CLEERLINE™
TECHNOLOGY GROUP

STRONGER

10,000X THE BEND
2.5 TO 4X GREATER PULL TENSION

SAFER

YES, SAFE
WILL NOT PUNCTURE SKIN

FASTER

TERMINATION IN 60 SECONDS
UP TO 80% LABOR SAVINGS

THE DEVELOPMENT OF SSF™ TECHNOLOGY

The question was simple. Why do we need to strip the protective coating from the glass? Could we eliminate many of the inherent challenges of fiber termination by incorporating a coating hard enough and concentric enough to allow for the technician to terminate fiber without getting down to bare glass?

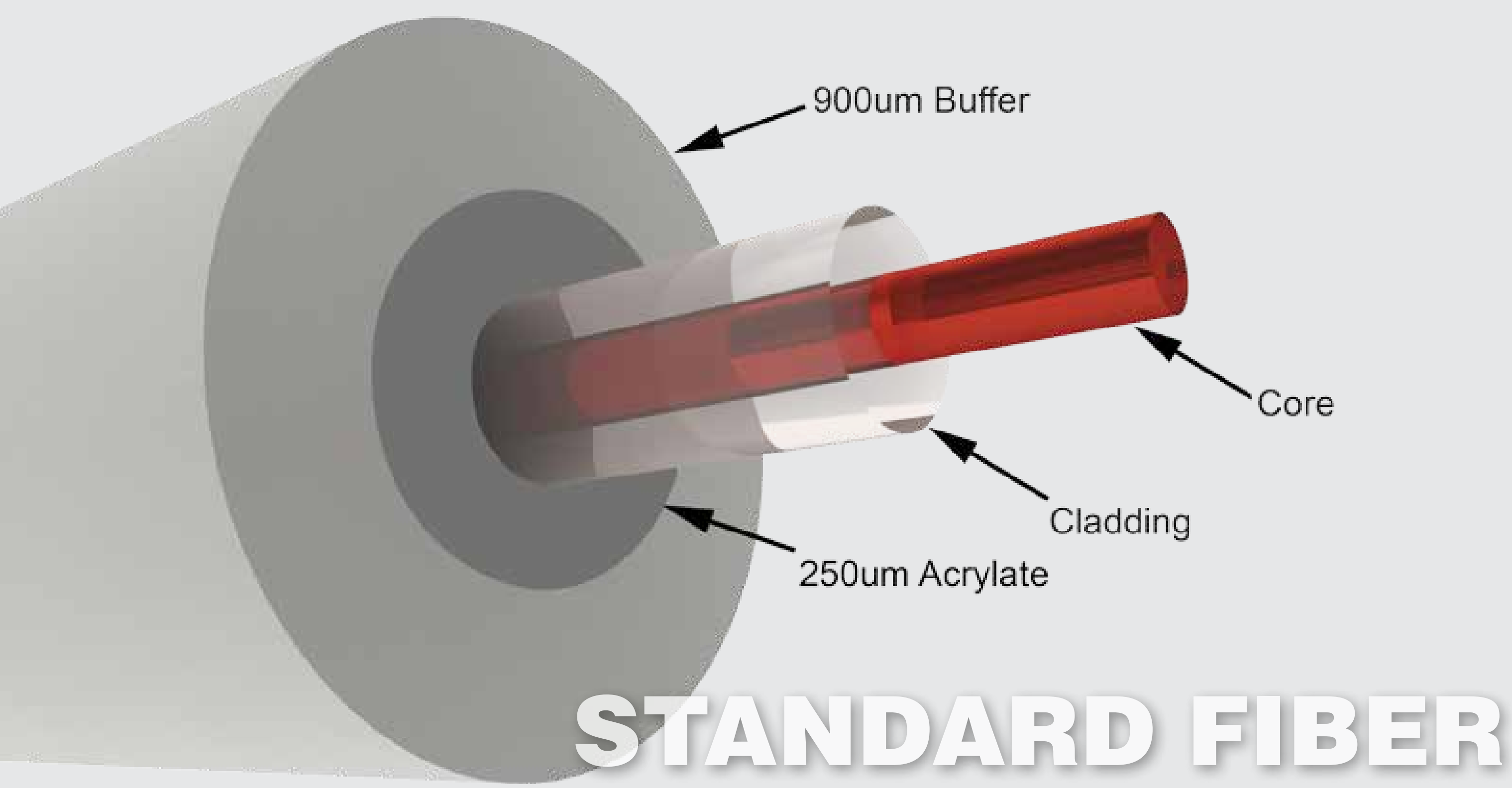
The core problem with glass, and especially with glass being the size of a human hair, is that it is fragile. Bend it, it will break, expose it to humidity it will breakdown back into silica and any imperfections it has on its surface will eventually cause it to fail. Glass is fragile, and terminating bare glass the way everyone has been required to for over 30 years is a delicate procedure. The technician must be precise and careful, because it can be dangerous. Overall this adds up to a complex procedure a technician spends time to learn and become proficient enough to perform for a living.

But what if you didn't have to remove a protective coating from the glass to terminate a fiber into a connector? What would this do for the process? What would this do for the durability of the fiber?

IT WOULD CHANGE EVERYTHING.
IT WOULD REDEFINE FIBER OPTICS.

Cleerline Technology Group's SSF™ Redefines Fiber Optics. Starting with an industry-proven Glass, Glass, Polymer Fiber—which today is known as being the most durable fiber construction available. We modified the coating layer, making it thinner. With a thinner polymer coating SSF™ product can be cleaved in the field using standard cleavers.

The benefits of our SSF™ proprietary GGP Fibers are that they are Stronger, Safer, and Faster terminating than any other product on the market.



STRONGER - 10,000 times the bend longevity, and up to 200 times the durability allows technicians to treat our product like standard Category cable with no fear of failure.

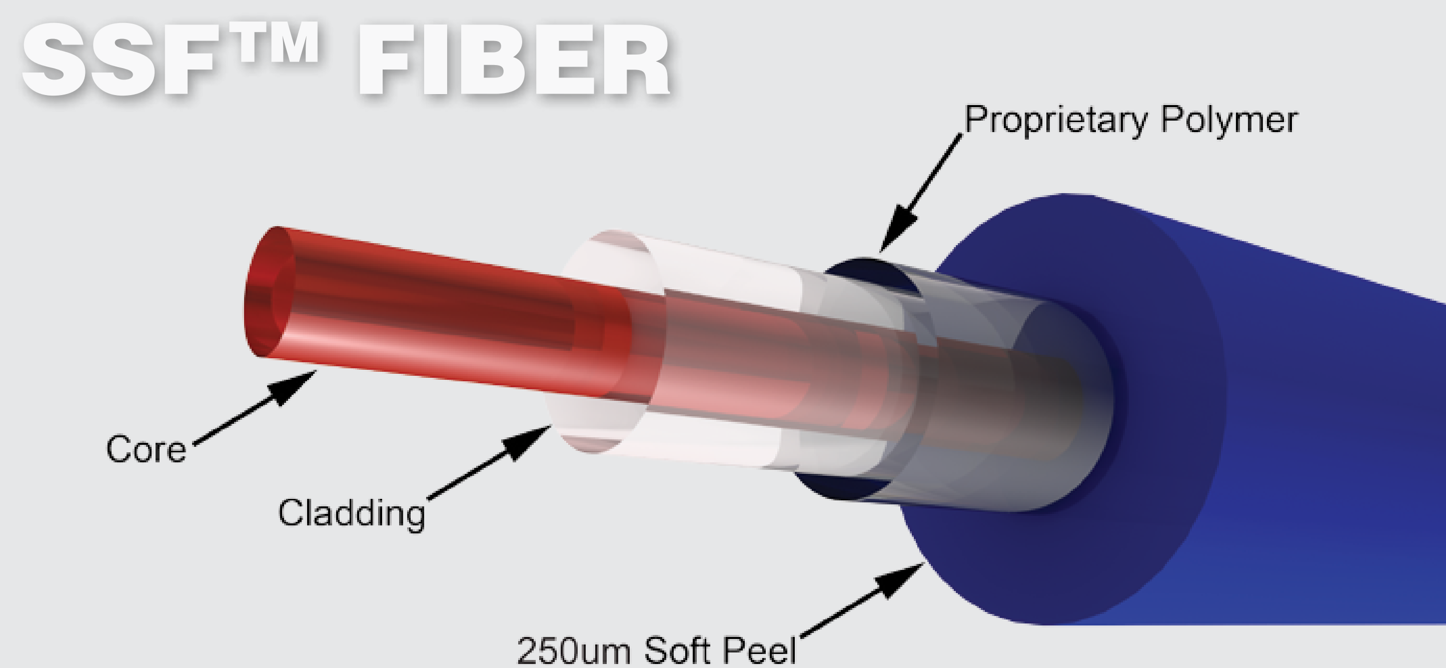
SAFER - The fiber with its smaller glass-cladding layer is more bendable and forgiving. The 125um coated GGP will not puncture the skin.

FASTER - SSF™ is faster to terminate by skilled technicians since there is less preparation, less precautions, and overall is simpler to handle. It is also faster to train a new technician to get up to speed making quality connections.
Note: with our Residential AV background we have successfully trained customers to terminate fiber over the phone on a job-site (not ideal, but speaks volumes on the ease of use SSF™ enables).

Cleerline makes the SSF™ fiber in two formats:

SSF-H comes with standard hard acrylate coating on top of the polymer to 250um. This version allows the fiber to be put into specific constructions where a 500–900um tight buffer is required or desired.

SSF-S is Cleerline's flagship product utilizing a soft peel acrylate coating, specifically designed to be simply removed from the fiber with your fingers.



STRONGER

Mechanical/Dynamic Fatigue is a rarely acknowledged value within the IEC60793-1-33 standard for fiber optics. Ninety percent of the fibers available in the market today all meet the requirement value of Nd=18, while the more durable fibers in the market typically meet a value of Nd=20. So what does it mean? How is it derived? What does it mean to have a value of Nd=30 vs. Nd=20?

Mechanical/Dynamic Fatigue is a value determined by three primary tests that simulate fiber under duress or stress for an extended period of time: the purpose is to create a standard value to determine whether a cable or fiber can meet the requirements of an installation and survive under adverse conditions of that installation for a period of time.

These three tests include:

- Repeat Bending Test - where the fiber is bent over a mandrel 200 times to determine if the fiber will illustrate micro fractures, or surface fractures.
- Hot Water Tight Bend Test - where the fiber is bent to 3–3.5mm between two metal plates, submerged in 90 degree Celsius water, and timed to failure/breakage.
- Elongation / Tensile Strength Test - where the fiber is stretched and tested to maximum capacity.

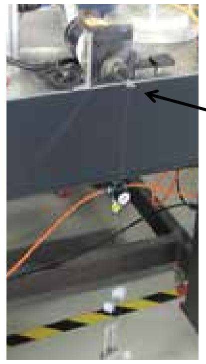
The values of these tests are put into a series of complex formulas to determine the ultimate value Nd="X".

Nd=30 MEANS SSF™ FIBER IS STRONGER.

SSF™ REPEAT BENDING TEST

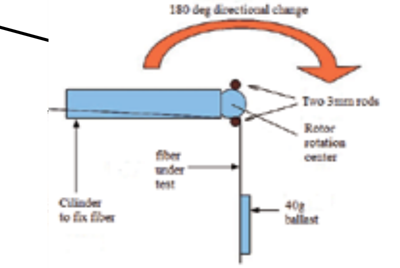
Repeated Bending Test

Equipment



Scheme

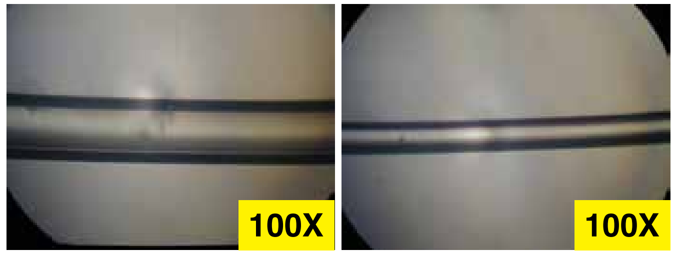
One fiber end is fixed to the cylinder. The other one is passed through two 3mm rods and equipped with 40g ballast. Then motorized engine rotates 180 degress back and forth to bend the fiber in different directions.



SSF™ Fiber Repeat Bending Test

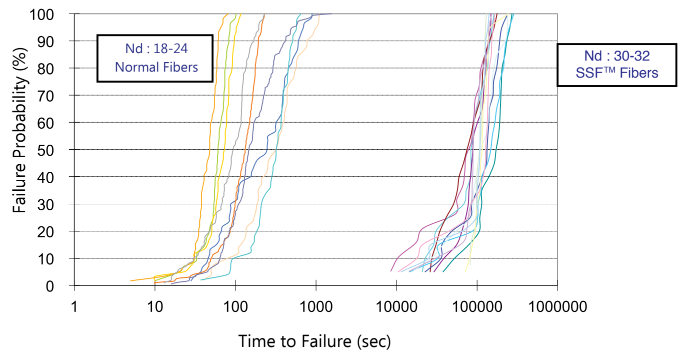
After 200 times of repeat bending procedure there is no measurable increase in signal loss. Acrylate layer cracks are found with microscope.

After removing the acrylate layer there's some marking on the coated layer. The breaking force was found to be the same as the initial test. After bend test, the strength of fiber is unchanged.



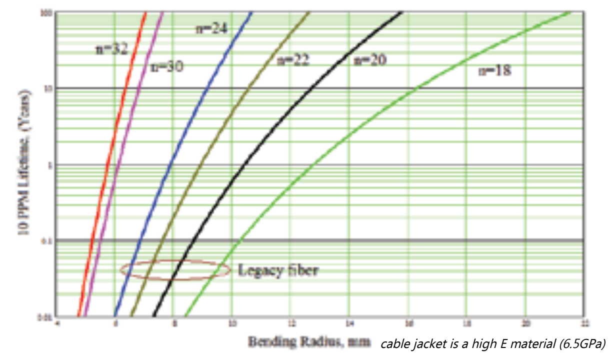
SSF™ HOT WATER TIGHT BEND TEST

Bending (D=3mm) in Hot Water (90°C)



SSF™ having an Nd=30 value exceeds typical fibers including "bend & curve" type fibers in bend performance by over 10,000x for greater reliability compared to standard fiber.

The impact of **n** on cable lifetime estimation (OD=3mm, cladding=125um, bending + 145N tension)



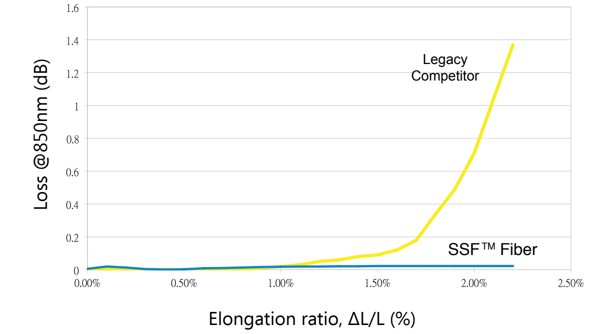
The graphs demonstrates the importance of fatigue value (n) for lifetime estimation. SSF™ (n=30) performs better under bend and pull conditions then all standard fibers including "bend & curve" types for extended lifetime, performance, and reliability.

SSF™ ELONGATION / TENSILE STRENGTH TEST

Tensile Strength Test Procedure

The fiber is tightly fixed between two translation stages. Then one stage is moved to elongate fiber.

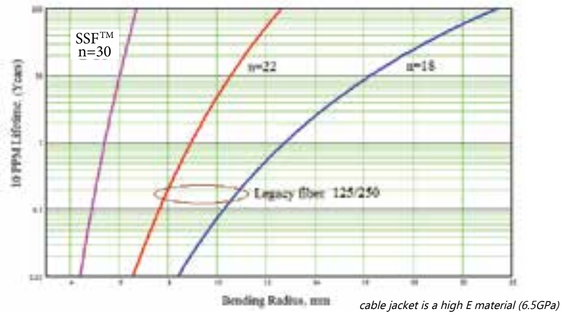
Tensile Strength Test



SSF™ fiber exceeds all other fibers in tensile strength allowing for increased pull force of over 3 to 4 times that of standard fibers during installation.

SSF™ IMPACT OF ND = X ON CABLE LIFETIME

Different fibers put in 3mm OD cable lifetime estimation (bending and 145N additional tension)



- All cables have OD=3mm and high E value for jacket material
- It is shown tat fibers with higher **n** values provide better performance/extended lifetime
- SSF™ performance exceeds typical "legacy" fibers and even "bend & curve" type fibers due to lower glass diameter and consequently smaller static bending stress

Cable Lifetime Estimates

- Both bending and tension force should be considered to accurately determine the long term mechanical reliability of the optical fiber.
- Fiber lifetime estimate- IEC TR 62048
- The additional tension force calculation- *Dave Mazzarese et al., Proc 57th IWCS (2008)*

The following test results prove that SSF™ has superior mechanical and bending properties in all environments, even under rugged conditions. SSF™ can withstand bend and pull tensions that cause standard fibers to fail, providing greater reliability and performance than any other commercially available fiber.

SAFER / FASTER

SAFER

How is SSF™ safer? What does it mean to be a safer fiber?

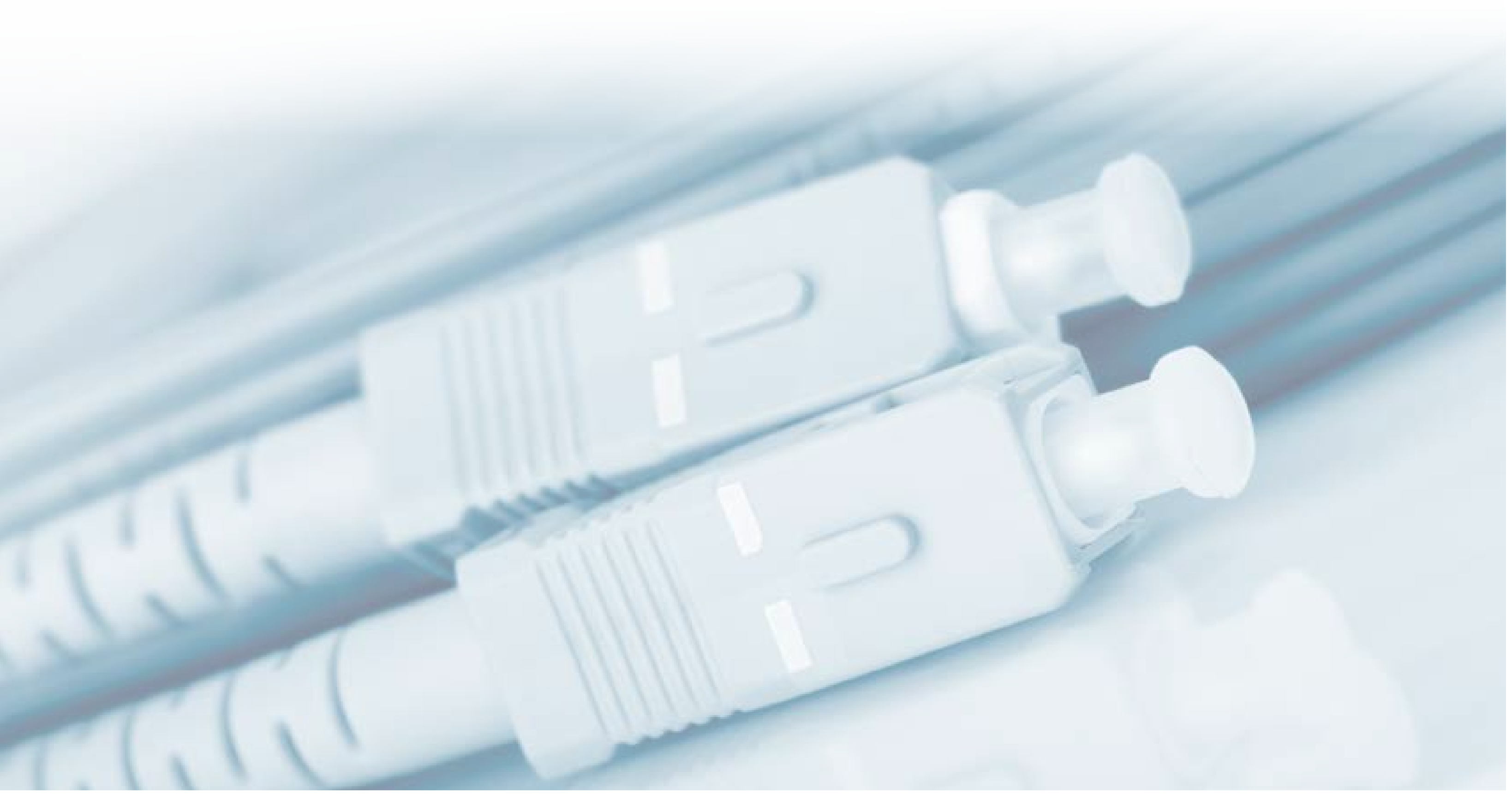
Have you ever seen a fiber technician work with fiber? They are generally very meticulous. They set up their work area to insure that all fiber pieces are collected and disposed of properly. Why?

Fiber is glass, it is a very small piece of glass that if left out can puncture your skin very easily. Everyone has heard the myth that fiber can get into your blood stream and run all the way to your heart and kill you. That myth isn't too far off. If you ingested a piece of fiber, it could puncture the intestinal walls and cause significant discomfort, possibly severe internal bleeding. While we do not recommend ingesting our fiber, handling SSF™ is not nearly as dangerous as standard 125um fiber.

The more important safety concern is that our fiber will not break as easily when inserting into a connector or present danger when handling the small piece of glass left after cleaving. This makes our fiber much easier to handle, and friendly to the touch.

Remember that smaller cladding diameter? Our fiber is more bendable, that smaller diameter with the addition of our proprietary polymer coating makes our fiber incredibly safe to handle. To this date, our fiber has not punctured soft tissues enabling technicians handling SSF™ to do so without fear.

No longer will you deal with embedded fiber in your fingers or infection from pieces of glass fiber stuck in your skin that cannot be removed because you cannot see them. Our fiber will not puncture the skin and will remain safe to handle even down to the smallest pieces of fiber found during an install, avoiding danger for the installer or end-user.



FASTER

Faster, in more ways than one. SSF™ technology removes 50% of the standard termination procedures from the process, and with its increased durability and enhanced safety allows technicians to handle the fiber easier, with no fear.

SSF™ is faster to terminate because the bare fiber is never exposed. This removes the need for being precise in measuring and stripping, making the whole process simpler and more approachable.

In a controlled case study with trained certified fiber technicians Cleerline SSF™ fiber was on average 33% faster to terminate compared to the leading products available on the market; this with only a brief 10 minutes of training on this new process. The study also illustrated identical attenuation loss for our fiber vs. the leading competition. The high level results for Cleerline's SSF™ fiber vs. the control are as follows:

- Average Time for Termination (Control) = 159 Seconds or 2 min. 39 sec.
- Average Time for Termination (SSF™) = 106 Seconds or 1 min. 46 sec.
- Average Loss SET @ 1310nm (Control) = 0.38db
- Average Loss SET @ 1310nm (SSF™) = 0.38db
- Average Loss SET @ 1550nm (Control) = 0.32db
- Average Loss SET @ 1550nm (SSF™) = 0.35db
- Average Loss DET @ 1310nm (Control) = 0.67db
- Average Loss DET @ 1310nm (SSF™) = 0.65db
- Average Loss DET @ 1550nm (Control) = 0.56db
- Average Loss DET @ 1550nm (SSF™) = 0.57db

SSF™ is also faster for training new technicians on mechanical field terminations. The coated glass makes it easier than terminating Cat5, Cat6, and most certainly Cat7. It's so easy we have trained installers over the phone.

In a case study conducted in China, we demonstrated that line workers could be trained with no previous fiber experience to terminate SSF™ with simple instructions within a 30 minute period. By the end of the session, all workers could terminate mechanical splice connections to FOA standards.

Further SSF™ technology does not require technicians to be certified to terminate, only that a proper measurement of loss after the job is complete that meets FOA standards be submitted for warranty.

Bottom line, Cleerline's SSF™ technology is Fiber Optics Redefined; it is fiber made easy, and it is changing the way the world thinks about fiber.

SSF™ MULTIMODE FIBER PERFORMANCE SPECIFICATIONS COMPARED TO INDUSTRY STANDARDS

Parameter	SSF™ Multimode Fiber Specification				Test Method	Industry Standard ISO/IEC 11801	Industry Standard IEC 60793-2-10	Industry Standard ITU G651.1	Industry Standard TIA/EIA 492AAAD	Industry Standard TIA/EIA 492AAAC-B	Industry Standard TIA/EIA 492AAAB-A
Attenuation(dB/km)					FOTP 78						
850nm	3.0				IEC 60793-1-40	≤ 3.5 (Cabled)	2.4-3.5 (A1a.1) 2.5 (A1a.2)	≤ 3.5 (Cabled)	≤ 2.5	≤ 2.5	≤ 3.0
1300nm	1.0					≤ 1.5 (Cabled)	0.7-1.5 (A1a.1) 0.8 (A1a.2)	≤ 1 (Cabled)	≤ 0.8	≤ 0.8	≤ 1.0
1380nm value minus 1300nm value	≤ 3.0						--	--	≤ 3.0	≤ 3.0	≤ 3.0
Point Discontinuity (dB)	≤ 0.05				FOTP 78		--	--	≤ 0.2	≤ 0.2	≤ 0.2
850 nm and 1300nm					IEC 60793-1-40						
Attenuation with Bending (dB)	Turns	Radius	nm	dB	FOTP 62						
	100	37.5	850	≤ 0.5	IEC 60793-1-47		≤ 0.5	--	--	--	--
	100	37.5	1300	≤ 0.5			≤ 0.5	--	--	--	--
	2	15	850	≤ 0.1			--	< 1	--	--	--
	2	15	1300	≤ 0.3			--	< 1	--	--	--
	2	7.5	850	≤ 0.2			--	--	--	--	--
	2	7.5	1300	≤ 0.5			--	--	--	--	--
Modal Bandwidth (MHz·km)	OM2	SSF™ Multimode Fiber OM3	OM4								
OFL @ 850 nm	≥ 500	≥ 1500	≥ 3500		FOTP 204	≥ 200 (OM1) ≥ 500(OM2) ≥ 1500 (OM3)	200-800 (A1a.1) 1500 (A1a.2)	≥ 500	≥ 3500	≥ 1500	≥ 400
OFL @1300 nm	≥ 500	≥ 500	≥ 500		IEC 60793-1-41	≥ 500 for OM1/OM2/OM3	500	≥ 500	≥ 500	≥ 500	≥ 400
EMB @ 850 nm	≥ 850	≥ 2000	≥ 4700		FOTP 220 IEC 60793-1-49	≥ 2000 for OM3	≥ 2000 (A1a.2)	--	≥ 4700	≥ 2000	--
Numerical Aperture	0.200 ± 0.015				FOTP 177 IEC 60793-1-43	Complies with IEC 60793-2-10	0.200 ±0.015	0.200 ±0.015	0.200 ±0.015	0.200 ±0.015	0.200 ±0.015
Core Diameter (µm)	50.0 ± 2.5				FOTP 176 IEC 60793-1-20	Complies with IEC 60793-2-10	50.0 ± 3.0	50.0 ± 3.0	50.0 ± 2.5	50.0 ± 3.0	50.0 ± 3.0

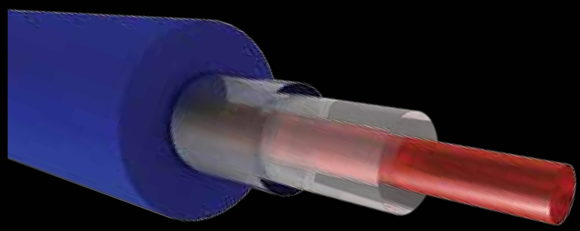
SSF™ SINGLEMODE FIBER PERFORMANCE SPECIFICATIONS COMPARED TO INDUSTRY STANDARDS

Parameter	SSF™ Singlemode				Test Method	Industry Standard ITU G.652.D	Industry Standard ITU G.657.A1	Industry Standard ITU G.657.A2	Industry Standard ITU G.657.B2	Industry Standard ITU G.657.B3
Attenuation(dB/km)					FOTP 78					
1310 nm	≤ 0.35				IEC 60793-1-40	≤ 0.4 (Cabled)	≤ 0.4 (Cabled)	≤ 0.4 (Cabled)	≤ 0.5 (Cabled)	≤ 0.5 (Cabled)
1385 nm	≤ 0.31					≤ 0.4 (Cabled)	≤ 0.4 (Cabled)	≤ 0.4 (Cabled)		
1550 nm	≤ 0.21					≤ 0.3 (Cabled)	≤ 0.3 (Cabled)	≤ 0.3 (Cabled)	≤ 0.3 (Cabled)	≤ 0.3 (Cabled)
1625 nm	≤ 0.23								≤ 0.4 (Cabled)	≤ 0.4 (Cabled)
Mode Field Diameter					FOTP 167					
1310 nm	8.6 ± 0.4					(8.6 ~9.5) ± 0.6	(8.6 ~9.5) ± 0.4	(8.6 ~9.5) ± 0.4	(6.3 ~9.5) ± 0.4	(6.3 ~9.5) ± 0.4
1550nm	9.7 ± 0.5									
Cable Cut-Off Wavelength	≤ 1260				FOTP 80	≤ 1260	≤ 1260	≤ 1260	≤ 1260	≤ 1260
Zero Dispersion Wavelength	1300 ~ 1324				FOTP 75	1300 ~ 1324	1300 ~ 1324	1300 ~ 1324	--	--
Zero Dispersion Slope	≤ 0.092				FOTP 75	≤ 0.092	≤ 0.092	≤ 0.092	--	--
Dispersion Coefficient					FOTP 75					
1285 - 1330 nm	≤ 3.1					--	--	--	--	--
1550 nm	≤ 18					--	--	--	--	--
Attenuation Directional Uniformity	≤ 0.03									
Point Discontinuity (dB)	≤ 0.05				FOTP 78					
Attenuation with Bending (dB)	Turns	R (mm)	nm	dB	FOTP 62					
	1	5	1550	≤ 0.75	IEC 60793-1-47	--	--	--	--	≤ 0.15
	1	5	1625	≤ 1.0		--	--	--	--	≤ 0.45
	1	7.5	1550	≤ 0.5		--	--	≤ 0.5	≤ 0.5	≤ 0.08
	1	7.5	1625	≤ 1.0		--	--	≤ 1.0	≤ 1.0	≤ 0.25
	1	10	1550	≤ 0.1		--	≤ 0.75	≤ 0.1	≤ 0.1	≤ 0.03
	1	10	1625	≤ 0.2		--	≤ 1.5	≤ 0.2	≤ 0.2	≤ 0.1
	10	15	1550	≤ 0.03		--	≤ 0.25	≤ 0.03	≤ 0.03	--
	10	15	1625	≤ 0.1		--	≤ 1.0	≤ 0.1	≤ 0.1	--
Cladding Diameter (µm)	125.0 ± 0.7				FOTP 176	125.0 ± 1.0	125 ± 0.7	125 ± 0.7	125 ± 0.7	125 ± 0.7
Cladding Non-Circularity (%)	≤ 1.0				IEC 60793-1-20	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0	≤ 1.0
Core-Clad Concentricity (µm)	≤ 0.5					≤ 0.6	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
Length (km)	2.2~25.2				Calibrated Winder IEC 60793-1-22	--	--	--	--	--
Environmental/ Attenuation (dB/km)	**1310 and 1550 nm**									
Temperature Dependence (-60℃ +85℃)	≤ 0.05				FOTP 3 IEC 60793-1-52	--	--	--	--	--
Dry Heat Soak (85 ± 2℃)	≤ 0.05				FOTP 67 IEC 60793-1-51	--	--	--	--	--
Water Immersion (23 ± 2℃)	≤ 0.05				FOTP 74 IEC 60793-1-53	--	--	--	--	--
Overall Coating Diameter (µm)	245 ± 10				FOTP 195	--	--	--	--	--
Coating-Cladding Concentricity (µm)	≤ 6				IEC 60793-1-21	--	--	--	--	--
Minimum Strength (by Proof Test)	≧0.69 Gpa				FOTP 31 IEC 60793-1-30	≥ 0.69 Gpa	≥ 0.69 Gpa	≥ 0.69 Gpa	≥ 0.69 Gpa	≥ 0.69 Gpa
Coating Strip Force (N)										
Peak	< 1.0				FOTP-178	--	--	--	--	--
Average	< 1.0				IEC 60793-1-32	--	--	--	--	--

FIBER OPTICS, REDEFINED

THERE HAVE BEEN MANY ADVANCEMENTS IN THE TECHNOLOGY OF FIBER OPTICS OVER RECENT DECADES. CLEERLINES'S SSF™ FIBER OPTIC CABLE HAS SET THE NEW STANDARD.

THIS IS FIBER OPTICS, REDEFINED.



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UP TO 80% LABOR SAVINGS

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www.cleerlinefiber.com

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