



**PAF Series  
Aspheric and Achromatic  
FiberPort Collimators with  
FC/PC, FC/APC, or SMA  
Adapters**

**User Guide**



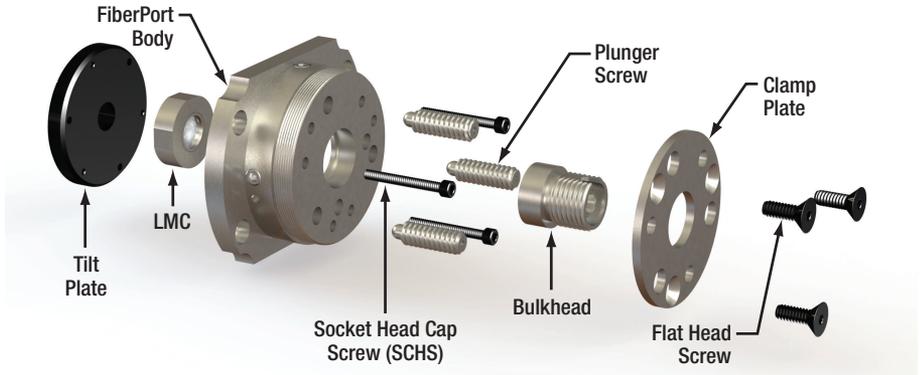
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# Chapter 1 Description

## 1.1. Mechanisms of the FiberPort

The FiberPort is a six-degree-of-freedom fiber collimator and coupler (5 axes, plus rotation). It uses a movable lens as the alignment mechanism while holding the fiber stationary. This provides an extremely stable and repeatable platform for coupling and collimating. All adjustments are coupled.



**Figure 1 Components of a FiberPort**

The FiberPort consists of a body, a Magnetic Lens Cell (LMC) adhered to a tilt plate, and a bulkhead with fiber connector. The bulkhead is locked onto the FiberPort body by three flat head screws and the clamp plate. By loosening the flat head screws, the fiber bulkhead can be rotated freely.

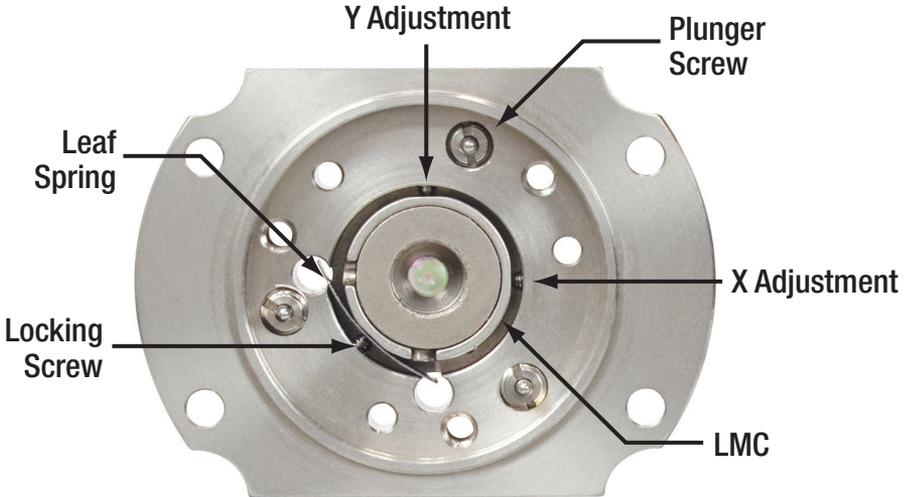
### Z/q/j Adjustment

The LMC adheres to the tilt plate, which can be adjusted in Z/q/j (Axial, Tip, Tilt) using the three socket head cap screws (SCHS). The plunger screws provide counterforce against the SCHS. The Z (optical axis) translation range is  $\pm 0.4$  mm for a given position of the plunger screws. The plunger screws can translate the positive extreme of the travel range in the Z direction over a distance of 2 mm.

### X-Y Adjustment

Additionally, the LMC can be translated in X-Y using the setscrews in the side of the fiberport body. The LMC rests on a leaf spring, and the X-Y screws push the cell against the leaf spring. A third setscrew behind the leaf spring can be used for locking. The travel range of the aspheric lens in the X and Y directions is  $\pm 0.7$  mm but when the FiberPort is used in a standard

collimation/coupling application only a small portion of this translation range is used.



**Figure 2 FiberPort Internal View: The Tilt Plate has Been Removed to Show the Lens Cell and Leaf Spring**

The X-Y lens adjustment screws are located on the outer diameter of the FiberPort body at the 3 o'clock and the 12 o'clock positions. The three plunger screws provide counterforce for the tilt plate. The three socket head cap screws (SHCS) provide the Z/q/j adjustments for the FiberPort. The three SHCS and the X-Y screws are the only screws that are normally used in the alignment of the FiberPort. However, the plunger screws can be used to adjust the tension on the tilt plate if needed. Also, the three flat head screws on the face of the FiberPort hold the clamp plate and bulkhead in place. By loosening these screws, the bulkhead can be rotated a full 360° and secured at any angle for PM applications. This is a coarse adjustment, however.

The locking screw is located on the outer diameter of the FiberPort body at the 7:30 position. The locking screw is not installed when the FiberPort is shipped but is included in the package. The locking screw is only used after the FiberPort is aligned.

NOTE: Locking the FiberPort is not necessary in most applications and can affect coupling.

## 1.2. Location of Screws on the FiberPort

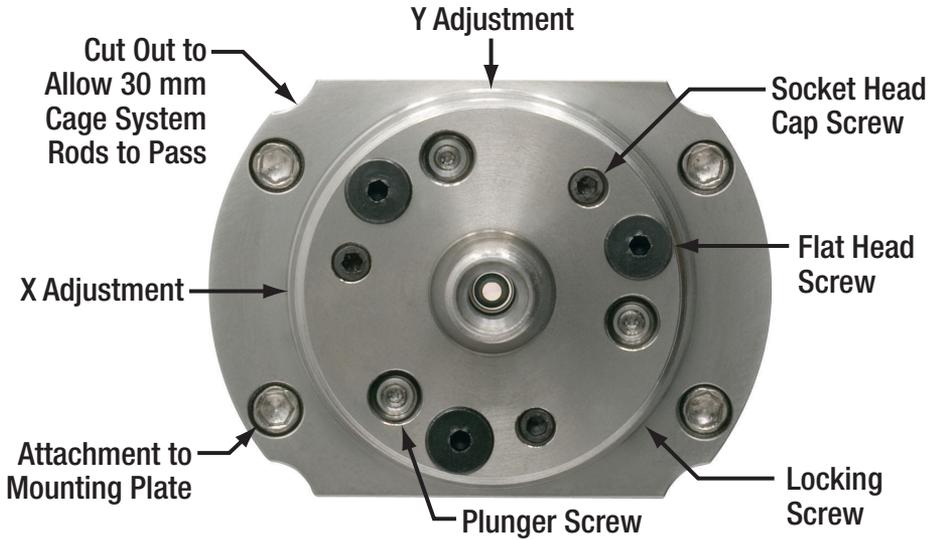


Figure 3 Location of Screws on the FiberPort

Part	Screw Size to Use	Head Size (Hex)
Mounting Plate Attachment Screws	2-56	5/64"
X, Y, and Locking Set Screws	0-80	0.050"
Z (Tip & Tilt) Socket Head Cap Screws	0-80	0.050"
Flat Head Screws	2-56	0.050"
Plunger Screws	6-32	0.035"

## Chapter 2 Specifications

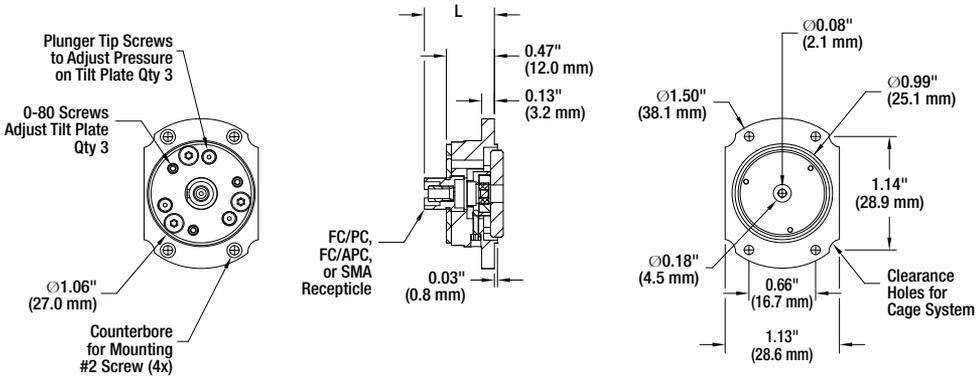


Figure 4 Schematic Diagram of the FiberPort

### 2.1. Achromatic FiberPorts

We offer achromatic FiberPorts as an alternative to our standard aspheric models. They perform similarly to our short focal length aspheric FiberPorts, but with a very small focal length shift over a broad wavelength range.

Item#	EFL (mm)	Input MFD <sup>1</sup> (μm)	Output Waist Dia. (1/e <sup>2</sup> ) (mm)	Max Waist Dist. <sup>2</sup> (mm)	Diverg. (mrad)	Focal Length Shift <sup>3</sup> (μm)	Lens Characteristics			Length L (in/mm)
							CA <sup>4</sup> (mm)	NA	AR Range <sup>5</sup> (nm)	
PAFA-X-4-A	4.0	3.5	0.65	378	0.875	8.3	1.8	0.22	400 - 700	0.69/17.5
PAFA-X-4-B	4.0	5.0	0.87	350	1.250	6.9	1.8	0.22	600 - 1050	0.69/17.5
PAFA-X-4-C	4.0	10.4	0.76	150	2.600	14.8	1.8	0.22	1050 - 1620	0.69/17.5

1) Mode-Field Diameter. This spec was calculated using the following equipment:

PAFA-X-4-A: 460HP at 450 nm

PAFA-X-4-B: 780HP at 850 nm

PAFA-X-4-C: SMF-28e+ at 1550 nm

2) Maximum Waist Distance: The max distance from the lens a Gaussian beam's waist can be placed.

3) Focal length shift is defined over the entire AR coating range.

4) Clear Aperture

5) Wavelength of the Antireflection Coating

### 2.2. Aspheric FiberPorts

Our standard aspheric lens FiberPorts are available with a variety of focal length and coating options. The first table details all of our SMA-compatible FiberPorts. PAF-X-2, -4, -5, and -7 FiberPorts in the second table have a straight FC bulkhead which will work with FC/PC and FC/APC connectors. The PAF-X-11, -15, and -18 in the last table come with either FC/PC- or FC/APC-compatible bulkheads.

## All Focal Lengths, SMA-Compatible

Item#	EFL (mm)	Input MFD <sup>1</sup> (μm)	Output Waist Dia. (1/e <sup>2</sup> ) (mm)	Max Waist Dist. <sup>2</sup> (mm)	Diverg. (mrad)	Lens Characteristics			Length L (in/mm)
						CA <sup>3</sup> (mm)	NA	AR Range (nm) <sup>4</sup>	
PAF-SMA-4-E	4.0	14.47	1.23	169	3.617	5.0	0.53	2000 - 5000	0.85/21.7
PAF-SMA-5-A	4.6	3.5	0.75	499	0.761	4.9	0.47	350 - 700	0.85/21.7
PAF-SMA-5-B	4.6	5.0	1.00	463	1.087	4.9	0.47	600 - 1050	0.85/21.7
PAF-SMA-5-C	4.6	10.4	0.87	198	2.261	4.9	0.47	1050 - 1620	0.85/21.7
PAF-SMA-5-D	4.6	13	0.90	164	2.826	4.9	0.47	1800 - 2400	0.85/21.7
PAF-SMA-7-A	7.5	3.5	1.23	1323	0.467	4.4	0.29	350 - 700	0.85/21.7
PAF-SMA-7-B	7.5	5.0	1.62	1125	0.667	4.4	0.29	600 - 1050	0.85/21.7
PAF-SMA-7-C	7.5	10.4	1.42	521	1.387	4.4	0.29	1050 - 1620	0.85/21.7
PAF-SMA-11-A	11.0	3.5	1.80	2841	0.318	4.4	0.20	350 - 700	1.04/26.3
PAF-SMA-11-B	11.0	5.0	2.38	2630	0.455	4.4	0.20	600 - 1050	1.04/26.3
PAF-SMA-11-C	11.0	10.4	2.09	1115	0.945	4.4	0.20	1050 - 1620	1.04/26.3
PAF-SMA-11-D	11.0	13	2.15	923	1.182	4.4	0.20	1800 - 2400	1.04/26.3
PAF-SMA-11-E	11.0	14.47	3.39	1258	1.315	4.0	0.18	2000 - 5000	1.04/26.3

- 1) Mode Field Diameter. Calculated using the following equipment: -A: 460HP at 450 nm, -B: 780HP at 850 nm, -C: SMF-28e+ at 1550 nm, -D: SM2000 at 2000 nm, -E: ZrF<sub>4</sub> at 3.39 μm
- 2) Maximum Waist Distance: The max distance from the lens a Gaussian beam's waist can be placed.
- 3) Clear Aperture
- 4) Wavelength Range of the Antireflection Coating

## Short Focal Length, FC/PC and FC/APC Compatible

Item#	EFL (mm)	Input MFD <sup>1</sup> (μm)	Output Waist Dia. (1/e <sup>2</sup> ) (mm)	Max Waist Dist. <sup>2</sup> (mm)	Diverg. (mrad)	Lens Characteristics			Length L (in/mm)
						CA <sup>3</sup> (mm)	NA	AR Range <sup>4</sup> (nm)	
PAF-X-2-A	2.0	3.5	0.33	96	1.750	2.0	0.45	400 - 600	0.65/16.6
PAF-X-2-B	2.0	5.0	0.43	89	2.500	2.0	0.45	600 - 1050	0.65/16.6
PAF-X-2-C	2.0	10.4	0.38	38	5.200	2.0	0.45	1050 - 1620	0.65/16.6
PAF-X-4-E	4.0	14.47	1.23	169	3.617	5.0	0.53	2000 - 5000	0.69/17.5
PAF-X-5-A	4.6	3.5	0.75	499	0.761	4.9	0.47	350 - 700	0.69/17.5
PAF-X-5-B	4.6	5.0	1.00	463	1.087	4.9	0.47	600 - 1050	0.69/17.5
PAF-X-5-C	4.6	10.4	0.87	198	2.261	4.9	0.47	1050 - 1600	0.69/17.5
PAF-X-5-D	4.6	13	0.90	164	2.826	4.9	0.47	1800 - 2400	0.69/17.5
PAF-X-7-A	7.5	3.5	1.23	1323	0.467	4.4	0.29	350 - 700	0.69/17.5
PAF-X-7-B	7.5	5.0	1.62	1225	0.667	4.4	0.29	600 - 1050	0.69/17.5
PAF-X-7-C	7.5	10.4	1.42	521	1.387	4.4	0.29	1050 - 1620	0.69/17.5

- 1) Mode Field Diameter. Calculated using the following equipment: -A: 460HP at 450 nm, -B: 780HP at 850 nm, -C: SMF-28e+ at 1550 nm, -D: SM2000 at 2000 nm, -E: ZrF<sub>4</sub> at 3.39 μm
- 2) Maximum Waist Distance: The max distance from the lens a Gaussian beam's waist can be placed.
- 3) Clear Aperture
- 4) Wavelength Range of the Antireflection Coating

## Long Focal Length, FC/APC or FC/PC Compatible

Item#	EFL (mm)	Input MFD <sup>1</sup> ( $\mu\text{m}$ )	Output Waist Dia. ( $1/e^2$ ) (mm)	Max Waist Dist. <sup>2</sup> (mm)	Diverg. (mrad)	Lens Characteristics			Length L (in/mm)
						CA <sup>3</sup> (mm)	NA	AR Range (nm) <sup>4</sup>	
<b>FC/APC Compatible</b>									
PAF-X-11-A	11.0	3.5	1.80	2841	0.318	4.4	0.20	350 - 700	0.87/22.0
PAF-X-11-B	11.0	5.0	2.38	2630	0.455	4.4	0.20	600 - 1050	0.87/22.0
PAF-X-11-C	11.0	10.4	2.09	1115	0.945	4.4	0.20	1050 - 1620	0.87/22.0
PAF-X-11-D	11.0	13	2.15	923	1.182	4.4	0.20	1800 - 2400	0.87/22.0
PAF-X-15-A	15.4	3.5	2.52	5562	0.227	5.0	0.16	400 - 600	0.87/22.0
PAF-X-15-B	15.4	5.0	3.33	5149	0.325	5.0	0.16	600 - 1050	0.87/22.0
PAF-X-15-C	15.4	10.4	2.92	2179	0.675	5.0	0.16	1050 - 1620	0.87/22.0
PAF-X-15-D	15.4	13	3.02	1802	0.844	5.0	0.16	1800 - 2400	0.87/22.0
PAF-X-18-A	18.4	3.5	3.01	7936	0.190	5.5	0.15	400 - 600	0.87/22.0
PAF-X-18-B	18.4	5.0	3.98	7347	0.272	5.5	0.15	600 - 1050	0.87/22.0
PAF-X-18-C	18.4	10.4	3.49	3107	0.565	5.5	0.15	1050 - 1620	0.87/22.0
PAF-X-18-D	18.4	13	3.60	2569	0.707	5.5	0.15	1800 - 2400	0.87/22.0
<b>FC/PC Compatible</b>									
PAF-X-11-PC-A	11.0	3.5	1.80	2841	0.318	4.4	0.20	350 - 700	0.87/22.0
PAF-X-11-PC-B	11.0	5.0	2.38	2630	0.455	4.4	0.20	600 - 1050	0.87/22.0
PAF-X-11-PC-C	11.0	10.4	2.09	1115	0.945	4.4	0.20	1050 - 1620	0.87/22.0
PAF-X-11-PC-D	11.0	13	2.15	923	1.182	4.4	0.20	1800 - 2400	0.87/22.0
PAF-X-11-PC-E	11.0	14.47	3.39	1258	1.315	4.0	0.18	2000 - 5000	0.87/22.0
PAF-X-15-PC-A	15.4	3.5	2.52	5562	0.227	5.0	0.16	400 - 600	0.87/22.0
PAF-X-15-PC-B	15.4	5.0	3.33	5149	0.325	5.0	0.16	600 - 1050	0.87/22.0
PAF-X-15-PC-C	15.4	10.4	2.92	2179	0.675	5.0	0.16	1050 - 1620	0.87/22.0
PAF-X-15-PC-D	15.4	13	3.02	1802	0.844	5.0	0.16	1800 - 2400	0.87/22.0
PAF-X-18-PC-A	18.4	3.5	3.01	8936	0.190	5.5	0.15	400 - 600	0.69/17.5
PAF-X-18-PC-B	18.4	5.0	3.98	7347	0.272	5.5	0.15	600 - 1050	0.69/17.5
PAF-X-18-PC-C	18.4	10.4	3.49	3107	0.565	5.5	0.15	1050 - 1620	0.69/17.5
PAF-X-18-PC-D	18.4	13	3.60	2569	0.707	5.5	0.15	1800 - 2400	0.69/17.5

1) Mode Field Diameter. Calculated using the following equipment: -A: 460HP at 450 nm, -B: 780HP at 850 nm, -C: SMF-28e+ at 1550 nm, -D: SM2000 at 2000 nm, -E: ZrF<sub>4</sub> at 3.39  $\mu\text{m}$

2) Maximum Waist Distance: The max distance from the lens a Gaussian beam's waist can be placed

3) Clear Aperture

4) Wavelength Range of the Antireflection Coating

## 2.3. Lens Materials

Item #	Material
PAF-xxx-2-x	ECO-550
PAFA-X-4-A*	N-SK16/N-LASF9
PAFA-X-4-B*	N-LAK22/N-SF6HT
PAFA-X-4-C*	N-SF66/N-LASF41
PAF-xxx-4-E	Black Diamond-2
PAF-xxx-5-x	H-LAK54
PAF-xxx-7-x	H-LAK54
PAF-xxx-11-A	H-LAK54
PAF-xxx-11-B	H-LAK54
PAF-xxx-11-C	H-LAK54
PAF-xxx-11-D	H-LAK54
PAF-xxx-11-E	Black Diamond-2
PAF-xxx-15-x	ECO-550
PAF-xxx-18-x	ECO-550

\*Achromatic doublet lenses. All other FiberPorts use aspheric lenses.

## Chapter 3 FiberPort Guide

### 3.1. Selection Table

The table below can be used as a selection guide to determine which FiberPort would best suit your needs.

Item#	EFL (mm)	Coupling Input Beam Diameter (mm)	Collimated Output Beam Diameter (mm)	Best Collimation Distance at	Connector Compatibility
PAF-X-2- $\lambda$	2.0	0.3 – 0.8	0.33	1 – 20 cm	All FC
PAF-X-5- $\lambda$	4.6	0.8 – 1.4	0.75	10 cm & Beyond	All FC
PAF-X-7- $\lambda$	7.5	1.2 – 2.0	1.4	20 cm & Beyond	All FC
PAF-X-11- $\lambda$	11.0	1.9 – 3.0	2.1	20 cm & Beyond	FC/APC
PAF-X-11- $\lambda$ -PC	11.0	1.9 – 3.0	2.1	20 cm & Beyond	FC/PC
PAF-X-15- $\lambda$	15.4	2.8 – 4.0	2.9	30 cm & Beyond	FC/APC
PAF-X-15- $\lambda$ -PC	15.4	2.8 – 4.0	2.9	30 cm & Beyond	FC/PC
PAF-X-18- $\lambda$	18.0	3.4 – 4.7	3.5	30 cm & Beyond	FC/APC
PAF-X-18- $\lambda$ -PC	18.0	3.4 – 4.7	3.5	30 cm & Beyond	FC/PC

*Note:* PAF-X-2, -5, and -7 FiberPorts have a straight FC bulkhead which will work with FC/PC and FC/APC connectors. The PAF-X-11, -15, and -18 come with either PC or APC compatible bulkheads. Please specify which type of connector you will be using when ordering a PAF-X-11 through -18 FiberPort.

### 3.2. Selection Example

The example presented here details the steps needed to ensure proper selection of a FiberPort to match the requirements of a particular fiber. For specific recommendations, please contact [TechSupport@thorlabs.com](mailto:TechSupport@thorlabs.com).

- Fiber: P1-630A-FC-2
- Collimated Beam Diameter Prior to Lens:  $\varnothing 3$  mm
- Wavelength: 633 nm

The specifications for the P1-630A-FC-2, 633 nm, FC/PC single mode patch cable indicate that the mode field diameter (MFD) is 4.3  $\mu\text{m}$  at 633 nm. The MFD should be matched to the diffraction-limited spot size  $\varnothing_{spot}$ , which is given by the following equation:

$$\varnothing_{spot} = \frac{4\lambda f}{\pi D}$$

Here,  $f$  is the focal length of the lens,  $\lambda$  is the wavelength of the input light,

and  $D$  is the diameter of collimated beam incident on the lens. Solving for the desired focal length of the collimating lens yields:

$$f = \frac{\pi D(\text{MFD})}{4\lambda} = \frac{\pi(0.003 \text{ m})(4.3 \times 10^{-6} \text{ m})}{4(633 \times 10^{-9} \text{ m})} = 0.016 \text{ m} = 16 \text{ mm}$$

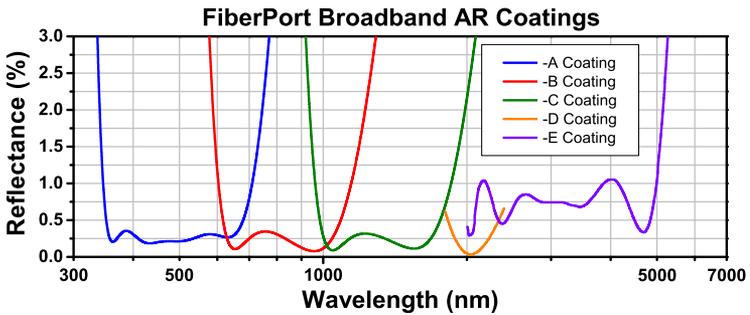
Thorlabs offers a large selection of FiberPorts. Scanning through the list of options under the *Specs* tab, you'll note that the FiberPort with a focal length closest to 16 mm has a focal length of 15.4 mm (Item # PAF-X-15-B), while also meeting the requirements for fiber connector and antireflection coating range. This FiberPort also has a clear aperture that is larger than the collimated beam diameter. Therefore, this is the best option given the initial parameters (i.e., a P1-630A-FC-2 single mode fiber and a collimated beam diameter of 3 mm).

Remember, for optimum coupling the spot size of the focused beam must be less than the MFD of the single mode fiber. As a result, if a FiberPort is not available that provides an exact match, then choose the FiberPort with a focal length that is shorter than the calculation above yields. Alternatively, if the clear aperture of the lens is large enough, the beam can be expanded before the lens, which has the result of reducing the spot size of the focused beam.

Please note that the NA listed in Chapters 2.1 and 2.2 is the NA of the lens, not the required numerical aperture of the fiber you are using. As long as the lens NA is at least as large as the NA of your fiber, you should be able to couple light. For best results, Thorlabs recommends using the equations above when choosing a FiberPort.

### 3.3. AR Coatings

Thorlabs offers FiberPort models with our A (350 - 700 nm, 400 - 600 nm, or 400 - 700 nm, depending upon the model), B (600 - 1050 nm), C (1050 - 1620 nm), D (1800 - 2400 nm), or E (2000 - 5000 nm) AR coatings. The plot below shows the typical per-surface reflectance of each AR coating. Each coating is available in FC/PC-, FC/APC-, and SMA-connectorized versions, except for the E coating, which is available in FC/PC- and SMA-connectorized versions. Care should be taken in selecting a FiberPort to make sure the correct fiber/connector/FiberPort combination is selected. If you need assistance, please contact tech support at your local office.



## Chapter 4 Collimating Out of Fiber

1. Attach a connectorized single mode fiber source to the bulkhead of the FiberPort and examine the output.
2. Adjust the X-Y screws to center the output beam in the tilt plate aperture. It is important to maintain the X-Y screws in a position neither too tight or loose at all times or they may not function properly.
3. Trace the beam away from the FiberPort to check for collimation. (See Figure 5, shown below).
  - a. For a converging beam (beam comes to a focus): The lens is too far away from the fiber. Alternately turn the socket head cap screws (SHCS) clockwise in small, equal increments.
  - b. For a diverging beam (beam diameter continually increases): The lens is too close to the fiber. Alternately turn the SHCS counter clockwise in small, equal increments.
4. Check the beam path and adjust the X-Y screws as needed to re-center the beam in the output aperture.
5. Use progressively smaller adjustments until collimation is achieved and the desired beam centration is obtained.

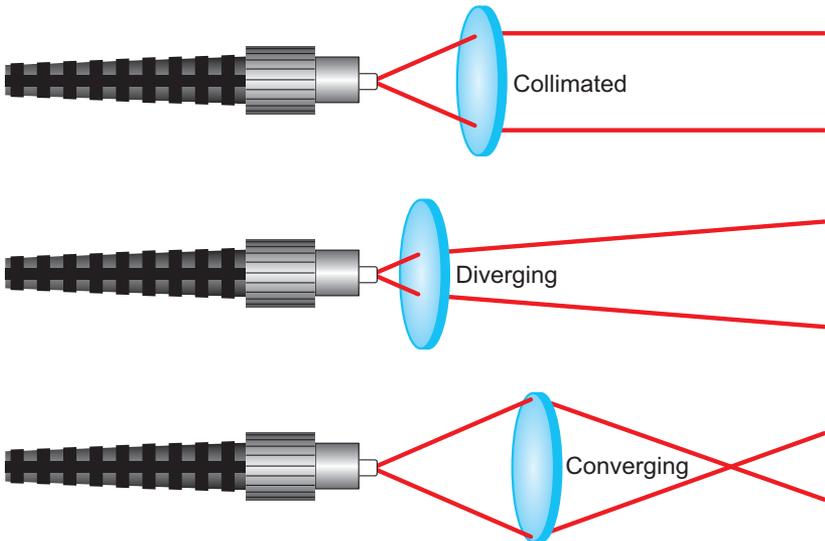
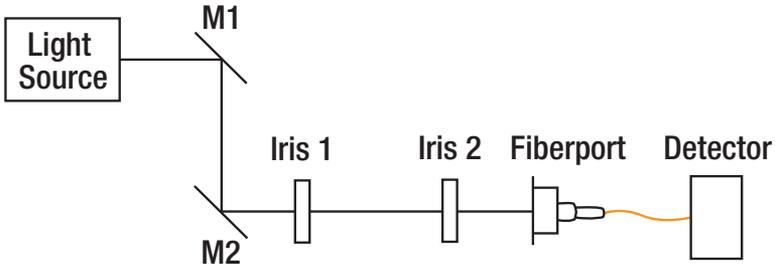


Figure 5 Three Lens Positions: Collimated, Converging, and Diverging Beams

## Chapter 5 Coupling into a Fiber



**Figure 6 Setup for Coupling with the FiberPort**

1. If possible, collimate light out of the FiberPort first (see Chapter 4). This will put the lens close to the correct position to start coupling. Also, the tilt plate should be level, so that the lens is free of tip or tilt. Please note that adjusting a FiberPort for coupling is an iterative process that takes time and practice.
2. In order to launch a free-space beam into the FiberPort effectively, it is essential that the incoming beam path be aligned with the central axis of the FiberPort. The diagram above illustrates a simple technique that can be implemented to achieve this alignment.
  - a. First, place two irises (set to the same height off the table) as shown in Figure 6 (above).
  - b. Adjust mirror 1 (M1) until the beam passes through the center of Iris 1, then adjust M2 to align the beam through the center of Iris 2. Iris 1 may need to be opened at this stage to allow the beam to pass through to Iris 2 during the initial part of alignment. Repeat this process iteratively until the beam is centered through both Iris 1 and Iris 2.
3. Place the FiberPort after Iris 2, as shown in Figure 6, shown above. Centering the input beam on the lens aperture of the FiberPort can be accomplished by affixing a target to the tilt plate in front of the lens.
  - a. Make adjustments to the FiberPort's position until the beam is visibly centered on the FiberPort aperture. The FiberPort can be mounted on to a HCP bracket mount, as shown in the image above, in order to adjust its position (see Chapter 8 for mounting accessories). Once the beam is centered, light should



**Figure 7 FiberPort Mounted on an HCP L-Bracket**

be clearly visible exiting the back of the FiberPort (with no fiber attached, as shown above). Make sure the beam is not visually clipped.

4. Make sure the tip of the fiber is clean as this will maximize the amount of light coupled into the fiber. Once light is passing through the FiberPort, attach a multimode (MM) fiber (50 – 100  $\mu\text{m}$  core) to the FiberPort, which will make the initial alignment process easier rather than coupling directly into a singlemode (SM) fiber.
5. Attach an optical detector to the end of the fiber not connected to the FiberPort and monitor the output signal. An optical detector has a faster response time than a power meter, and thus may be more helpful for fiberport alignment. Steps 2 and 3 should ensure that enough light is coupled into the fiber in order to detect an output signal at this stage. If you do not have any measurable power, repeat steps 2 and 3.
6. Use the X and Y adjustment screws to maximize the output signal. These adjustments are extremely sensitive. Small adjustments here translate to large coupling changes. The X and Y adjustments are coupled, so finding the maximum signal is an iterative process between the X and Y adjustments. Once the XY maximum is achieved, only VERY SMALL adjustments are needed. It is important to maintain the X-Y screws in a position neither too tight or loose at all times or they may not function properly.
7. Monitor and maximize the output signal while making small, **equal** adjustments in Z/q/j positioning socket head cap screws (SHCS). This will allow the lens to move in the Z direction without altering the tip/tilt. **Be sure to adjust the SHCS in equal increments.**

*Note:* In order to determine which way to adjust the screws, unscrew the fiber connector from the bulkhead and monitor the output as the fiber is retracted from the bulkhead. If the power increases, then the lens needs to move further away from the fiber, and if it decreases then the lens still has to move closer to the fiber. (Turn the SCHS clockwise to move the lens closer to the fiber, and counterclockwise to move the lens farther from the fiber.)

- a. Start at any SHCS on the face of the FiberPort and make very small adjustments to get a maximum in the output signal.
- b. Move in a clockwise or counterclockwise direction to the next SHCS and make a similarly small adjustment.
- c. Continue in the same direction with the final SHCS, and again make an equal adjustment.
- d. After adjusting the SHCS, the signal may be lower than before the adjustment. Re-adjustment of the XY screws in the next step will show the increase in signal power.

8. Repeat step 6 (XY adjustment) to reach an absolute maximum signal. Note that adjusting the XY screws may involve losing the signal when the hex key is inserted into the setscrew, and then finding the signal again through slow adjustment. Adjust the X and Y screws iteratively to find an absolute maximum. Gains from Z-axis adjustment will now be evident.

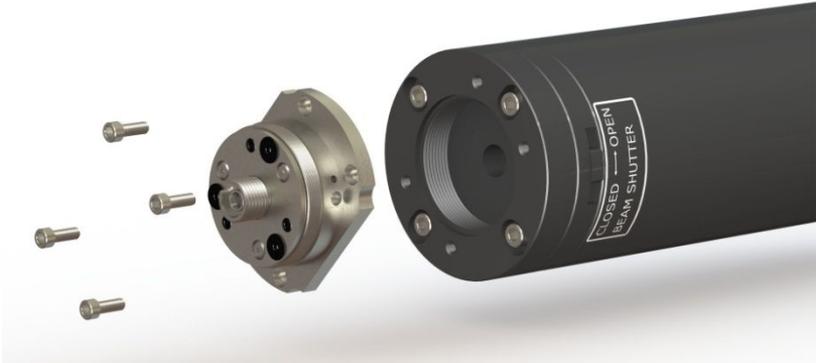
If you intend to couple into an SM fiber, switch the MM fiber to an SM fiber at this point (once there is good coupling into the MM fiber after steps 5 and 6). It will be necessary to repeat steps 5 and 6 with the SM fiber in place to maximize the coupling.

*Note:* When coupling into SM fiber, even the smallest adjustments can drastically affect the coupling. When adjusting the SHCS be aware that by simply monitoring the power of the output signal, one can get stuck in a local maxima and never achieve best coupling. The ideal procedure is to make a small EQUAL adjustment in each of the SHCS in the chosen direction (see 6d above) and only monitor the power once all the screws have been adjusted. Usually, one will see a drop in power once the 2<sup>nd</sup> screw is adjusted but then a large increase in power when the 3<sup>rd</sup> screw is adjusted.

If you are using PM fiber, you can rotate the bulkhead to align the axis if needed. Please see Chapter 1 for more information on how to adjust the FiberPort bulkhead.

## 5.1. Coupling Light from a HeNe Laser

To couple light from a HeNe laser into a FiberPort using an HCL adapter, first attach the HCL to the HeNe laser using the 4-40 (M4) cap screws provided but do not fully tighten the screws. Next, attach the FiberPort to the HCL, and again, do not fully tighten the screws (See Figure 8 shown below). Maximum coupling can be achieved by adjusting these screws to center the beam into the FiberPort, while monitoring the output from the FiberPort (with no fiber attached). After the FiberPort is attached to the HeNe laser, the alignment procedure from Chapter 5 should be followed.



**Figure 8 HCL Adapter Used to Connect the FiberPort to a HeNe Laser**

When using the HNLS008 series of self-contained HeNe lasers, the HCL2 adapter should be used instead. This adapter attaches to the front of the HeNe using the 5/8"-32 threaded aperture. However, the HCL2 also features the slip-plate design of the HCL, and so the coupling procedure is similar. Simply thread the adapter onto the front of the HeNe, and then follow the procedures outlined above.



**Figure 9 HCL2 Adapter Used to Connect the Fiberport to the HNLS008L Laser**

## Chapter 6 FiberPort to FiberPort on a Single-Axis FiberBench

### Rough Alignment

1. Assemble the FiberBench with both ports on the FiberBench facing each other as shown to the right.
2. **Collimate beam from input FiberPort:** Attach an optical fiber to the input FiberPort in order to launch light into the FiberBench. Adjust the three SHCS screws in a near equal amount so the "Z" positioning is fine tuned to collimate the beam out of the fiber (see Chapter 4). It may only require very small adjustment.



Figure 10 Two FiberPorts Mounted on a Single-Axis FiberBench

3. **Center Beam on Output FiberPort:** Once good collimation is achieved, use slight (quarter or eighth) turns of the SHCS to steer the beam to the center of the other FiberPort. If this adjustment is not enough, DO NOT adjust the screws any more. Instead, set them back to the previous position which gave good collimation (from Step 2) and this time use the X-Y adjustment screws to move the lens in X-Y to steer the beam.
4. **Collimate and Center other FiberPort:** Repeat Steps 2 and 3 for the other FiberPort, launching light backward through the output fiber.
5. **Beam Waist at Center:** In order to maximize the coupling of light between the FiberPorts, place the waist of the beam at the center of the FiberBench between the two FiberPorts.

### Fine Tuning

1. **Use Multimode Fiber for Coarse Alignment:** To align the FiberBench, start with multimode (50 – 100  $\mu\text{m}$  core) fiber (if you have one) on the output port. The large core allows for easy coupling and good practice for the feel of the fiberport and which types of adjustments translate to coupling. This also helps to understand how quickly one can go out of alignment. NOTE: It does not help to use multimode fiber on the input port.
2. **Check Output Power:** Connect the output fiber to a suitable detector in order to determine and monitor the power coupled into the

output fiber, and the quality of the alignment. Some power should be present from steps 2 – 4 at this stage (possibly only 10 – 250 nW). If there is no measurable power, repeat steps 2 – 4 again.

3. **Fine-tune Coupling:** Once you have a measurable signal from the output fiber, you can further improve and fine tune the alignment/coupling by making adjustments and monitoring the power level on the detector. See the section on fiber coupling for details.

4. **Switch to SM Fiber:** Once the alignment is optimized, you can switch to using SM fiber on the output FiberPort. You may need to repeat step 3 to optimize the coupling efficiency.

## Chapter 7 Locking the FiberPort



### CAUTION



**Most applications DO NOT require locking.**

If you are leaving the FiberPort on a table, it does not need to be locked. Screw on the black end cap to minimize unauthorized alignment changes. Typically, an aligned FiberPort can be hand carried and moved without causing alignment changes. The locking process can cause a shift in the alignment of the FiberPort. For situations where the FiberPort might undergo large vibrations or shock, such as shipping, we recommend locking or potting the FiberPort. Locking the FiberPort is an iterative process requiring patience. The locking screw pushes the lens cell firmly against the X and Y screws. If the locking screw is tightened too quickly, the alignment of the FiberPort LMC (Magnetic Lens Cell) will be shifted.

When locking the position of the LMC using the procedure below, monitor the position of the beam if the FiberPort is being used as a collimator. If the FiberPort is being used to couple light into a fiber, attach a suitable optical detector to the output end of the fiber and monitor the output signal of the detector during the locking process. In either case, make sure that the locking process does not change the alignment of the LMC.

1. Carefully thread the small locking screw into the FiberPort at the 7:30 o'clock position on the outer diameter.
2. As you slowly tighten the locking screw, adjust the X-Y screws as required to maintain the alignment. DO NOT torque down any of the screws. Applying too much pressure with the screws can permanently damage the magnet/lens assembly, the 0-80 screws, and/or destroy the alignment. When the X,Y, and locking screws are just snug, the lens is locking in place.
3. To prevent accidental changes in Z/q/j, carefully tighten the plunger screws with the small size hex wrench. Make minor adjustments to the SHCS as necessary to maintain the alignment of the LMC. DO NOT torque down any of the screws.
4. If optimal alignment is lost when locking, first loosen the locking screw two full turns, then loosen the plunger screws ¼ turn each. The less the plunger screws have to travel to be locked, the better. Now adjust the X-Y screws to regain optimal alignment. Repeat Steps 2 and 3.
5. Screw the black end cap on to discourage any further adjustment of the alignment screws.

## Chapter 8 Other Accessories

### *HCL and HCL2 HeNe Laser Adapters*

The HCL and HCL2 adapters allow a FiberPort to attach directly to the front of a HeNe laser utilizing a HeNe industry-standard four-bolt pattern, or the 5/8"-32 thread on Thorlabs' self-contained HeNe. This adapter includes the necessary 4-40 (M4) cap screws for attaching to a HeNe as well as four cap screws to attach a FiberPort. For added mounting options, the HCL features internal C-Mount threading, which is utilized on some lasers.



### *HCP L-Bracket Mount*

The L-Bracket FiberPort mount has four 2-56 threaded holes for securing a FiberPort to the front plate. The bottom of the L-bracket can be easily attached to an optical table, a breadboard, or a post since it has 8-32 and M4 threaded holes as well as a counterbored through hole for a 1/4"-20 or an M6 screw.



### *CP08FP 30 mm Cage Mount*

The CP08FP is designed to center a FiberPort inside a 30 mm cage system. The CP08FP secures to the four ER rods of a 30 mm cage assembly. Four #2-56 stainless steel socket head screws are included to secure a FiberPort to the adapter. The CP08FP has internal SM1 threading, enabling it to be used with our extensive line of lens tubes. This plate features a 8-32 tapped hole for post mounting, while the CP08FP/M has an M4 tapped hole for metric compatibility.



### *Multi-Axis FiberBenches*

The FiberBench product selection offers platforms with support for three or more wall plates (HCA). Each table is designed so that multiple PAF series FiberPort fiber couplers/collimators can be used to assemble complex systems. An array of holes are positioned on the top surface to allow for the mounting of wave plates, polarizers, beamsplitters, and other optical components without the need for alignment and adjustment. The tables provide a common, compact, and stable platform for optical system designs with parallel and perpendicular beam propagation paths.



## Chapter 9 Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out “wheelie bin” logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated



**Wheelie Bin Logo**

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e.g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

### 9.1. Waste Treatment is Your Own Responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

### 9.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

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