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M41L01 - August 3, 2015

Item # M41L01 was discontinued on August 3, 2015. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

STEP-INDEX MULTIMODE FIBER OPTIC PATCH CABLES: SMA TO SMA

- ▶ Wide Variety of NAs and Core Sizes Available
- ▶ Available in Lengths up to 20 m
- ▶ Custom Cables Available with Same-Day Shipping

Application Idea

M28L01 Patch Cable with M625F1 Fiber-Coupled LED Light Source

SMA905 Connectors on Both Ends

OVERVIEW

Features

- Numerical Apertures from 0.10 to 0.48
- Cables Available for Wavelengths from 250 nm to 2400 nm
- Available in Lengths up to 20 m
- SMA905 Connectors on Both Ends
- Ø3 mm, Ø3.8 mm, or Ø5 mm Outer Jacket
- Custom Cables Available

Applications

- Spectroscopy
- Illumination
- LED Energy Transmission
- Medical Instruments
- Optogenetics

Item #	Core	NA	Wavelength Range[a]	Fiber Used
M65L	Ø10 µm	0.10	400 - 550 nm and 700 - 1400 nm	HPSC10
M68L	Ø25 µm	0.10	400 - 550 nm and 700 - 1400 nm	HPSC25
M14L	Ø50 µm	0.22	400 to 2400 nm (Low OH)	FG050LGA
M15L	Ø105 µm	0.22	400 to 2400 nm (Low OH)	FG105LCA
M92L	Ø200 µm	0.22	250 to 1200 nm (High OH)	FG200UEA
M25L	Ø200 µm	0.22	400 to 2200 nm (Low OH)	FG200LCC
M38L	Ø200 µm	0.39	400 to 2200 nm (Low OH)	FT200EMT
M28L	Ø400 µm	0.39	400 to 2200 nm (Low OH)	FT400EMT
M40L	Ø400 µm	0.48	400 to 2200 nm (Low OH)	BFL48-400
M37L	Ø550 µm	0.22	400 to 2200 nm (Low OH)	FG550LEC
M29L	Ø600 µm	0.39	400 to 2200 nm (Low OH)	FT600EMT
M41L	Ø600 µm	0.48	400 to 2200 nm (Low OH)	BFL48-600
M35L	Ø1000 µm	0.39	400 to 2200 nm (Low OH)	FT1000EMT
M71L	Ø1000 µm	0.48	400 to 2200 nm (Low OH)	BFL48-1000
M93L	Ø1500 µm	0.39	300 to 1200 nm (High OH)	FT1500UMT

- Click on the wavelength range to view the attenuation plot. Some graphs have a shaded region, which indicates the specified wavelength range.

Thorlabs offers multimode step index fiber optic patch cables with SMA905 (straight ferrule) connectors on both ends. These cables are ideal for a broad range of wavelengths from 250 nm to 2400 nm.

Each patch cable includes two protective caps that shield the connector ends from dust and other hazards. Additional CAPM Rubber Fiber Caps and CAPMM Metal Threaded Fiber Caps for SMA-terminated ends are also sold separately. All patch cables on this page are sold from stock with same-day shipping available.

The majority of the cables on this page have orange or red PVC furcation tubing, while the Ø1500 µm core cables have stainless steel jackets. The large core diameter and high NA of the fibers on this page makes it easier for stray ambient light to enter through FT030 and FT038 fiber jackets; for light-sensitive applications, use cables with these jackets in a dark room. Alternatively, customers can also purchase custom patch cables using our black or stainless steel furcation tubing (e.g., FT030-BK, FT038-BK, FT061PS, and others) to minimize stray light entering the fiber.

Compared to unterminated fiber, the maximum power of these cables is limited due to their connectorization. Please see the *Damage Threshold* tab for detailed information.

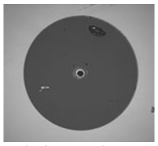
We have extensive patch cable capabilities including a large, diverse stock of optical fiber and many different types of fiber connectors. If you do not see a stock cable suitable for your application, please see our Custom Patch Cables webpage to request a cable that meets your specific needs.

In-Stock Multimode Fiber Optic Patch Cable Selection

Step Index														Graded Index	Fiber Bundles
SMA	FC/PC	FC/PC to SMA	High-Power SMA	Solarization-Resistant SMA	AR-Coated SMA	HR-Coated FC/PC	Beamsplitter-Coated FC/PC	Armored SMA	Fluoride FC and SMA	Rotary Joint FC/PC and SMA	Lightweight FC/PC	Lightweight SMA	Vacuum-Compatible SMA	FC/PC	

DAMAGE THRESHOLD

Laser Induced Damage in Optical Fibers



Click to Enlarge
Damaged Fiber End

Click to Enlarge
Undamaged Fiber End

The following tutorial details damage mechanisms in unterminated (bare) and terminated optical fibers, including damage mechanisms at both the air-to-glass interface and within the glass of the optical fiber. Please note that while general rules and scaling relations can be defined, absolute damage thresholds in optical fibers are extremely application dependent and user specific. This tutorial should only be used as a guide to estimate the damage threshold of an optical fiber in a given application. Additionally, all calculations below only apply if all cleaning and use recommendations listed in the last section of this tutorial have been followed. For further discussion about an optical fiber's power handling abilities within a specific application, contact Thorlabs' Tech Support.

Damage at the Free Space-to-Fiber Interface

There are several potential damage mechanisms that can occur at the free space-to-fiber interface when coupling light into a fiber. These come into play whether the fiber is used bare or terminated in a connector.

Unterminated (Bare) Fiber

Unterminated Silica Fiber Maximum Power Densities

Damage mechanisms in bare optical fiber can be modeled similarly to bulk optics, and industry-standard damage thresholds for UV Fused Silica substrates can be applied to silica-based fiber (refer to the table to the right). The surface areas and beam diameters involved at the air-to-glass interface are extremely small compared to bulk optics, especially with single mode (SM) fiber, resulting in very small damage thresholds.

Type	Theoretical Damage Threshold	Practical Safe Value
CW (Average Power)	1 MW/cm^2	250 kW/cm^2
10 ns Pulsed (Peak Power)	5 GW/cm^2	1 GW/cm^2

The effective area for SM fiber is defined by the mode field diameter (MFD), which is the effective cross-sectional area through which light propagates in the fiber. A free-space beam of light must be focused down to a spot of roughly 80% of this diameter to be coupled into the fiber with good efficiency. MFD increases roughly linearly with wavelength, which yields a roughly quadratic increase in damage threshold with wavelength. Additionally, a beam coupled into SM fiber typically has a Gaussian-like profile, resulting in a higher power density at the center of the beam compared with the edges, so a safety margin must be built into the calculated damage threshold value if the calculations assume a uniform density.

Multimode (MM) fiber's effective area is defined by the core diameter, which is typically far larger than the MFD in SM fiber. Kilowatts of power can be typically coupled into multimode fiber without damage, due to the larger core size and the resulting reduced power density.

It is typically uncommon to use single mode fibers for pulsed applications with high per-pulse powers because the beam needs to be focused down to a very small area for coupling, resulting in a very high power density. It is also uncommon to use SM fiber with ultraviolet light because the MFD becomes extremely small; thus, power handling becomes very low, and coupling becomes very difficult.

Example Calculation

For SM400 single mode fiber operating at 400 nm with CW light, the mode field diameter (MFD) is approximately Ø3 µm. For good coupling efficiency, 80% of the MFD is typically filled with light. This yields an effective diameter of Ø2.4 µm and an effective area of 4.52 µm^2:

$$\text{Area} = \pi r^2 = \pi(\text{MFD}/2)^2 = \pi \cdot 1.2^2\ \mu\text{m}^2 = 4.52\ \mu\text{m}^2$$

This can be extrapolated to a damage threshold of 11.3 mW. We recommend using the "practical value" maximum power density from the table above to account for a Gaussian power distribution, possible coupling misalignment, and contaminants or imperfections on the fiber end face:

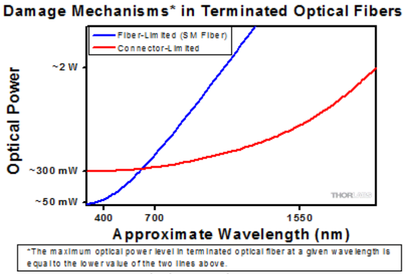
$$250\ \text{kW/cm}^2 = 2.5\ \text{mW}/\mu\text{m}^2$$

$$4.25\ \mu\text{m}^2 \cdot 2.5\ \text{mW}/\mu\text{m}^2 = 11.3\ \text{mW}$$

Terminated Fiber

Optical fiber that is terminated in a connector has additional power handling considerations. Fiber is typically terminated by being epoxied into a ceramic or steel ferrule, which forms the interfacing surface of the connector. When light is coupled into the fiber, light that does not enter the core and propagate down the fiber is scattered into the outer layers of the fiber, inside the ferrule.

The scattered light propagates into the epoxy that holds the fiber in the ferrule. If the light is intense enough, it can melt the epoxy, causing it to run onto the face of the connector and into the beam path. The epoxy can be burned off, leaving residue on the end of the fiber, which reduces coupling efficiency and increases scattering, causing further damage. The lack of epoxy between the fiber and ferrule can also cause the fiber to be decentered, which reduces the coupling efficiency and further increases scattering and damage.



Click to Enlarge

The power handling of terminated optical fiber scales with wavelength for two reasons. First, the higher per photon energy of short-wavelength light leads to a greater likelihood of scattering, which increases the optical power incident on the epoxy near the end of the connector. Second, shorter-wavelength light is inherently more difficult to couple into SM fiber due to the smaller MFD, as discussed above. The greater likelihood of light not entering the fiber's core again increases the chance of damaging scattering effects. This second effect is not as common with MM fibers because their larger core sizes allow easier coupling in general, including with short-wavelength light.

Fiber connectors can be constructed to have an epoxy-free air gap between the optical fiber and ferrule near the fiber end face. This design feature, commonly used with multimode fiber, allows some of the connector-related damage mechanisms to be avoided. Our high-power multimode fiber patch cables use connectors with this design feature.

Combined Damage Thresholds

As a general guideline, for short-wavelength light at around 400 nm, scattering within connectors typically limits the power handling of optical fiber to about 300 mW. Note that this limit is higher than the limit set by the optical power density at the fiber tip. However, power handing limitations due to connector effects do not diminish as rapidly with wavelength when compared to power density effects. Thus, a terminated fiber's power handling is "connector-limited" at wavelengths above approximately 600 nm and is "fiber-limited" at lower wavelengths.

The graph to the right shows the power handling limitations imposed by the fiber itself and a surrounding connector. The total power handling of a terminated fiber at a given wavelength is limited by the lower of the two limitations at that wavelength. The fiber-limited (blue) line is for SM fibers. An equivalent line for multimode fiber would be far above the SM line on the Y-axis. For terminated multimode fibers, the connector-limited (red) line always determines the damage threshold.

Please note that the values in this graph are rough guidelines detailing estimates of power levels where damage is very unlikely with proper handling and alignment procedures. It is worth noting that optical fibers are frequently used at power levels above those described here. However, damage is likely in these applications. The optical fiber should be considered a consumable lab supply if used at power levels above those recommended by Thorlabs.

Damage Within Optical Fibers

In addition to damage mechanisms at the air-to-glass interface, optical fibers also display power handling limitations due to damage mechanisms within the optical fiber itself. Two categories of damage within the fiber are damage from bend losses and damage from photodarkening.

Bend Losses
Bend losses occur when a fiber is bent to a point where light traveling in the core is incident on the core/cladding interface at an angle higher than the critical angle, making total internal reflection impossible.Under these circumstances, light escapes the fiber, often in one localized area. The light escaping the fiber typically has a high power density, which can cause burns to the fiber as well as any surrounding furcation tubing.

A special category of optical fiber, called double-clad fiber, can reduce the risk of bend-loss damage by allowing the fiber’s cladding (2nd layer) to also function as a waveguide in addition to the core. By making the critical angle of the cladding/coating interface higher than the critical angle of the core/clad interface, light that escapes the core is loosely confined within the cladding. It will then leak out over a distance of centimeters or meters instead of at one localized spot within the fiber, minimizing damage. Thorlabs manufactures and sells 0.22 NA double-clad multimode fiber, which boasts very high, megawatt range power handling.

Photodarkening
A second damage mechanism within optical fiber, called photodarkening or solarization, typically occurs over time in fibers used with ultraviolet or short-wavelength visible light. The pure silica core of standard multimode optical fiber can transmit ultraviolet light, but the attenuation at these short wavelengths increases with the time exposed to the light. The mechanism that causes photodarkening is largely unknown, but several strategies have been developed to combat it. Fibers with a very low hydroxyl ion (OH) content have been found to resist photodarkening. Other dopants, including fluorine, can also reduce photodarkening.

Germanium-doped silica, which is commonly used for the core of single mode fiber for red or IR wavelengths, can experience photodarkening with blue visible light. Thus, pure silica core single mode fibers are typically used with short wavelength visible light. Single mode fibers are typically not used with UV light due to the small MFD at these wavelengths, which makes coupling extremely difficult.

Even with the above strategies in place, all fibers eventually experience photodarkening when used with UV light, and thus, fibers used with these wavelengths should be considered consumables.

Tips for Maximizing an Optical Fiber's Power Handling Capability

With a clear understanding of the power-limiting mechanisms of an optical fiber, strategies can be implemented to increase a fiber’s power handling capability and reduce the risk of damage in a given application. All of the calculations above only apply if the following strategies are implemented.

One of the most important aspects of a fiber’s power-handling capability is the quality of the end face. The end face should be clean and clear of dirt and other contaminants that can cause scattering of coupled light. Additionally, if working with bare fiber, the end of the fiber should have a good quality cleave, and any splices should be of good quality to prevent scattering at interfaces.

The alignment process for coupling light into optical fiber is also important to avoid damage to the fiber. During alignment, before optimum coupling is achieved, light may be easily focused onto parts of the fiber other than the core. If a high power beam is focused on the cladding or other parts of the fiber, scattering can occur, causing damage.

Additionally, terminated fibers should not be plugged in or unplugged while the light source is on, again so that focused beams of light are not incident on fragile parts of the connector, possibly causing damage.

Bend losses, discussed above, can cause localized burning in an optical fiber when a large amount of light escapes the fiber in a small area. Fibers carrying large amounts of light should be secured to a steady surface along their entire length to avoid being disturbed or bent.

Additionally, choosing an appropriate optical fiber for a given application can help to avoid damage. Large-mode-area fibers are a good alternative to standard single mode fibers in high-power applications. They provide good beam quality with a larger MFD, thereby decreasing power densities. Standard single mode fibers are also not generally used for ultraviolet applications or high-peak-power pulsed applications due to the high spatial power densities these applications present.

NA TUTORIAL

Numerical Aperture

Numerical Aperture (NA), a measure of the acceptance angle of a fiber, is a dimensionless quantity. For applications, it is most commonly expressed as

$$NA = n_i sin\theta_a$$

where θ_a is the maximum 1/2 acceptance angle of the fiber, and n_i is the index of refraction of the material outside of the fiber. This material is typically air, making it equal to approximately 1.0, as shown in the figure below.

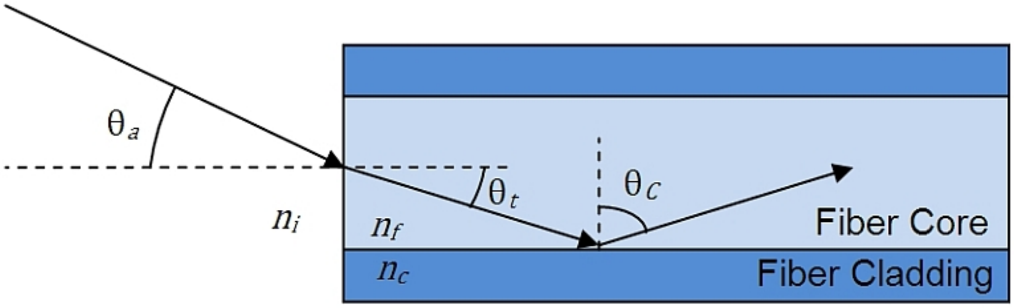


Figure: A ray at the maximum 1/2 acceptance angle propagates into a fiber.

Numerical Aperture can also be defined in terms of the index of refraction of the fiber core and cladding. Due to Snell's law, there is a critical angle above which all of the light at a fiber-cladding interface will experience total internal reflection. In turn, this means that there is a maximum acceptance angle at which light can enter the fiber. Following Snell's law, the maximum acceptance angle can be determined:

$$sin\theta_c = \frac{n_c}{n_f} = cos\theta_t$$
$$\frac{n_c}{n_f} = \sqrt{1 - sin^2\theta_t}$$
$$NA = n_i sin\theta_a = \sqrt{n_f^2 - n_c^2}$$

Where:
n_f is the index of refraction of the fiber core, n_c is the index of refraction of the cladding,
θ_c is the critical angle for total internal reflection, and
θ_a is the maximum 1/2 acceptance angle.

This is the common way numerical aperture is defined for optical fibers. It is also important to note that these equations assume that a Gaussian beam is being outputted from the fiber.

LAB FACTS

Thorlabs Lab Fact: Modifying Beam Profiles with Multimode Fibers

We present laboratory measurements demonstrating how the output beam profile from multimode fiber can be affected by the beam entry angle. In some applications, an alternative beam distribution such as a top hat or donut are desired instead of the inherent Gaussian distribution provided by typical optics. Here we investigated the effect of changing the input angle of a focused laser beam into a multimode fiber patch cable. Focusing the light normal to the fiber face produced a near-Gaussian output beam profile (Figure 1) and increasing the angle resulted in top hat- (Figure 2) and donut-shaped (Figure 3) beam profiles. These results demonstrate how multimode fibers can be used to change the shape of a beam profile.

For our experiment we used an M38L01 Ø200 µm, 0.39 NA, Step-Index Fiber Patch Cable (Bare Fiber Item # FT200EMT) as the test fiber into which we launched the focused laser beam. The input light was set incident at 0°, 11°, and 15° to the input face of the multimode fiber to create the initial, top hat, and donut profiles, respectively. Each time the angle was changed, the alignment of the input fiber was optimized while the output power was monitored with a power meter to ensure maximum coupling was achieved. Images were then acquired with a 9 second exposure and the shape of the beam profile was evaluated. Note that during the exposure, a 1500 grit diffuser was manually rotated between the coupling optics (before the fiber under test) to reduce the spatial coherence and create a clean output beam profile.

Lab Facts

Click for full Lab Facts summary

Assuming a ray tracing model, there are two general types of rays that propagate along a multimode fiber: (a) meridional rays, which pass through the central axis of the fiber after each reflection, and (b) skew rays, which never pass through the central axis of the fiber. The figures below illustrate the three basic ray propagation scenarios observed during the experiment. Figures 4 and 6 depict meridional and skew ray propagation through multimode fiber, respectively, and the associated theoretical beam distribution at the fiber output. As illustrated in Figure 6, skew rays propagate in a helical path along the fiber that is tangent to the inner caustic of the path with radius *r*. Figure 5 depicts the beam propagation and beam distribution from a combination of meridional and skew rays. By changing the input angle of the light launched into a multimode fiber, we were able to modify the proportion of light rays propagating as meridional rays vs. skew rays, and consequently, modify the output from a near-Gaussian distribution (primarily meridional rays, see Figure 1) to a top hat (mixture of meridional and skew rays, see Figure 2) to a donut (primarily skew rays, see Figure 3). The beam profiles shown in Figures 4 through 6 were obtained at a distance of 5 mm from the fiber end face. These results demonstrate the ability to use a standard multimode fiber patch cable as a relatively inexpensive method to modify an input Gaussian profile into a top hat and donut profile with minimal loss. For details on the experimental setup employed and these summarized results, please click here.

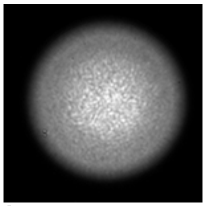


Figure 1. Near-Gaussian Beam Profile
Obtained at 0° Input Angle
(Normal to Fiber Face)

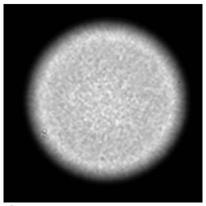


Figure 2. Top Hat Beam Profile
Obtained at 11° Input Angle

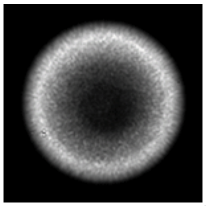
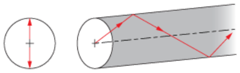
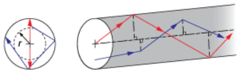
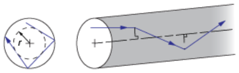


Figure 3. Donut Beam Profile
Obtained at 15° Input Angle


Click to Enlarge
Figure 4. Meridional Ray Propagation Corresponding to Near-Gaussian Output Profile


Click to Enlarge
Figure 5. Meridional and Skew Ray Propagation
Corresponding to Top Hat Profile


Click to Enlarge
Figure 6. Skew Ray Propagation Corresponding to Donut Profile

Ø10 µm, 0.1 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Coating Diameter	Wavelength Range	Attenuation Plot	Jacket
HPSC10	10 ± 3 µm	0.100 ± 0.015	125 ± 2 µm	245 ± 10 µm	400 - 550 nm and 700 - 1400 nm	ℹ	FT030 (Ø3 mm)

Part Number	Description	Price	Availability
M65L01	**Ø10 µm, 0.10 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$111.00**	**Today**
M65L02	**Ø10 µm, 0.10 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$128.00**	**3-5 Days**

Ø25 µm, 0.1 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Coating Diameter	Wavelength Range	Attenuation Plot	Jacket
HPSC25	25 ± 3 µm	0.100 ± 0.015	125 ± 2 µm	245 ± 10 µm	400 - 550 nm and 700 - 1400 nm	ⓘ	FT030 (Ø3 mm)

Part Number	Description	Price	Availability
M68L01	**Ø25 µm, 0.10 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$113.00**	**Today**
M68L02	**Ø25 µm, 0.10 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$132.00**	**Today**

Ø50 µm, 0.22 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Short-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FG050LGA	50 µm ± 2%	0.22 ± 0.02	125 ± 1 µm	15 mm	30 mm	400 to 2400 nm (Low OH)	ⓘ	FT030 (Ø3 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M14L01	**Ø50 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$60.00**	**Today**
M14L02	**Ø50 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$66.70**	**Today**
M14L05	**Ø50 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 5 Meters**	**$86.60**	**Today**
M14L10	**Ø50 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 10 Meters**	**$124.00**	**Today**
M14L20	**Ø50 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 20 Meters**	**$192.00**	**Today**

Ø105 µm, 0.22 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FG105LCA	105 µm ± 2%	0.22 ± 0.02	125 ± 1 µm	15 mm	30 mm	400 to 2400 nm (Low OH)	ⓘ	FT030 (Ø3 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M15L01	**Ø105 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$62.80**	**Today**
M15L02	**Ø105 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$68.00**	**Today**
M15L05	**Ø105 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 5 Meters**	**$84.10**	**Today**
M15L10	**Ø105 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 10 Meters**	**$114.00**	**Today**
M15L20	**Ø105 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 20 Meters**	**$169.00**	**Today**

Ø200 µm, 0.22 NA, High OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FG200UEA	200 µm ± 2%	0.22 ± 0.02	220 ± 2 µm	26 mm	53 mm	250 - 1200 nm (High OH)	ℹ	FT030 (Ø3 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M92L01	**Ø200 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, High OH, 1 Meter**	**$88.30**	**Today**
M92L02	**Ø200 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, High OH, 2 Meters**	**$94.60**	**Today**

Ø200 µm, 0.22 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FG200LCC	200 ± 8 µm	0.22 ± 0.02	240 ± 5 µm	12 mm	24 mm	400 to 2200 nm (Low OH)	ℹ	FT030 (Ø3 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M25L01	**Ø200 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$88.30**	**Today**
M25L02	**Ø200 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$94.60**	**Today**
M25L05	**Ø200 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 5 Meters**	**$113.00**	**Today**

Ø200 µm, 0.39 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FT200EMT	200 ± 5 µm	0.39 ± 0.02	225 ± 5 µm	9 mm	18 mm	400 to 2200 nm (Low OH)	ℹ	FT030 (Ø3 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M38L01	**Ø200 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$68.00**	**Today**
M38L02	**Ø200 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$71.10**	**Today**

Ø400 µm, 0.39 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FT400EMT	400 ± 8 µm	0.39 ± 0.02	425 ± 10 µm	20 mm	40 mm	400 to 2200 nm (Low OH)	ℹ	FT030 (Ø3 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M28L01	**Ø400 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$84.10**	**Today**
M28L02	**Ø400 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$89.30**	**Today**
M28L05	**Ø400 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 5 Meters**	**$102.00**	**Today**

Ø400 µm, 0.48 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter[a]	Short-Term Bend Radius[b]	Long-Term Bend Radius[b]	Wavelength Range	Attenuation Plot	Jacket
BFL48-400	400 ± 8 µm	0.48 ± 0.02	430 µm ± 2%	22 mm	65 mm	400 to 2200 nm (Low OH)	i	FT030 (Ø3 mm)

- The material used in the cladding of this fiber to achieve an NA of 0.48 is softer than conventional fiber coatings. Due to this the connectors on this cable are terminated to the buffer layer to prevent the cladding from being disturbed.
- Limited by the optical fiber.

Part Number	Description	Price	Availability
M40L01	**Ø400 µm, 0.48 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$70.20**	**Today**
M40L02	**Ø400 µm, 0.48 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$75.40**	**3-5 Days**

Ø550 µm, 0.22 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FG550LEC	550 ± 19 µm	0.22 ± 0.02	600 ± 10 µm	30 mm	60 mm	400 to 2200 nm (Low OH)	i	FT030 (Ø3 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M37L01	**Ø550 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$98.30**	**Today**
M37L02	**Ø550 µm, 0.22 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$143.00**	**Today**

Ø600 µm, 0.39 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FT600EMT	600 ± 10 µm	0.39 ± 0.02	630 ± 10 µm	30 mm	60 mm	400 to 2200 nm (Low OH)	i	FT030 (Ø3 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M29L01	**Ø600 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$93.50**	**Today**
M29L02	**Ø600 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$104.00**	**Today**
M29L05	**Ø600 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 5 Meters**	**$113.00**	**Today**

Ø600 µm, 0.48 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter[a]	Short-Term Bend Radius[b]	Long-Term Bend Radius[b]	Wavelength Range	Attenuation Plot	Jacket
BFL48-600	600 ± 12 µm	0.48 ± 0.02	630 µm ± 2%	32 mm	95 mm	400 to 2200 nm (Low OH)	ⓘ	FT038 (Ø3.8 mm)

- The material used in the cladding of this fiber to achieve an NA of 0.48 is softer than conventional fiber coatings. Due to this the connectors on this cable are terminated to the buffer layer to prevent the cladding from being disturbed.
- Limited by the optical fiber.

Part Number	Description	Price	Availability
M41L01	**Ø600 µm, 0.48 NA SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$74.20**	**Today**
M41L02	**Ø600 µm, 0.48 NA SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$83.40**	**Today**

Ø1000 µm, 0.39 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FT1000EMT	1000 ± 15 µm	0.39 ± 0.02	1035 ± 15 µm	50 mm	100 mm	400 to 2200 nm (Low OH)	ⓘ	FT038 (Ø3.8 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M35L01	**Ø1000 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$87.40**	**Today**
M35L02	**Ø1000 µm, 0.39 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$112.00**	**Today**

Ø1000 µm, 0.48 NA, Low OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
BFL48-1000	1000 µm ± 2%	0.48 ± 0.02	1035 µm ± 2%	52 mm	155 mm	400 to 2200 nm (Low OH)	ⓘ	FT038 (Ø3.8 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M71L01	**Ø1000 µm, 0.48 NA, SMA-SMA Fiber Patch Cable, Low OH, 1 Meter**	**$108.00**	**Today**
M71L02	**Ø1000 µm, 0.48 NA, SMA-SMA Fiber Patch Cable, Low OH, 2 Meters**	**$127.00**	**Today**

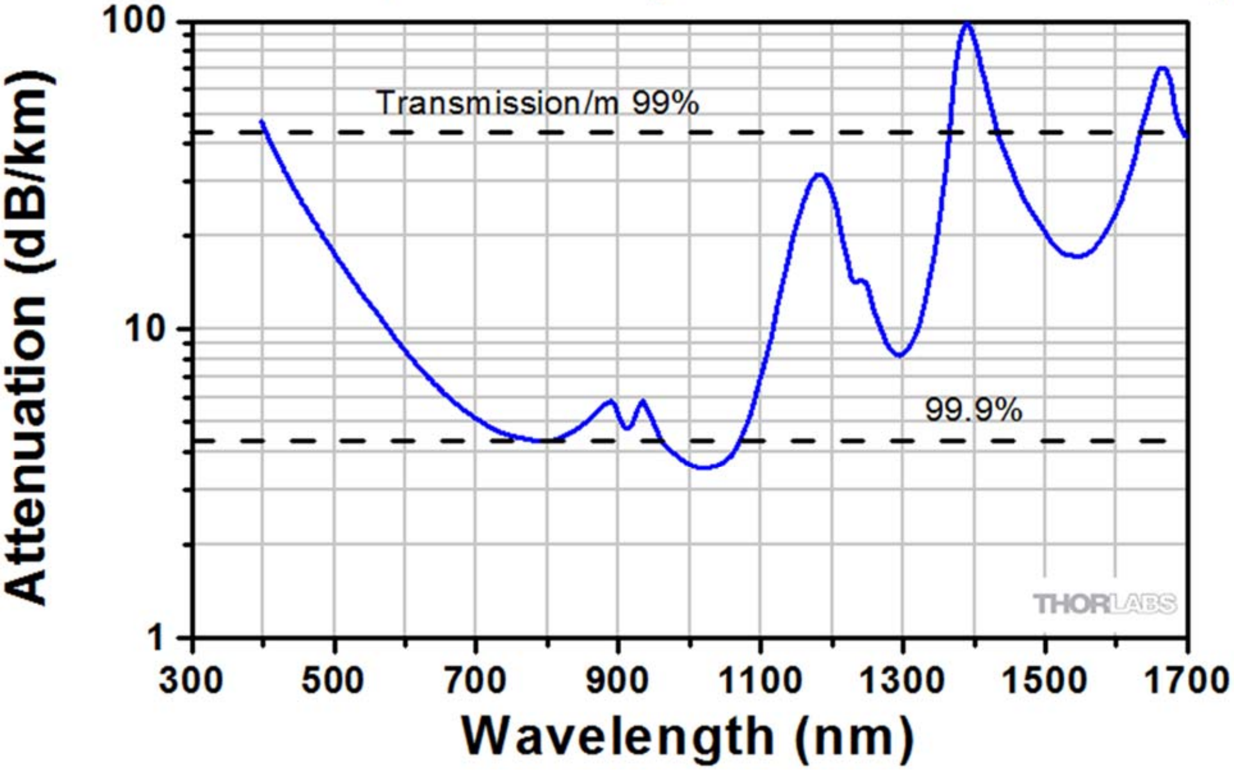
Ø1500 µm, 0.39 NA, High OH, SMA to SMA Fiber Patch Cables

Fiber	Core Diameter	NA	Cladding Diameter	Short-Term Bend Radius[a]	Long-Term Bend Radius[a]	Wavelength Range	Attenuation Plot	Jacket
FT1500UMT	1500 ± 30 µm	0.39 ± 0.02	1550 ± 31 µm	75 mm	150 mm	300 to 1200 nm (High OH)	ℹ	FT05SS (Ø5 mm)

- Limited by the optical fiber.

Part Number	Description	Price	Availability
M93L01	**Ø1500 µm, 0.39 NA, Stainless Steel SMA-SMA Fiber Patch Cable, High OH, 1 Meter**	**$139.40**	**Today**
M93L02	**Ø1500 µm, 0.39 NA, Stainless Steel SMA-SMA Fiber Patch Cable, High OH, 2 Meters**	**$191.40**	**Today**

Visit the *Step-Index Multimode Fiber Optic Patch Cables: SMA to SMA* page for pricing and availability information:
http://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=351



BFL48 Series Attenuation Curve
(Low-OH, Hard-Polymer Clad MM Fibers)