)	< 15 @ -28 °C < 5 @ 25 °C < 5 @ 85 °C	1000 s



Typical RIA for Draka RH 50 µm MMF at 1300 nm; dose rate 1.67 Gy/s, T=28 C

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Draka

A brand of the Prysmian Group

RadHard 50 µm OM2 Multimode Fiber (MIL-PRF-49291/1)

Optical Specifications (uncabled Fiber)

Attenuation	
Attenuation Coefficient @ 850 nm	≤ 2.4 dB/km
Attenuation Coefficient @ 1300 nm	≤ 0.6 dB/km
Overfilled Modal Bandwidth (min.)[1]	
850 nm	500 MHz.km
1300 nm	500 MHz.km
Aperture	
Numerical Aperture	0.200 ± 0.015
Chromatic Dispersion	
Zero Dispersion Wavelength (λ_0)	1295 nm ≤ λ_0 ≤ 1340 nm
Zero Dispersion Slope (S_0)	
1295 nm ≤ λ_0 ≤ 1310 nm	≤ 0.105 ps/(nm^2.km)
1310 nm ≤ λ_0 ≤ 1340 nm	≤ 0.000375 (1590- λ_0) ps/(nm^2.km)
Bending Loss	
100 turns, Radius = 75 mm; 850 nm /1300 nm	≤ 0.5 dB
Backscatter Characteristics**	
Point Discontinuity***	
850 nm, 1300 nm	≤ 0.1 dB
Irregularities Over Fiber Length 850 nm, 1300 nm	≤ 0.1 dB
Reflections	Not Allowed
Group Index of Refraction (Typical) 850 nm 1300 nm	 1.482 1.477

*** OTDR measurement 0.5 µs pulse width*
**** mean of bi-directional measurement*

Geometrical Specifications

Glass Geometry	
Core Diameter	50 ± 2.5 µm
Core Non-Circularity	≤ 5 %
Core/Cladding Concentricity Error	≤ 1 µm
Cladding Diameter	125.0 ± 1.0 µm
Cladding Non-Circularity	≤ 0.7 %
Coating Geometry	
Coating Diameter	M49291/1-01 | 242 ± 10 µm M49291/1-02 | 500 ± 15 µm
Coating Non-Circularity	M49291/1-01 | ≤ 5 % M49291/2-02 | ≤ 5 %
Coating/Cladding Concentricity Error	M49291/1-01 | ≤ 10 µm M49291/1-02 | ≤ 20 µm
Standard Length	M49291/1-01 | 2.2 - 8.8 km M49291/1-02 | 1.1 - 6.6 km

Mechanical Specifications

Proof Test (offline)	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged** and unaged	Median > 3.8 GPa (550 kpsi)
*** Aging at 85°C, 85% RH, 30 days*	
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged**	n_d > 18
Coating Performance	
Coating strip force unaged and aged***	
- Average strip force:	M49291/1-01 | 1 N to 3 N M49291/1-02 | Not Spec.
- Peak strip force:	M49291/1-01 | 1.8 N to 13.2 N M49291/1-02 | 1.8 N to 20 N

*** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C

Environmental Specifications

Environmental Test	Test Conditions	Induced attenuation at 850, 1300 nm (dB/km)
Attenuation		
Temperature Cycling	- 60°C to 85°C	≤ 0.2
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.2
Water Immersion	30 days; 23°C	≤ 0.2
Dry Heat	30 days; 85°C	≤ 0.2
Damp Heat	30 days; 85°C, 85% RH	≤ 0.2
Operating Temperature Range		-55°C to +85°C
Non-Operating Temperature + Storage Temperature Range		-62°C to +85°C

Typical Radiation Induced Attenuation (RIA)

Radiation Induced Attenuation	Dose: 10 KGy; Dose rate: 1.67 Gy/s; T=28°C; 1300 nm	~7.5 dB/100 m

1). The modal bandwidth is linearly normalized to 1 km, according to IEC 60793-2-10.

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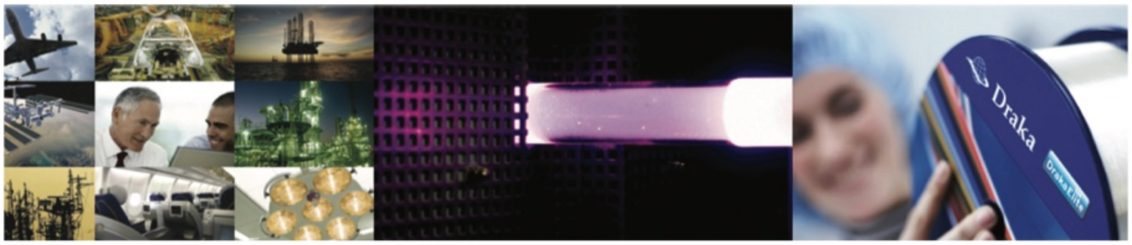
Draka

A brand of the Prysmian Group

Multimode Fiber

RadHard 50 µm OM3/OM4 Multimode Fiber (MIL-PRF-49291/1)

Radiation hardened 50 µm MMF for irradiative environments



This DrakaElite™ RadHard 50 µm core diameter OM3/OM4 multimode fiber (MMF) can be used for high irradiative environments (e.g. gamma rays, X-flash, neutrons protons) up to a dose of about 10 kGy. For extreme irradiative environments (some MGy dose) DrakaElite™ Super RadHard 50 µm core diameter MMF is recommended.
Note: 1 Gy = 100 Rad.

This Germanium-doped 50 µm core diameter OM3/OM4 RadHard MMF has been qualified and approved by the U.S. Defense Supply Center, Columbus (DSCC) in accordance with the U.S. Military MIL-PRF-49291/1 specification and offers increased laser-launch bandwidth (OM3 / OM4 quality).

Because Radiation Induced Attenuation (RIA) is a strong function of time after dose, dose rate, temperature, system operational wavelength, and system operational power, assessing the RIA performance of fibers should be conducted as close to conditions in the final application as possible.

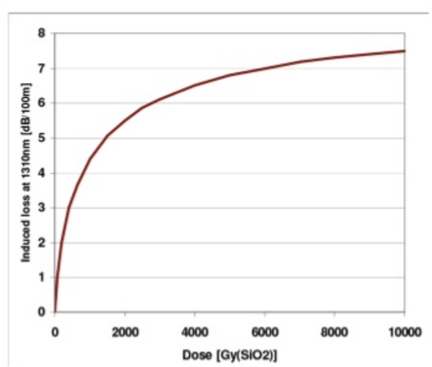
The Draka 50 µm core diameter RadHard MMF can be used in all cable constructions, including loose tube, tight buffered, ribbon and central tube designs. This fiber complies with or exceeds IEC 60793-2-10 category A1a.2 and A1a.3 Optical Fiber Specification, TIA-492AAAC / 492AAAD and Telcordia GR-20-Core.

Prysmian Group' fiber plant Draka Comteq Fiber B.V. in Eindhoven , Netherlands, is MIL-STD-790 certified.

Features	Advantages
RadHard behavior	• Suitable for medium irradiative environments
Coated with the dual layer UV Acrylate	• Optimized performance in tight-buffer cable applications

Steady state gamma irradiation test conditions – MIL 49291-1		
Temperature	Dose Rate	Total Dose
- 28°C / 25°C / 85°C	0.50 Gy/s (SiO2)	Classified

Irradiation test requirements – MIL 49291-1		
Max. Induced Attenuation @1310nm	Attenuation At Specified Recovery Time	Specified Recovery Time
< 50 dB/km (Total dose classified)	< 15 @ -28 °C < 5 @ 25 °C < 5 @ 85 °C	1000 s



Typical RIA for Draka RH 50 µm MMF at 1300 nm; dose rate 1.67 Gy/s, T=28 C

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A brand of the Prysmian Group

RadHard

RadHard 50 µm OM3/OM4 Multimode Fiber (MIL-PRF-49291/1)

Optical Specifications (uncabled Fiber)

Attenuation	
Attenuation Coefficient @ 850 nm	≤ 2.4 dB/km
Attenuation Coefficient @ 1300 nm	≤ 0.6 dB/km
Effective Modal Bandwidth(EMB) (min.)[1]	
OM3 / 850 nm	2000 MHz.km
OM4 / 1300 nm	4700 MHz.km
Overfilled Modal Bandwidth (min.)[1]	
OM3 / 850 nm	1500 MHz.km
OM4 / 850 nm	3500 MHz.km
OM3 + OM4 / 1300 nm	500 MHz.km
Aperture	
Numerical Aperture	0.200 ± 0.015
Chromatic Dispersion	
Zero Dispersion Wavelength (λ_O)	1295 nm ≤ λ_O ≤ 1340 nm
Zero Dispersion Slope (S_O)	
1295 nm ≤ λ_O ≤ 1310 nm	≤ 0.105 ps/(nm²·km)
1310 nm ≤ λ_O ≤ 1340 nm	≤ 0.000375 (1590- λ_O) ps/(nm²·km)
Bending Loss	
100 turns, Radius = 75 mm; 850 nm /1300 nm	≤ 0.5 dB
Backscatter Characteristics**	
Point Discontinuity***	
850 nm, 1300 nm	≤ 0.01 dB
Irregularities Over Fiber Length 850 nm, 1300 nm	≤ 0.1 dB
Reflections	Not Allowed
Group Index of Refraction (Typical) 850 nm 1300 nm	 1.482 1.477

*** OTDR measurement 0.5 µs pulse width*
**** mean of bi-directional measurement*

Geometrical Specifications

Glass Geometry	
Core Diameter	50 ± 2.5 µm
Core Non-Circularity	≤ 5 %
Core/Cladding Concentricity Error	≤ 1 µm
Cladding Diameter	125.0 ± 1.0 µm
Cladding Non-Circularity	≤ 0.7 %
Coating Geometry	
Coating Diameter	M49291/1-01 | 242 ± 10 µm M49291/1-02 | 500 ± 15 µm
Coating Non-Circularity	M49291/1-01 | ≤ 5 % M49291/2-02 | ≤ 5 %
Coating/Cladding Concentricity Error	M49291/1-01 | ≤ 10 µm M49291/1-02 | ≤ 20 µm
Standard Length	M49291/1-01 | 1.8 - 13.2 km M49291/1-02 | 1.8 -20 km

Mechanical Specifications

Proof Test (offline)	
The entire length is subjected to a tensile proof stress ≥ 0.7 GPa (100 kpsi) 1% strain equivalent	
Tensile Strength (medium value)	
Dynamic tensile strength (0.5 meter gauge length):	
Aged** and unaged	Median > 3.8 GPa (550 kpsi)
*** Aging at 85°C, 85% RH, 30 days*	
Fatigue Parameter (typical)	
Dynamic fatigue unaged and aged**	n_d > 18
Coating Performance	
Coating strip force unaged and aged***	
- Average strip force:	M49291/1-01 | 1 N to 3 N M49291/1-02 | Not Spec.
- Peak strip force:	M49291/1-01 | 1.8 N to 13.2 N M49291/1-02 | 1.8 N to 20 N

*** Aging:
- 0°C and 45°C
- 30 days at 85°C and 85% RH
- 14 days water immersion at 23°C

Environmental Specifications

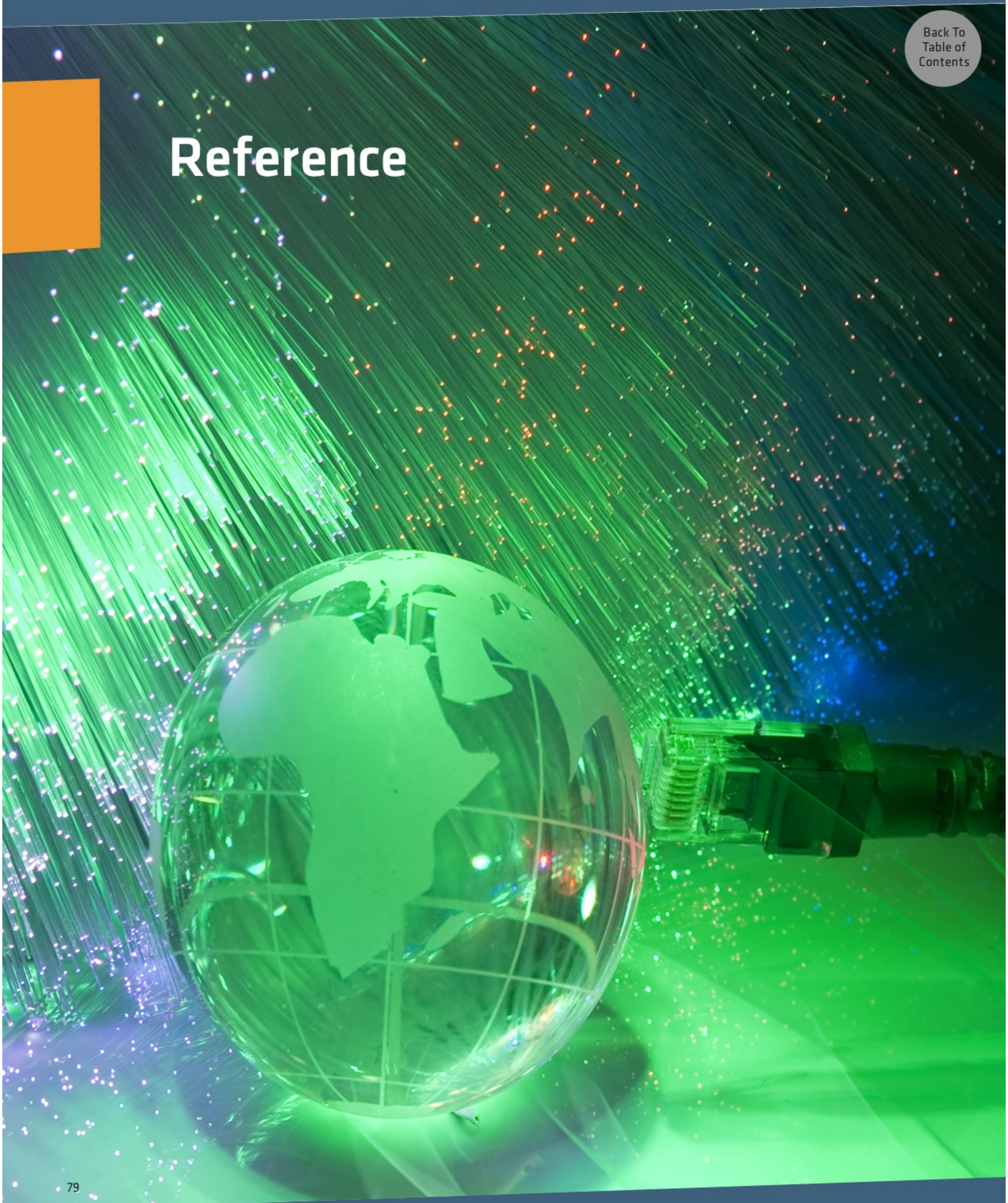
Environmental Test	Test Conditions	Induced attenuation at 850, 1300 nm (dB/km)
Attenuation		
Temperature Cycling	- 60°C to 85°C	≤ 0.2
Temperature - Humidity Cycling	- 10°C to 85°C, 4-98% RH	≤ 0.2
Water Immersion	30 days; 23°C	≤ 0.2
Dry Heat	30 days; 85°C	≤ 0.2
Damp Heat	30 days; 85°C, 85% RH	≤ 0.2
Operating Temperature Range		-55°C to +85°C
Non-Operating Temperature + Storage Temperature Range		-62°C to +85°C

Typical Radiation Induced Attenuation (RIA)

Radiation Induced Attenuation	Dose: 10 KGy; Dose rate: 1.67 Gy/s; T=28°C; 1300 nm	~7.5 dB/100 m

1). The modal bandwidth is linearly normalized to 1 km, according to IEC 60793-2-10.

Reference



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Guidance for OTDR Assessment of Fusion Spliced Single-mode Fibers

Application Note

AN3060
Issued: March 2014
Supersedes: July 2009
ISO 9001 Registered

Introduction

This Corning paper explains measurement behaviors of fusion spliced optical fibers and how glass properties and MFD (mode field diameter) differences across fiber splice junctions can lead to erroneous interpretations of splice loss when performing uni-directional OTDR (optical time domain reflectometer) tests. This paper explains how uni-directional OTDR test results yield misleading splice loss values in cases of heterogeneous splices (dissimilar fibers types) as well as homogeneous splices (fibers of the same type or specification). Examples of practical splice loss measurements using an OTDR are presented along with measurement and inspection techniques that can be used to assess splice loss performance relative to specification and industry requirements.

OTDR Inspection Techniques

OTDRs offer a convenient and powerful tool for rapidly assessing attenuation behavior in optical fibers. Due to the way an OTDR works, the attenuation characteristics along the length of a fiber or at particular regions of interest make them ideally suited for certification of installed optical fiber cable and assessment of fusion splice losses as well as attenuation testing. In very simple terms, an OTDR consists of a laser light source and optical detector to capture and record backscattered light as a means of assessing the optical characteristics of a fiber link. The optical receiver records the tiny proportion of light (typically <0.000001% or <-79 dB) that is backscattered by the molecular structure of the glass in response to an injected light pulse from the OTDR. The measurement trace generated by the OTDR is an integrated sum plot of the magnitude of light received from scattering locations along the length of the fiber. The time-dependent backscattered power P_{bs}(t) received by the OTDR detector from an input light pulse power P_0 and pulse duration W is described by [1];

$$P_{bs}(t) = P_0 W \eta(z) e^{-2\alpha z} \qquad (1)$$

where; α is the attenuation coefficient and η is the overall backscatter factor, which for a weakly guided single-mode fiber and using a Gaussian approximation is given by [2];

$$\eta = \frac{1}{2}\alpha_s B(z) \upsilon_g = \frac{12\, c\, \alpha_s}{(k_0 MFD)^2 n^2_{eff} n_g} \qquad (2)$$

In (2) above it is apparent that the backscatter factor describes of a number of light and fiber interactions along the length governed by material properties and glass design; where α_s is the scattering-coefficient, which is the contribution of light attenuation due to localized inhomogeneity of the glass medium, n_{eff} is the effective refractive index, n_g is the group refractive index, υ_g is the group velocity, k_0 is the wave number in free space, and c is the velocity of light in a vacuum. The backscatter capture fraction $B(z)$ describes the proportion of light energy that is scattered by the structure of the glass at points (z) along fiber which is

captured by the fiber in the return direction. Therefore, B(***z***) describes factors related to fiber design, which include; core geometry, refractive properties of the core and cladding (i.e. index profile), material composition (glass and dopants) and coupling efficiency. Using a Gaussian approximation and assuming the modes to be weakly guided provides a simplified approximation of the backscatter capture fraction B(***z***) with fiber properties which can be characterized for the purposes of interpretation of OTDR measurements.

Assessment of Fiber Attenuation and Splice Loss Using an OTDR

International Standards IEC 60793-1-40 and the Telecommunications Industry Association (TIA) optical fiber test procedure (TIA-FOTP-61) indicate that splice and attenuation measurements with an OTDR must be conducted from both directions and averaged for accuracy and to eliminate the effects of backscatter differences, also referred to as "gainers" and "exaggerated losses". It is an industry misconception that uni-directional OTDR inspections can be used to accurately and reliably measure attenuation and or splice loss, particularly in deployed cables. When bi-directional OTDR measurements are not feasible (e.g. due to poor accessibility at one end of the spliced system), an installer may choose to rely upon uni-directional OTDR estimates. An assessment of fiber attenuation and or splice loss using only a uni-directional OTDR inspection, therefore, assumes all optical properties to be consistent along the length of fiber or any spliced sections under test. The problem with this assumption is that the level of backscatter light detected by the OTDR can increase or decrease at many points along individual or concatenated sections of fiber independently of fiber attenuation or actual splice loss [3]. Differences in the intensity of backscattered light can be the result of changes in the optical properties encountered by the forward propagating measurement pulse from the OTDR. The forward propagating light is unaffected by small intensity changes in backscatter and therefore has no functional impact on system performance. When two fibers (***A*** and ***B***) are spliced together the difference in the uni-directional backscatter apparent loss value is given by [2];

$$\alpha_{splice} = |\Delta \boldsymbol{S}| + \Delta \boldsymbol{BS} \tag{3}$$

where $\Delta \boldsymbol{S}$ is the difference in OTDR backscatter trace at the splice junction due to the actual loss and $\Delta \boldsymbol{BS}$ is a measurement error artifact caused by changes in the backscatter efficiency between the two fibers, which can be described in terms of differences in fiber parameters [2];

$$\Delta \boldsymbol{BS} = 5(\log \eta_{A} - \log \eta_{B}) \tag{4}$$

$$\Delta \boldsymbol{BS} = 10 \log \left[\frac{MFD_B}{MFD_A}\right] + 5 \log \left[\frac{\alpha_{s_A}}{\alpha_{s_B}}\right] + 10 \log \left[\frac{n_{eff_B}}{n_{eff_A}}\right] + 5 \log \left[\frac{n_{g_B}}{n_{g_A}}\right] \tag{5}$$

By applying the approximations from (2) into (4), we obtain a more detailed estimation for the expected OTDR backscatter response at a splice location (5). In practical OTDR measurement terms, backscattering characteristics are mostly influenced by the refractive index profile and geometrical properties of the fiber. Figure 1 is an illustration of a pair of "unidirectional OTDR measurement" backscatter traces of two fibers spliced together as measured from each side of the splice. The ***A*** and ***B*** notations used in (4) and (5) refer to the fiber-measurement direction sequence A→B and B→A (→ indicates the OTDR launch direction). This example shows how the changes in MFD cause a measurable shift in both backscatter intensity traces as recorded by the OTDR at the splice junction, which can lead to misinterpretation of splice loss results.

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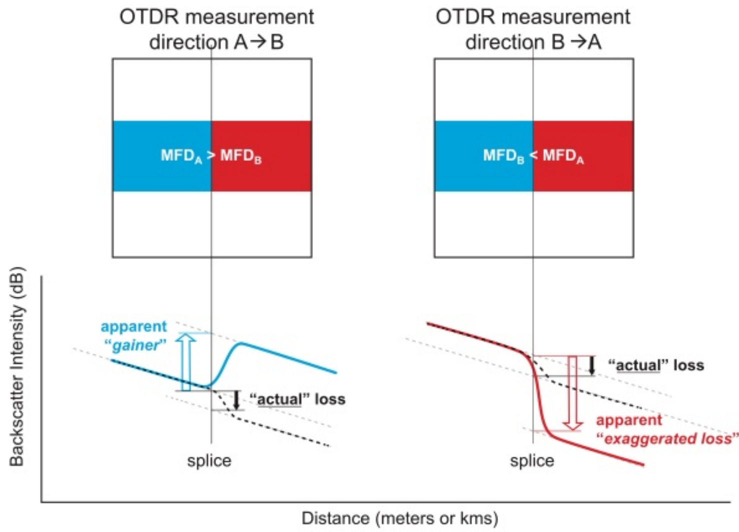

Figure 1. Illustration of OTDR backscatter trace behavior at splice location between fibers of different MFD; a) larger MFD → smaller MFD, b) smaller MFD → Larger MFD.

The backscatter capture fraction of an optical fiber is inversely proportional to the MFD. Thus, when two fibers of dissimilar MFD are spliced together, measurable differences in the OTDR backscattered signal will occur. A uni-directional OTDR trace will show the MFD transition as either a "gainer"; an apparent increase in optical power, or as an "exaggerated loss", depending on the direction of the measurement. When measuring from a fiber with a larger MFD to one with a smaller MFD, the OTDR measurement will result in a "gainer". Conversely, when measuring from a smaller MFD to a larger MFD, the measurement will result in an exaggerated loss. Figure 1 illustrates both "gainer" and "exaggerated loss" events as depicted on an OTDR measurement trace. The "true" or actual attenuation or splice loss is calculated from the bi-directional average of the two uni-directional OTDR inspection measurements, which eliminates any spurious backscatter differences from the two uni-directional measurements. The blue [gainer] and red [exaggerated loss] colored traces show the results collected from A→B and B→A measurement directions respectively, whereby MFD_A is larger than MFD_B. The actual splice loss depicted by the black-dotted trace is the mathematical bi-directional average of the two measurement traces.

Figure 2 shows the results of uni-directional and bi-directional averaged OTDR measurement values used to assess splice loss in fusion spliced Corning® SMF-28e+® fibers. The results are presented using the same conventions as the illustration in Figure 1 to indicate the results obtained in forward and reverse measurement directions. The test specimens were specially selected to span a range of MFD values and OTDR traces were taken in both measurement directions, A→B and B→A, for each spliced fiber pair tested. The splices were conducted using a commercially available fusion splicer operating in a default automatic core-alignment G.652 single-mode splicing program. In all instances the splicer reported a predicted splice loss of 0.01 dB or lower and all splicing images indicated good visual splice quality and passed a 25 kpsi mechanical proof test (applied by the splicing machine). The results show uni-directional splice loss dependency on MFD difference as measured on each of the A and B samples. The increase in the OTDR backscatter intensity is inversely proportional to the square of the MFD difference at the splice junction. Many uni-directional results falsely predict high splice loss values that would likely raise a concern during network cabling installation. In reality, all actual splice loss values comfortably met typical industry requirements of ≤0.10 dB/splice average and all splices were below 0.05 dB.

Predicted uni-directional splice loss values show no correlation to the bi-directional averaged (actual) splice loss values over the MFD range tested. In fact, some of the lowest measured splice loss values were recorded with moderate MFD mismatches. Corning estimates that MFD mismatch in the same type fiber contributes less than 0.04 dB to the actual splice loss. Examination of the results also indicated that other extrinsic effects, such as fiber cleave angle (typically 0.3°), had no impact on the actual splice loss results. However, from (5) it is possible that small localized variations in other optical parameters could alter the backscatter factor $\eta(\boldsymbol{z})$ which would increase measurement uncertainty in uni-directional OTDR traces.

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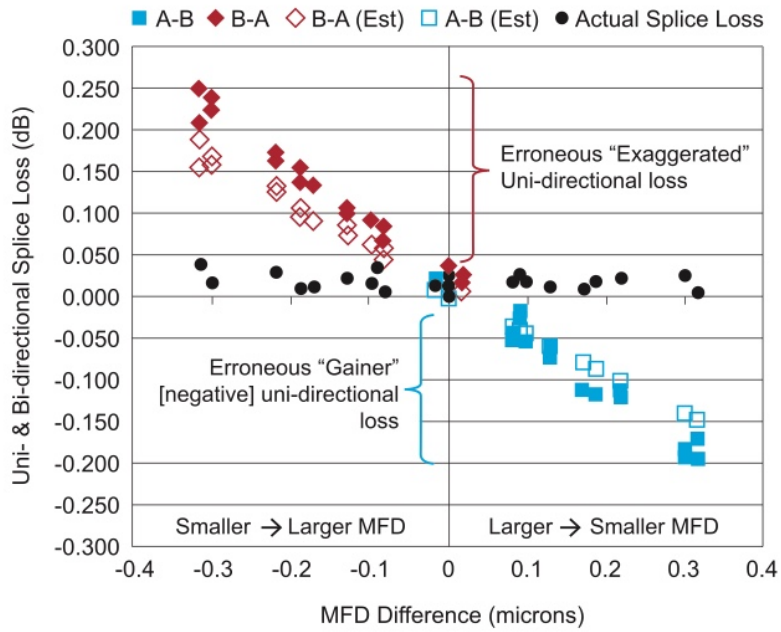

(2a)

(2b)

(2c)

Figure 2a. Comparison of uni-directional and bi-directional OTDR inspection results of spliced SMF-28e+® G.652.D fiber samples with known MFD mismatch. **2b** and **2c** are representative fusion splicer machine images of spliced SMF-28e+ fiber with MFD mismatches.

The results in Figure 2 show the accuracy of uni-directional OTDR backscatter traces in predicting actual splice loss is limited to near zero values or in cases where there is little or no fiber parameter mismatch. For field splicing and taking into account the existence of variability in MFD, uni-directional testing typically requires splice loss acceptance criteria of 0.3 dB or higher although proportionately such elevated uni-directional losses typically occur less frequently. Table 1 below shows the MFD variability that may be permitted according to ITU-T recommendations for single-mode fibers alongside Corning specified values for various widely deployed G652 and G657 category fibers. Industry specifications for MFD typically employ tighter limits than permitted by ITU-T range limits. For example, a nominal MFD of 9.2 ± 0.5 microns is more typical at 1310 nm.

Table 1. Estimated uni-directional OTDR splice loss based upon MFD mismatch.

MFD / Wavelength	**ITU-T G.652.D & IEC 60793-2-50 type B1.3 fibers**	**ITU-T G.657 A1 & A2 & IEC 60793-2-50 type B6_a fibers**	**SMF-28® Ultra, SMF-28e+® LL & SMF-28e+® fibers (G.652)**		**ClearCurve® single-mode fibers (G.657)**	
Wavelength (nm)	1310	1310	1310	1550	1310	1550
MFD (microns)	8.6 to 9.5 ± 0.6	8.6 to 9.5 ± 0.4	9.2 ± 0.4	10.4 ± 0.5	8.6 ± 0.4	9.5 ± 0.5
Max. Diff. (microns)	2.1	1.7	0.8	1.0	0.8	1.0
Estimated Uni-directional OTDR Loss (2)[1] $10 \log \left[\frac{MFD_{B/A}}{MFD_{A/B}}\right]$	Max: 1.0 dB Typ: 0.47 dB (9.2 ± 0.5 microns)	Max: 0.82 dB Typ: < 0.4 dB	Max: ±.38 dB Typ: ±< 0.2 dB	Max: ± 0.42 dB Typ: ±< 0.2 dB	Max: ± 0.4 dB Typ: ±< 0.2 dB	Max: ± 0.45 dB Typ: ±< 0.2 dB

[1] These estimates are based exclusively MFD mismatch for fibers of same classification or specifications that may be encountered during field installation testing (excludes other optical or fiber design property differences).

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When splicing dissimilar fiber types, larger changes in uni-directional OTDR backscatter are to be expected as a result of differences that may exist in the intrinsic glass properties of the fibers being spliced together [2][5]. These can be due to differences in fiber manufacturing processes, glass composition, or differences in the fiber refractive index profile design. For example, larger "gainers" or "exaggerated losses" may be observed when splicing G.652 and G.657, owning to the typically smaller MFD range of G.657 bend-insensitive fibers. Similarly, splicing conventional G.652 to "***ultra low loss***" technologies such as SMF-28® ULL fiber, results in larger "gainers" and "exaggerated losses" due to glass composition and fiber design differences although they share the same MFD specifications. OTDR traces that may result from these splicing arrangements are illustrated in Figure 3.

Figure 3 shows the splice loss measurements of SMF-28e+ fiber [***A***] spliced to SMF-28 ULL [***B***] fiber using an OTDR. Uni-directional estimates taken in the measurement direction (A→B) show exaggerated splice loss values due to a combination of optical property differences due to fiber design as well as MFD mismatch. The spliced fibers had a MFD range of 9.1 ~ 9.5 microns at 1310 nm and were chosen to compare measurement results of closely matching MFD versus splices with typical ranges of MFD mismatch.

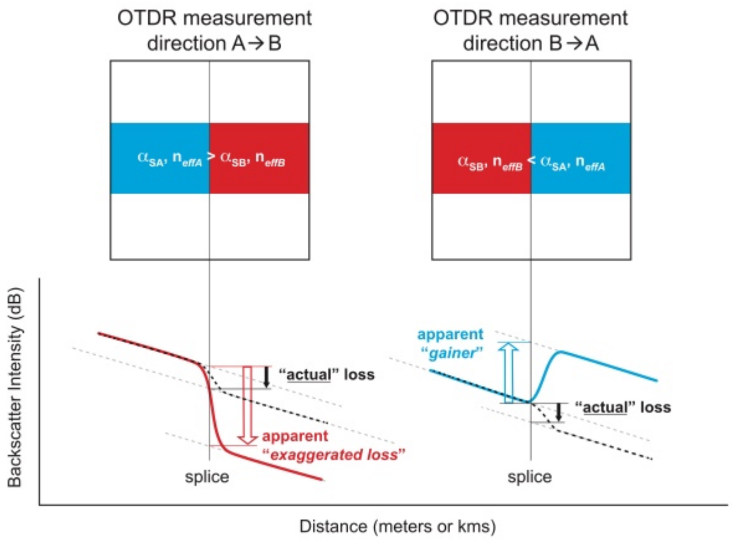

Figure 3. Illustration of OTDR backscatter trace behavior at splice location between heterogeneous splice junctions with fibers of different optical properties such as scattering coefficient, α_s, and group refractive index, n_{eff}.

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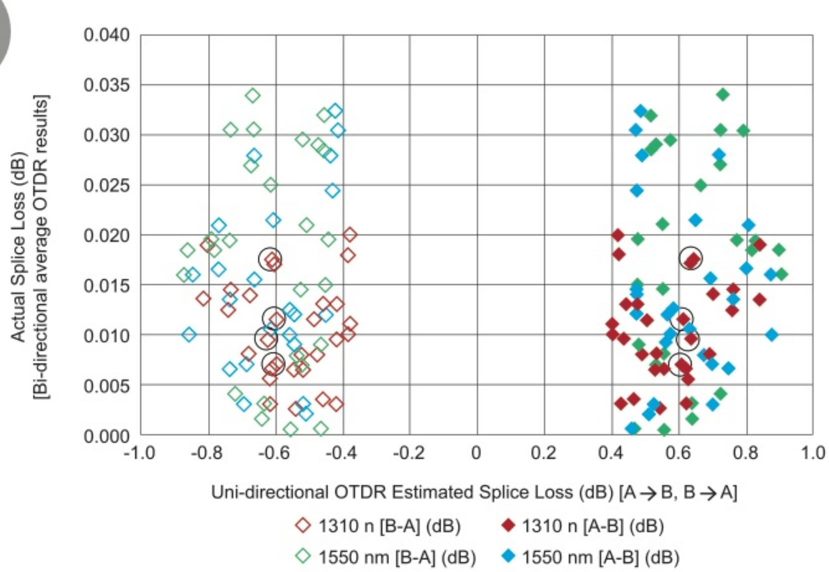

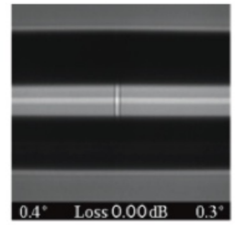

Figure 4b – SMF-28® ULL fiber spliced to SMF-28® ULL fiber

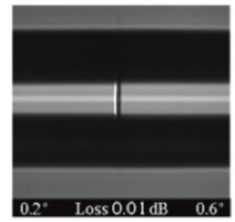

Figure 4c – SMF-28e+® fiber spliced to SMF-28® ULL fiber

Figure 4 - 4a. Comparison of unidirectional estimates and actual splice loss (bi-directional averaged results) for Corning SMF-28e+® fiber spliced to Corning SMF-28® ULL fiber. 4b and 4c show fusion splicer images of b) SMF-28® ULL spliced to itself and c) spliced to SMF-28e+ fiber.

The results in Figure 4 show larger errors in the estimated uni-directional OTDR results as compared to the actual bi-directional averaged results. The splice values circled are of the fiber pairs with closely matching MFDs (difference <0.04 microns) and show that the uni-directional estimates include a backscatter change of ~0.6 dB when measured in the A→B direction. This apparent loss is due to the change in scattering characteristics of the fiber when transitioning from a 'good' attenuation fiber to the superior, lower attenuation characteristics of SMF-28 ULL fiber. The images collected from the fusion splicer show an apparent refractive index artifact at the splice junction between SMF-28e+ and SMF-28 ULL fiber, which is not functional. The maximum actual splice loss was less than 0.035 dB, and the average splice loss was less than 0.02 dB for all wavelengths measured.

Uni-directional OTDR Inspection – Splice Loss Estimate Uncertainty

Statistical analysis can be used to evaluate the validity of a rule of thumb that may be applied to uni-directional OTDR inspections of splices losses where the accuracy of the results are in question [5]. For homogenous fiber types, Table 2 provides guidance on the typical probability of uni-directional splice accuracy based upon normal distributions of MFD.

Table 2. Statistical assessment of uni-directional OTDR splice loss accuracy

Splice Loss (actual)	Estimated Splice Loss [uni-directional OTDR] (Homogenous splices)
±0.05 dB	54%
±0.10 dB	78%
±0.20 dB	97%
±0.30 dB	<100%

NOTE: These estimates are based upon homogenous splices. Inclusion of fiber types with differing MFD specifications or different fiber design may lead to increased uncertainty of uni-directional OTDR-based estimated values.

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In cases where uni-directional OTDR inspection measurements indicate “gainer” or suspected “exaggerated loss events”, the following steps can be used to reduce the uncertainty in uni-directional OTDR measurement results:
NOTE: None of the following options should be regarded as preferable substitutes for proper OTDR splice loss measurements that can only be obtained with bi-directional averaging. Reliance upon uni-directional OTDR measurements may not be a viable option as evidenced by the Splice Loss Estimate Accuracy shown in Table 1 and may mask poor splices or invalidate acceptable splices. For optimal splicing results, good working practices and suitable equipment and procedures should be followed [6].

- System links should be engineered with specification acceptance criteria for average splice loss and overall attenuation of the end-to-end link. The use of average splice specification targets can be used to accommodate outlier values provided the attenuation and insertion loss targets of the overall link are satisfactory. e.g. average link splice loss of 0.1 dB/splice and a threshold of 0.3 dB for uni-directional loss estimates (above which further steps are taken to assess the measurement uncertainty, described below).
- In cases where dissimilar fiber types are being spliced e.g. FTTx installations using bend insensitive fibers with typically smaller MFD or in long distance networks using optimized low attenuation fibers, any use of uni-directional estimates should make allowances for potentially larger “gainer” or “exaggerated loss” estimates of 0.3 dB or higher. For FTTx networks, it may be possible to combine OTDR inspection results with measured 1490 nm down-link signal power in such services as GPON.
- A gainer event is most likely the indication of a glass refractive index property change, either by dissimilar fiber types, differing MFD values, or a change in bulk scattering level. Comparing the loss characteristics of adjacent splices in the link can enable a pseudo averaging based on a uni-directional trace. Breaking and re-making splices is unlikely to change the result, but could be used to confirm measurement data accuracy.
- Suspected inaccurate “exaggerated loss” estimate: Compare results of adjacent splices, a corresponding “gainer” may confirm MFD mismatch or index of refraction mismatch between fibers. Breaking and re-making of a splice and yielding the same loss characteristics in combination of the above may reduce uncertainty in results.
- For heterogeneous splices, information should be obtained about the fiber types prior splicing to ensure the optimal fusion splicing program or setting are selected. Knowledge about the fiber types being spliced allows the use rules of thumb to address uncertainty when interpreting uni-directional OTDR traces. Heterogeneous splices tend to be location specific, e.g. at a demarcation point in a network and are usually less commonplace. If there is uncertainty about the accuracy of uni-directional traces, then bi-directional measurements should be used to accurately determine splice loss.
- Fusion splicers with PAS (profile-alignment system) and/or LID (local injection/detection) can help reduce uncertainty in uni-directional measurements, either through estimated splice loss based upon visual and geometrical alignment characteristics or, in the case of LID, an insertion-loss based splice loss estimate. A visual inspection of X-Y axis splicing imagery captured by the splice machine can be used to assess uncertainty in uni-directional estimates.
- It is also suggested that a test splice using a reference fiber sample with a known MFD be used to separately test and compare uni-directional values to the objective fibers being spliced in the field.

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OTDR

Summary

Uni-directional OTDR inspection testing of fiber attenuation and splice loss can lead to inaccuracies due to the manner in which OTDR backscatter data is recorded and reported. Discrepancies usually arise when backscatter results suggest "exaggerated loss" or "gainer" values that are cause by optical refractive index changes at splice locations. These may be caused by MFD mismatch between same type fibers or other refractive index property differences between fibers. Bi-directional OTDR inspection measurements are recommended by international standards bodies as a reference method for accurate fiber attenuation and splice loss assessment. However, in cases where uni-directional inspection tests are the basis of field installation testing or certification, there are several additional steps that can be taken to reduce the level of

uncertainty in the results. These include capture of other records and data to help certify field installations.

References

[1] A.H. Hartog, and M.P. Gold, "On the theory of backscattering in single-mode optical fibers", J. Lightwave Technol., vol. LT-2, pp. 78-82, 1984.

[2] J. Warder, M-J. Li, P. Townley-Smith & C. Saravanos, "Effects of Fiber Parameter Mismatch on Uni-Directional OTDR Splice Loss Measurement", NIST Technical Digest Symposium on Optical Fiber Measurements (1994).

[3] WP1281, "Explanation of Reflection Features in Optical Fiber as Sometimes Observed in OTDR Measurement Traces", Corning White Paper (2012).

[4] AN4091, "Explanation of the Sources of Variation in Optical Fiber Effective Group Index of Refraction Values", Corning Application Note (2012).
Corning Application Note AN4091 (Corning web site)

[5] S.C. Metter, "Monte-Carlo analysis of the effects of mode field diameter mismatch on single-mode fiber splices", 8th Annual National Fiber Optic Engineers Conference, pp. 647-773 (1992).

[6] AN103 "Single Fiber Fusion Splicing", Corning Application Note (2009).
Corning Application Note AN103 (Corning web site)

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Bend-Insensitive Fiber Splicing Considerations

When splicing Bend-Insensitive Fiber (BIF), certain fiber classes may require some procedure changes depending of the splice machine type, model and age. There are three classes of BIF available in the industry. Prysmian® uses BIF from both Draka® and Corning® in cable designs.

ITU BIF Specifications	ITU G652.D Compliant	1 turn Bend Radius	Procedure Change?	Draka™ Brand	Corning™ Brand
G.657.A1	Yes	10 mm	No	BendBright™	SMF-28 Ultra™ Fiber
G.657.A2	Yes	7.5 mm	Possible	BendBright-XS™	ClearCurve™ LBL Fiber
G.657.B3	Yes	5.0 mm	Possible	BendBright-Elite™	ClearCurve™ ZBL Fiber

All BIF fiber used by Prysmian is fully compliant with SMF industry standard specifications.

As the above chart shows, ITU G657.A1 (10mm) BIF (i.e. BendBright™ and SMF-28 Ultra™ Fiber) is also fully interchangeable from a splicing perspective with standard single mode fiber using standard SMF splicing settings.

ITU G657.A2 (7.5mm) & G657.B3 (5mm) BIFs have unique refractive index "trench" profiles in the cladding to guide the light. These "trenches" may confuse the auto fiber identification.

- Some core/profile alignment machines may require selection of a specific splice program for some BIFs. Mass fusion or cladding alignment splice machines are not affected.

Fiber Type	Draka™ Brand	Corning™ Brand	SMF Fusion Splice Procedure Change?		
			Mass Fusion	Cladding Alignment	Core/Profile Alignment
G.657.A1	BendBright™	SMF-28 Ultra™ Fiber	No	No	No
G.657.A2	BendBright-XS™	ClearCurve™ LBL Fiber	No	No	Maybe
G.657.B3	BendBright-Elite™	ClearCurve™ ZBL Fiber	No	No	Maybe

When splicing G.657.A2 or .B3 BIF, the "core" may also appear larger in the viewer since both the core and the cladding "trench" can be seen. In reality, the core & mode field diameter of BIF is similar to SMF.

When using an OTDR with G.657.A2 or .B3 BIF spliced to SMF, minor mode field diameter differences may increase or decrease the "apparent splice loss". The actual loss (bi-directional average) is not impacted. When splicing BIF to itself, the OTDR "apparent splice loss" is not any different than measuring SMF to SMF.

The following Draka link describes this in more detail: **www.prysmiangroup.com/en/business_markets/markets/fibre/downloads/application-notes/Application-Note_Splicing-and-OTDR-Measurements.pdf**

IN SUMMARY:

G.657.A2 or .B3 BIF splicing with core/profile alignment machines may require

- Selection of the appropriate BIF program.
- A software download with older machines to make the BIF program option available.
- Switching to a diameter alignment or multimode setting for some obsoleted splice machines.

For additional assistance from Prysmian, please call: 1-800-669-0808 or 1-800-879-9862

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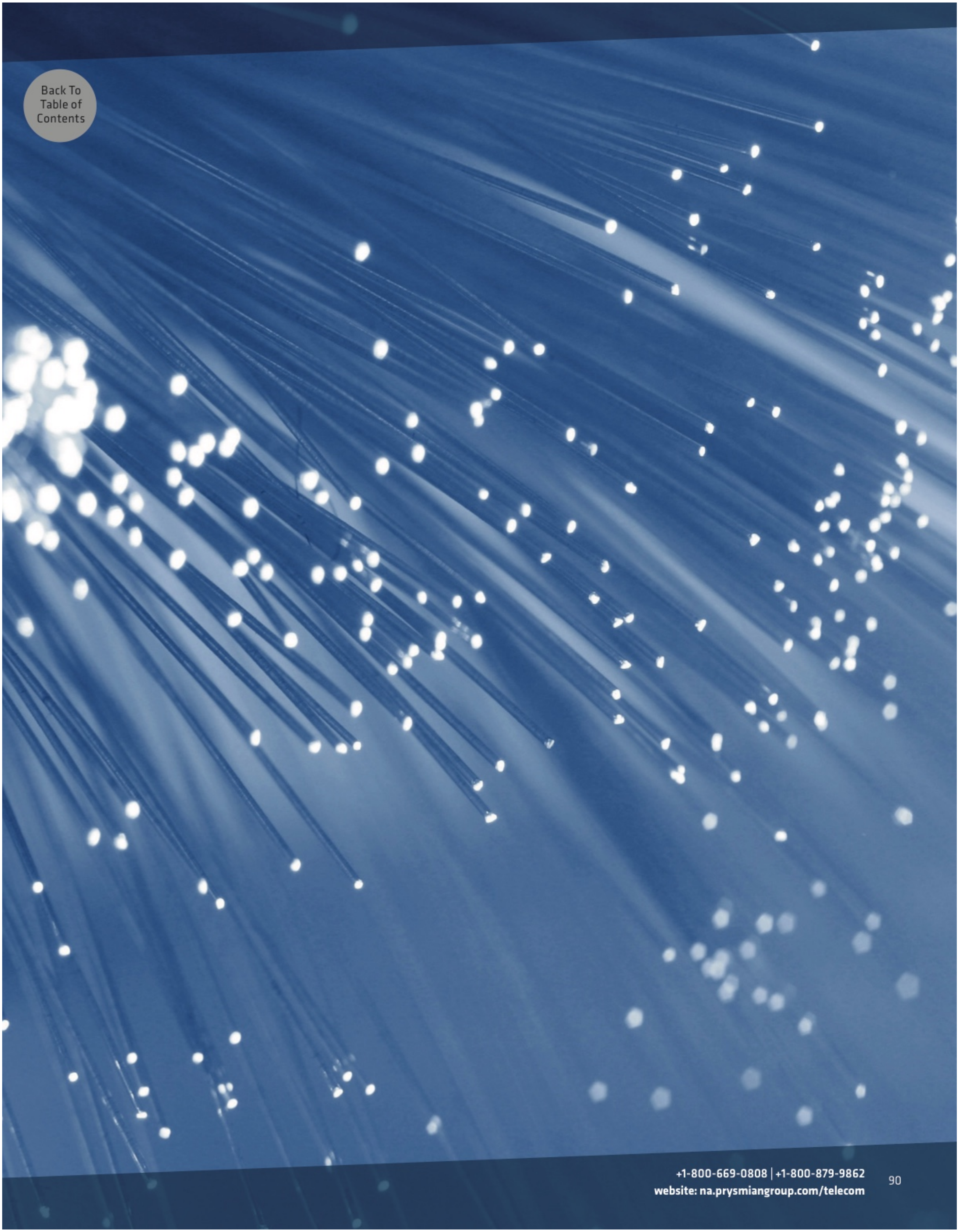

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