



## OptiGrade 50/125 R.H. Radiation Hardened Fiber

Optical fiber technology has been considered for quite some time for communication and sensing applications in radiation environments: As in non-radiation environments ever increasing bandwidth hungry applications did appear and high performance systems are required to transmit increasing data rates. This development can be seen e.g. in satellite technology, sensoric applications, military systems, space and nuclear industry. With OptiGrade R.H. j-fiber offers the first high bandwidth Multimode fiber designed to withstand hazards of radiation threatened environments capable to transmit 10Gb/s data rates.

The fiber features a graded index configuration with 50/125 core/clad design and is optimized for use in 850nm wavelength operation.

### Features and Benefits

- Low attenuation change under radiation exposure
- Highest bandwidth with guaranteed transmission at 10Gb/s data rates up to 300m distance
- Allows the use of low cost 850nm system applications (VCSELs)
- Reliable system performance guaranteed by measurement of effective modal bandwidth EMB and most stringent DMD characterization
- Provides high performance at overfilled launch (OFL) bandwidth of up to 1500MHz-km @850nm and 500MHz-km @1300nm to support conventional applications
- 50µm core allows for high coupling efficiency
- Guarantees all j-fiber Multimode fiber standard features: easy to work with in cabling and installation and high-performance results;
- Excellent compatibility in all cable constructions, such as tight buffering and loose tube
- Proven product consistency and reliability through our patented MCVD based process manufacturing technology

### Application

OptiGrade R.H. is designed to provide high connectivity to allow bandwidth intensive applications within radiation environments or at the threat of a possible exposure to radiation such as deployment in

- retrieval applications like video coverage of news events or
- space-borne structure monitoring,
- medical imaging programs,
- passive media in communication centers of civil nuclear power stations or
- in tactical cable in military communication systems

**OptiGrade R.H.** The high-bandwidth fiber enables short-reach connectivity for high speed 10Gb/s fiber links at rated distances of 150m and 300m.

### Optimized Process

j-fiber OptiGrade R.H. Multimode fiber are manufactured by j-fiber's patented, proprietary technology using a MCVD (Modified Chemical Vapour Deposition) process. This technology allows us to flexibly provide innovative fiber designs according to the customer's own specifications. Our improved patented process results in low attenuation fiber with consistent geometric properties, high strength, and precise control of each fiber's index of refraction. The fiber has a high level of splice compatibility with optical fibers manufactured by other processes.

For further information about our Multimode Fiber and other j-fiber products and services, please contact us:

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## Performance Characteristics

OptiGrade R.H.		150	300	Unit
Bandwidth (Overfilled Launch, LED based sources)	850nm	≥ 750	≥ 1500	MHz.km
	1300nm	≥ 500	≥ 500	MHz.km
Effective Modal Bandwidth	850nm	≥ 1000	≥ 2000	MHz.km
<p>Assured by: Measurement of Differential Mode Delay (DMD) Fibers shall meet the respective DMD templates specified in or according to the standard TIA/EIA 455-220 or IEC 60793-2-10, for transmitters meeting TIA/EIA-492 AAAC. Each template includes an inner and an outer mask requirement with:</p> <p>Inner mask: <math>R_{inner} = 5\mu\text{m}</math> to <math>R_{outer} = 18\mu\text{m}</math>      Outer mask: <math>R_{inner} = 0\mu\text{m}</math> to <math>R_{outer} = 23\mu\text{m}</math></p> <p>Upon request our fiber can be selected meeting inner mask radial specifications more stringent than the TIA/EIA-492 AAAC requirement: Inner mask: <math>R_{inner} = 0\mu\text{m}</math> to <math>R_{outer} = 18\mu\text{m}</math></p> <p>Further to meeting the respective DMD template OptiGrade R.H. fiber meets the additional requirement of IEC 60793-2-10 in the radial offset interval masks, which sources out fibers which have rapid changes of the DMD.</p>				
Transmission link lengths for 10Gb/s* <sup>1</sup>	850nm	150	300	m
	1300nm (LX4)	150	300	m
*at 850nm operating wavelength with transmitters meeting encircled flux at	Radius 4.5μm	≤ 30		%
	Radius 19.0μm	≥ 86		%

<sup>1</sup> other transmission lengths available on request

## Optical Characteristics

		Spec. Values	Unit
Attenuation	850nm	≤ 2.4	dB/km
Coefficient	1300nm	≤ 0.7	dB/km
Attenuation at 1383nm (OH-Peak)		< 2.0	dB/km
Attenuation Discontinuities (OTDR 1300nm)		< 0.05	dB/km
Macrobend <sup>2</sup>		≤ 0.5	dB
Zero Dispersion Wavelength		$1295 \leq \lambda_0 \leq 1320$	nm
Zero Dispersion Slope	$1295 \leq \lambda_0 \leq 1300$	≤ 0.001 ( $\lambda_0 - 1190$ )	ps/nm·km
	$1300 \leq \lambda_0 \leq 1320$	≤ 0.11	ps/nm·km
Numerical Aperture		$0.200 \pm 0.015$	
Effective Group Index of Refraction	850nm	1.483	
	1300nm	1.478	

<sup>2</sup> Bend induced attenuation at 850nm and 1300nm, 100 turns around a mandrel of 75mm diameter

## Fiber Characterization

j-fiber's OptiGrade R.H. fiber feature a DMD controlled core that assures 10Gb/s support with 850nm serial applications: For each length of OptiGrade R.H. fiber shipped DMD characterization has been performed according to TIA/EIA 455-220 or IEC 60793-2-10 to ensure the specified Effective Modal Bandwidth at 850nm:

- The fiber shall pass at least one of the 6 respective DMD templates as defined in TIA and IEC
- In addition, the fiber shall pass the more stringent DMD specification in respect to the 4 radial interval DMD masks as defined in TIA/EIA and IEC (sliding window).

To assure reliable system performance to rated distances for 10Gb/s systems each fiber is subject to direct DMD measurements.

The DMD specifications for OptiGrade R.H. Class 300 is compliant with or exceed the TIA and IEC DMD template and radial offset interval mask requirements for 2000 MHz·km Effective Modal Bandwidth. For OptiGrade R.H. class 150 corresponding calculated values are applicable.

## Applied Measurement Standards

j-fiber OptiGrade R.H. Multimode fiber complies with or exceeds the ITU recommendation G.651 or the IEC 60793-2-10 Optical Fiber Specifications. Each length of fiber is 100% quality measured according to the following standards:

- TIA/EIA 455-220 or IEC 60793-1-49, differential mode delay (DMD), to measure effective modal bandwidth (EMB) for 10Gb/s data rates
- TIA/EIA 455-204 or IEC 60793-1-41, overfilled mode launch bandwidth (OFL BW) to measure bandwidth for less than 1Gb/s data rates

## Standardization and Compliances for OptiGrade R.H. 300

- ISO/IEC 11801(2) and CENELEC EN50173 (2) as OM3 type fiber
- IEC 60793-2-10 as fiber type A1a.2
- TIA/EIA 492AAAC as Laser-Optimized Multimode Fiber 50/125 at 850nm

## Applied Measurement of Irradiation Performance

The radiation hardness of the fiber has been assessed according to TIA/EIA 455-64, Procedure for Measuring Radiation-Induced Attenuation in Optical Fibers.

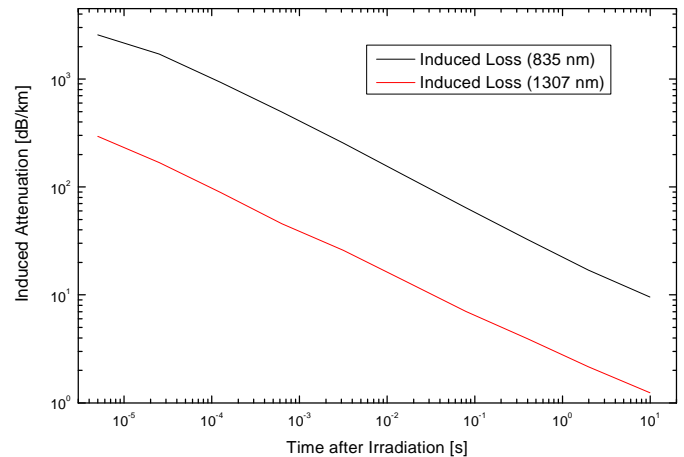
## Performance under Irradiation

### Pulsed Irradiation

Pulsed Irradiation	Spec. Values	Unit	
Irradiation dose	2700rad/27Gy		
Pulse duration	50	ns	
Light power	about 1	$\mu\text{W}$	
Temperature range	room temperature (25)	C	
Wavelength	835	1307	nm
Induced attenuation (1min after irradiation)	0.96	0.12	dB/100m

## Applicable Specification

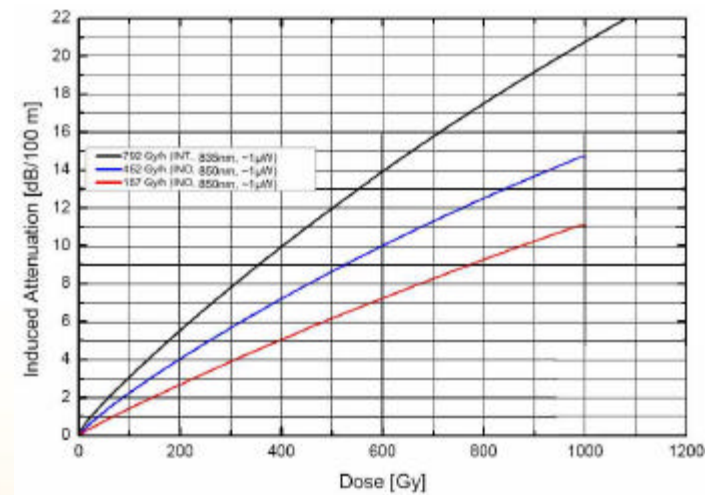
according to MIL-F-49291/1B (MMF 50/125)



Recovery time after pulsed Irradiation

### Continuous Irradiation

Continuous Irradiation	Spec. Values	Unit	
Irradiation dose	22rad/s / 0,22Gy/s		
Max. dose	1·10 <sup>5</sup> rad / 1·10 <sup>3</sup> Gy		
Light Power	about 1	$\mu\text{W}$	
Temperature Range	room temperature (25)	C	
Wavelength	835	1307	nm
Induced attenuation	20.8	1.2	dB/100m



Continuous radiation induced attenuation

## Geometrical Characteristics

	Spec. Values	Unit
Core Diameter	50 ± 2.5	μm
Core Non-Circularity	≤ 5.0	%
Core/Clad Concentricity Error	≤ 1.5	μm
Cladding Diameter	125 ± 2.0	μm
Cladding Non-Circularity	≤ 1.0	%
Coating Diameter	245 ± 10	μm
Coating /Clad Concentricity Error	≤ 12.5	μm
Standard Lengths	1.1/2.2/3.3/4.4/5.5 /6.6/7.7/8.8	km

## Mechanical Characteristics

	Spec. Values	Unit
Proof Test	≥ 100	kpsi
	≥ 8.8	N
Dynamic Tensile Strength Unaged Fiber (0.5m)		
Median Tensile Strength	≥ 3.8	GPa
15th Percentile Tensile Strength	≥ 3.3	GPa
Aged Fiber (0.5m)		
Median Tensile Strength	≥ 3.03	GPa
15th Percentile Tensile Strength	≥ 2.76	GPa
Dynamic Fatigue		
Stress Corrosion Parameter $n_4$	≥ 20	
Operating Temperature Range	-60 C to +85 C	
Coating Strip Force (typical)	5.5	N

## Environmental Characteristics

	Spec. Values	Unit
	at 850/1300nm	
Change of Temperature Attenuation increase, -60 C to +85 C	≤ 0.20	dB/km
Dry Heat Attenuation increase, 30 days at 85 C	≤ 0.20	dB/km
Damp Heat Attenuation increase, 30 days at 85 C/85% R.H.	≤ 0.20	dB/km
Water Immersion Attenuation increase, 30 days in 23 C water	≤ 0.20	dB/km

## Environmental friendly Packaging

The shipping spool is designed to safeguard j-fiber optical fiber not only during shipping but also during subsequent handling in the customer's plant. It features smooth inside surfaces to ensure that the fiber is wound on and off the reel without the risk of breaking. The reel barrel is isolated via a polyethylene cover. The inside end of the fiber can be accessed for various measurements while still on the shipping spool. Each spool carries product information, including fiber type,

measurement data and peel-off bar coding to assist with inventory control. All reels and transport boxes are designed to take advantage of our recycling program.

## Coating

j-fiber OptiGrade R.H. Multimode fiber is protected with our FCC, an enhanced coating material that guarantees long-term performance and reliability. The dual layer acrylate material is user friendly and compatible in all cable constructions, such as tight buffer and loose tube designs with low bending loss. Optimized for Multimode fiber the coating shows best-in-class low microbending sensitivity. The coating is mechanically strippable and leaves no residue.

## Spool Sizes

	Standard
Fiber length	≤ 8.8km
Spool diameter	9.25 /23.5cm
Spool width	4.21 /10.7cm
Spindle	1 /2.54cm
Traverse width	3.75 /9.5cm

## Ordering Information

To order OptiGrade R.H. radiation hardened optical fiber please call, fax or email us and specify the following parameters when ordering:

Fiber Type: OptiGrade R.H. Radiation  
Hardened Multimode Fiber

Performance class: 150 or 300

Fiber quantity: kms

Other: Desired ship date,  
reel length, special requests

All fibers and preforms are subject to j-fiber's ongoing process and quality improvement programs ensuring excellent performance and high reliability. We reserve the right to make changes to the above specification without notice.

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