

Fiber Couplers Series 60FC-A19.5

The Schäfter+Kirchhoff fiber couplers series 60FC-A19.5 collimate the radiation from a polarization-maintaining single-mode fiber or from a multi-mode fiber.

This document provides assistance in installing and adjusting the fiber couplers series 60FC-A19.5. It describes, how a fiber cable is attached and how the collimation setting is adjusted. Additionally it describes how the series 60FC-A19.5 fiber couplers reversely are used as an in-coupler for multi-mode fiber cables.

1. Before You Start

The fiber coupler is shipped with a protection cap for the fiber receptacle and with a front cap.



Notice: Please remove all the protection caps first and do not use them as beam dumps (risk of photo contamination).

There is a two-part protection cap on the receptacle. Please perform the following steps in order to remove this cap:



Figure 1:

First, remove the threaded cap from the fiber receptacle of the fiber coupler.

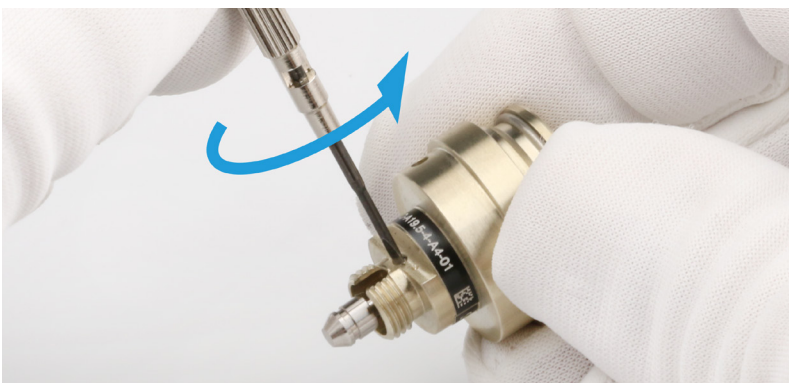


Figure 2:

Then, slightly loosen the small pin screw. Use the screwdriver 9D-12. Make sure to not loosen it too far, as it is small and easily lost.

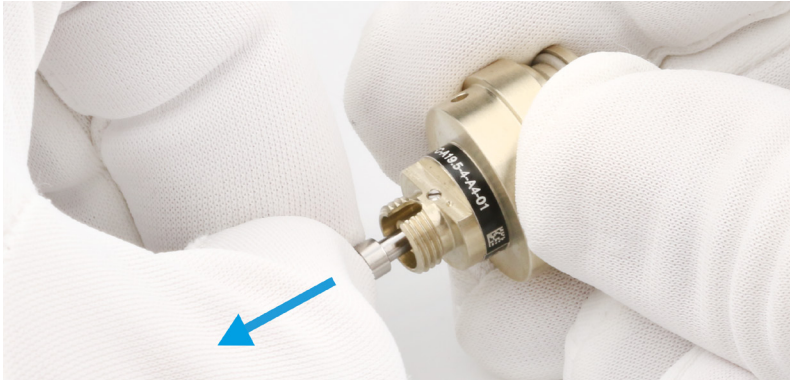


Figure 3:
Now, pull out the plug.

Now, make sure that the connector of the fiber you want to attach matches the receptacle type of the fiber coupler:

- Use fibers with FC-APC (8°-polish) connectors for fiber couplers with an inclined coupling axis (60FC-A19.5-4).
- Use fibers with FC-PC (0°-polish) connectors for fiber couplers with a coaxial axis (60FC-A19.5-0).

The fiber couplers are compatible to all fiber connectors type FC, including fiber connectors with end caps (single-mode only).

**Notice:**

- Do not touch either the optical surface of the lens or the fiber end-face.
- If the coupler is not in use, reattach both rear and front protection caps.

**Caution!****Refer to the laser instruction manual for all instructions regarding laser safety!**

- Do not stare directly into the laser beam (which can cause permanent damage to the eyes).
- Do not stare at the reflected beam from reflective objects.
- Do not point the laser beam to other individuals.

2. Attaching a Fiber Cable to the Fiber Coupler

For attaching a fiber cable to the fiber coupler perform the following steps:

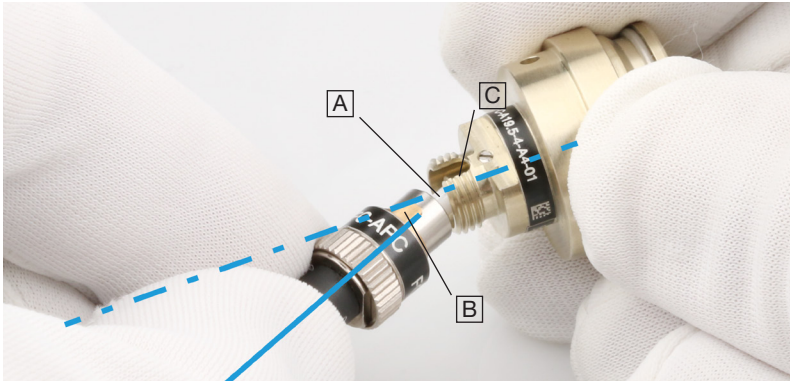


Figure 4:

To prevent damage to the sensitive fiber end-face, always insert the fiber connector's ferrule **A** at an angle, with the connector key **B** properly aligned to the receptacle notch **C**.

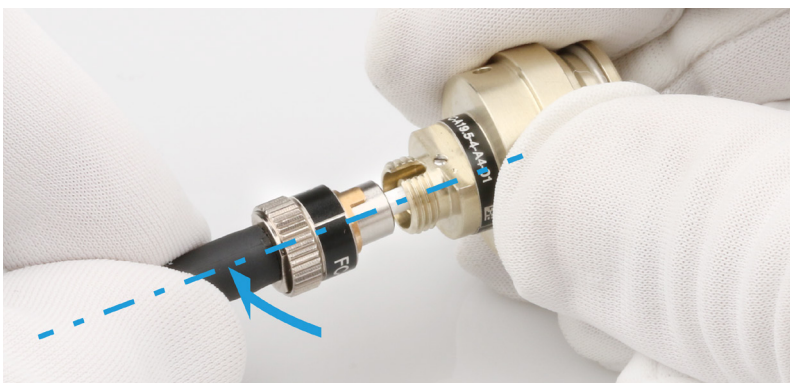


Figure 5:

When the ferrule tip is safely located in the inner cylinder of the receptacle, align the connector to the receptacle axis and carefully introduce the connector into the fiber coupler.



Figure 6:

Then, orient the connector key in a way that it is pressed gently onto the right-hand side of the receptacle notch.

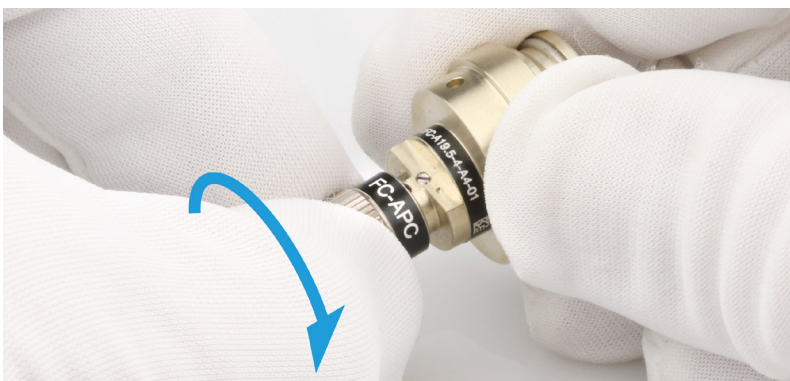


Figure 7:

Gently screw on the connector cap nut onto the receptacle until it is finger-tight.

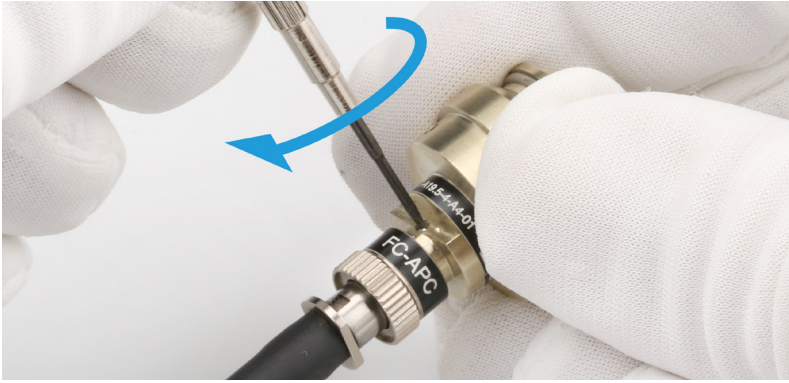


Figure 8:

Finally, gently tighten the fiber grub screw to reduce the free play of the ferrule in the receptacle.

The free play in between the connector ferrule and receptacle is only a few microns, but necessary for inserting the ferrule without force.

The tightened grub screw and the right-hand orientation rule for the connector, ensure a high reproducibility in mode field position and angle, which is especially important for attaching and reattaching polarization-maintaining fibers reproducibly.

3. Adjusting the Focus Setting

Focus adjustment (adjustment of the coupling lens in z-direction) is a demanding task and should be performed preferably using a collimating telescope.



Notice: The fiber coupler is shipped pre-adjusted for the labeled wavelength and, often, it is not necessary for the customer to readjust the coupling lens position. This is why you can skip this step in most cases.

To check the collimation setting of the fiber coupler, couple a radiation source of appropriate wavelength into the fiber connected to the fiber coupler.



Caution! Refer to the laser instruction manual for all instructions regarding laser safety!

- Do not stare directly into the laser beam (which can cause permanent damage to the eyes).
- Do not stare at the reflected beam from reflective objects.
- Do not point the laser beam to other individuals.

Depending on the fiber type used with the fiber coupler there are two options:

- If you use the fiber coupler with a multi-mode fiber, use the factory setting. In case of in-coupling high power levels into a multi-mode fiber, a fine-adjustment of a fiber coupler already installed is described in Chapter 7.
- If you use the fiber coupler with a single-mode or polarization-maintaining fiber, you can use the following procedure:

Direct the beam to a target about half a Rayleigh length z_R away:

$$\frac{z_R}{2} = \frac{\pi \cdot \varnothing_{\text{beam}}^2}{\lambda \cdot 8}$$

Here λ is the optical wavelength and $\varnothing_{\text{beam}}$ the collimated beam diameter ($1/e^2$ level).

When correctly collimated, the laser spot diameter on a target about $z_r/2$ away must have approximately the same diameter such as the beam directly behind the laser beam coupler. Additionally, make sure that there is no focused spot between the laser beam coupler and the target at $z_r/2$.

The lens position is adjusted by means of an eccentric key. The eccentric key type 60EX-4 is used for fiber couplers with focal lengths ≤ 11 mm. For fiber couplers with focal lengths ≥ 12 mm please use the eccentric key type 60EX-5.

For adjusting the lens position perform the following steps:

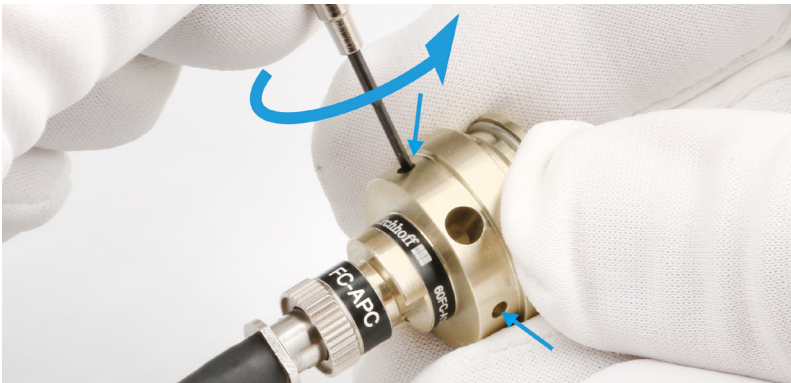


Figure 9:

Loosen the two grub screws fixing the lens position by means of a screwdriver type 9D-12.



Figure 10:

Insert the eccentric key type 60EX-4 or type 60EX-5 into the large hole.



Figure 11:

Now, adjust the focus setting by rotating the eccentric key. Adjust the collimation by minimizing the size of the laser spot on the target about half the Rayleigh length z_r away.

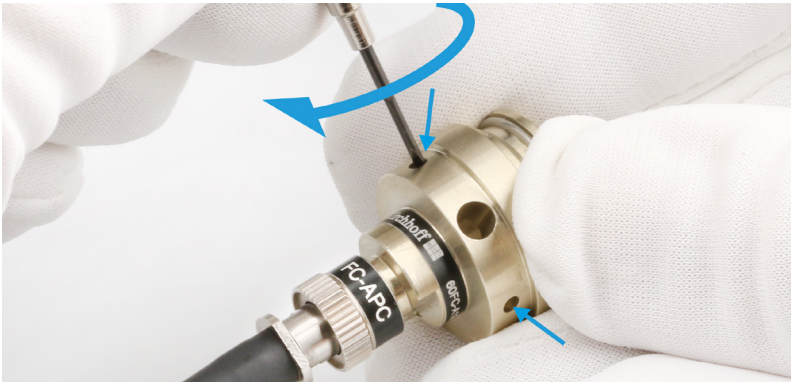


Figure 12:

Finally, fix the two grub screws in order to lock the focus setting.

4. Adapter for the Lateral Adjustment

The fiber coupler can be connected to your laser system or optical bench by using an adapter flange or it can be attached directly to a multicube element from Schäfter+Kirchhoff.

It is very important for an efficient coupling that the laser beam passes the aperture of the fiber coupler centrally.

Many lasers, such as HeNe lasers or DPSS lasers, have a 1" x 1" drilling pattern around the beam exit. For these lasers, Schäfter+Kirchhoff offers an adapter flange which can be moved laterally in oversized holes in order to center the adapter flange to the laser beam (Figure 13). Always attach the flange with the recommended washers and spring washers.



Figure 13:

DPSS laser with a 1" x 1" drilling pattern and attached adapter type 60A19.5-F.

The proper centering of the beam can be tested by attaching an aperture type 13H or a variable iris diaphragm type 13BL1-13 instead of the laser beam coupler (Figure 14).

For centering the adapter flange, perform the following steps:

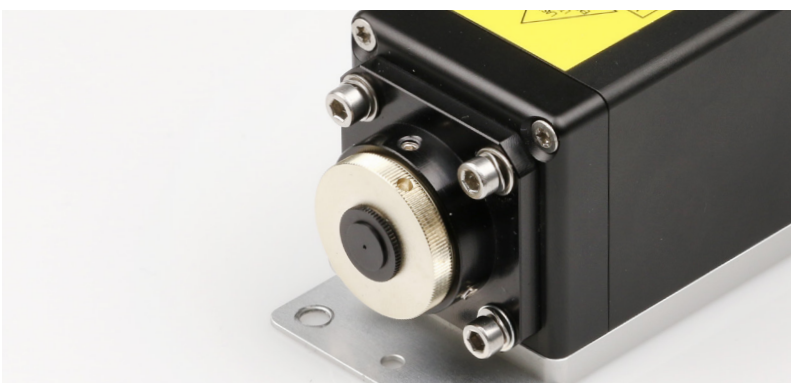


Figure 14:

Instead of a 60FC-A19.5 fiber coupler, an aperture 13H is attached.

Measure the power transmitted by this aperture. Maximize the transmitted power by laterally shifting the adapter. The adjustment is most sensitive if the aperture diameter is chosen to be about 70% of the collimated beam diameter ($1/e^2$).

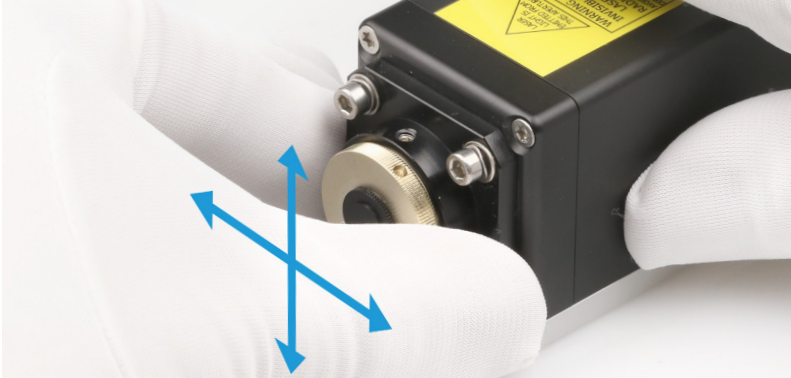


Figure 15:

Laterally shift the adapter in order to maximize the radiation that is transmitted by the aperture.

Only a coarse alignment is necessary, which can be done by hand (Figure 15), as the positioning accuracy must only be a fraction of the collimated beam diameter.

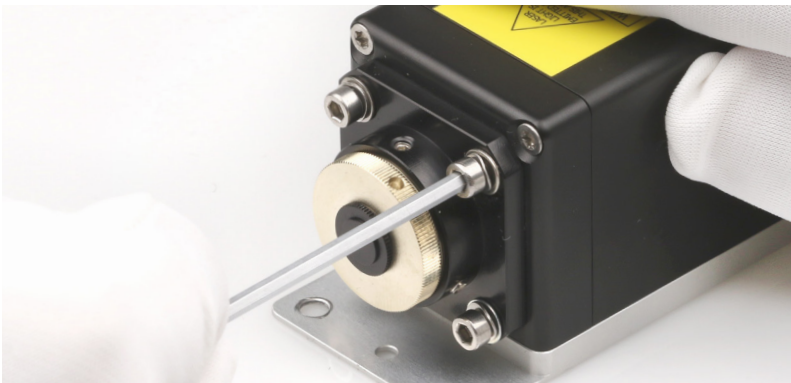


Figure 16:

Finally, fix the adapter and remove the aperture.



Notice:

If you have performed the described steps in this chapter accurately, you can skip the subsequent optimization of the fiber coupling described in chapter 6. The fiber-coupling efficiency should already be good.

5. Connecting the Fiber Coupler to Your System

Before you install the fiber coupler we recommend to measure the output power of the laser as a reference for the next steps.

Now, perform the following steps:

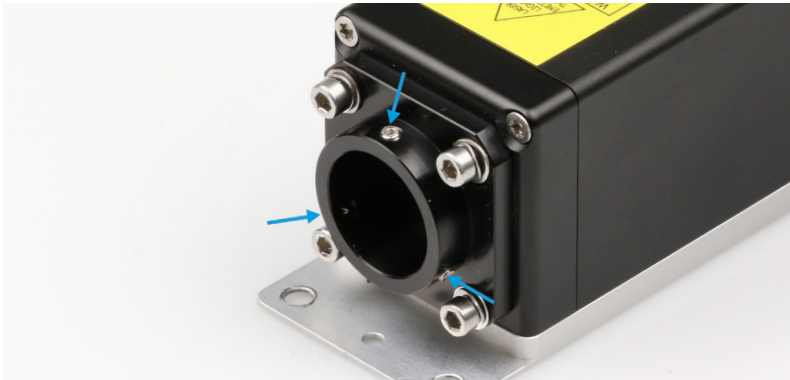


Figure 17:

Locate the three radially arranged tapered pin screws in the adapter flange and loosen them using the hex screwdriver 50HD-15.

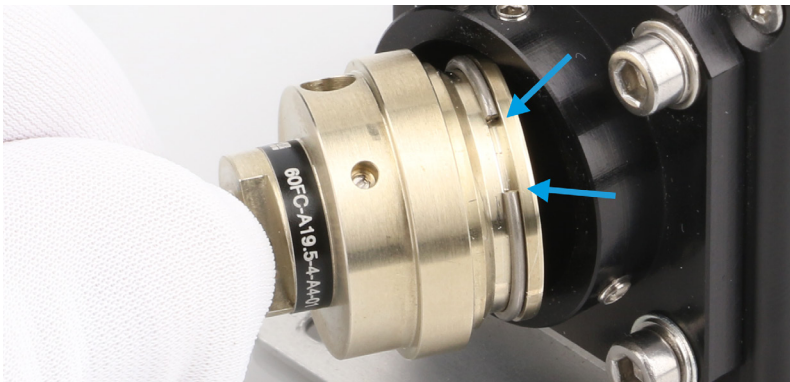


Figure 18:

Gently introduce the fiber coupler into the vacant aperture. Make sure that none of the tapered pin screws are located in the gap.



Attention: The \varnothing 19.5 mm system mount of the 60FC-A19.5 fiber coupler has a steel ring. This steel ring has a gap of approx. 2 mm, see Figure 18. Please make sure that none of the three pin screw is located in the gap of the steel ring. Otherwise the connection in between the adapter and the fiber coupler and therefore the alignment is not long-term stable.

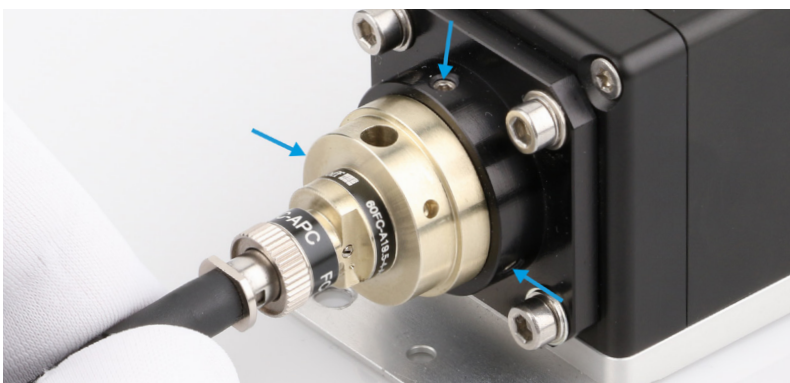


Figure 19:

Now, fix the three tapered pin screws at the adapter flange. please use the same torque of about 0.48 Nm for all three pin screws, respectively.

6. Optimizing the Fiber Coupling

When coupling into multi-mode fibers, the fiber couplers should produce a small focus at the fiber end-face. Thus, coupling a laser beam into a multi-mode fiber requires precise adjustment and needs some patience.



Caution! Refer to the laser instruction manual for all instructions regarding laser safety!

- Do not stare directly into the laser beam (which can cause permanent damage to the eyes).
- Do not stare at the reflected beam from reflective objects.
- Do not point the laser beam to other individuals.

Measure the coupled light at the opposite end of the fiber cable using a light detector or power meter. The detector may have to be adjusted to maximum sensitivity in order to detect a low transmission level possible at beginning of the following adjustment step:

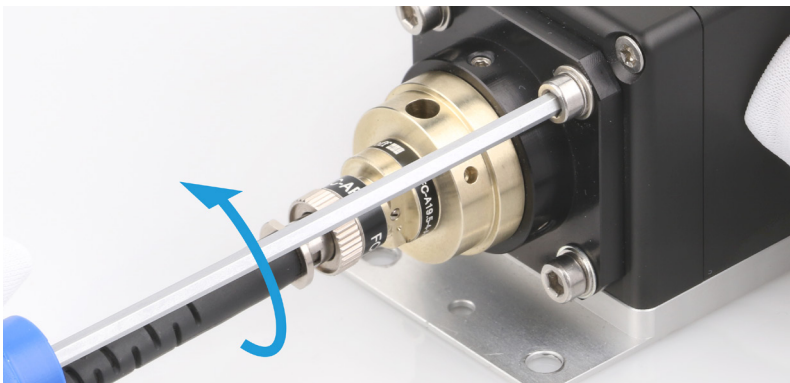


Figure 20:

Slightly loosen the the four screws fixing the flange.

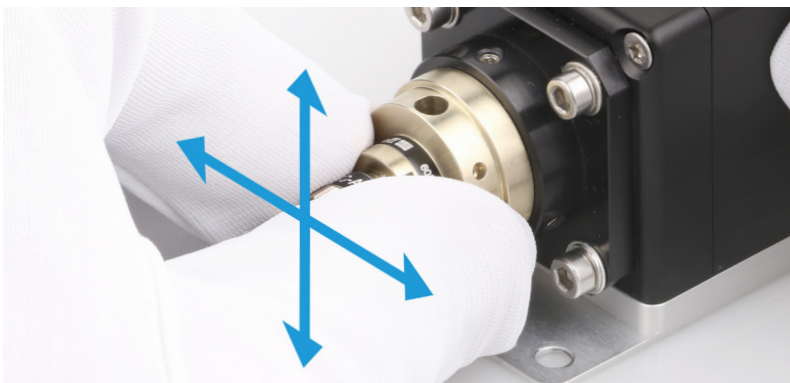


Figure 21:

Laterally shift the adapter in order to maximize the radiation that is detected at the fiber end.

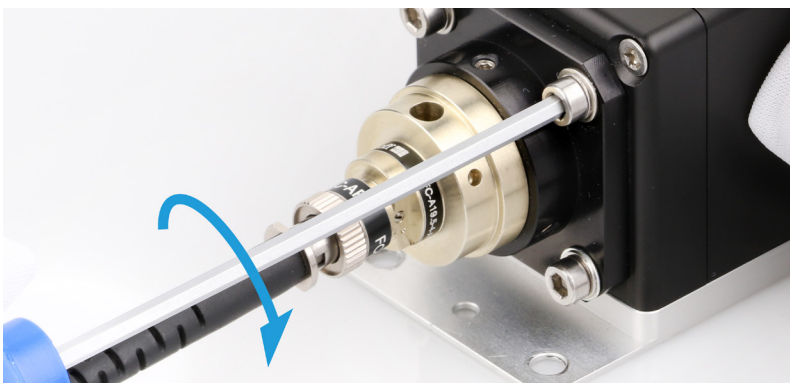


Figure 22:

Now, fix the four screws at the flange.

7. Focus Setting in Case of High Power Levels

If you have performed the previous steps described in chapters 1-5 (+ 6 if necessary), the fiber coupling to the multi-mode fiber is already optimized.

However, if the laser has a high power level it might be advisable to readjust the focus setting in a further step.

With the default focus setting a small focus is produced exactly at the end-face of the fiber. Therefore the power density is quite high, which can cause problems.

You can decrease the power density at the fiber end-face, by slightly de-adjusting the focus setting for high power level lasers. If done right, the fiber coupling efficiency will still be high, but power density will be decreased.

A fine-adjustment of the focus setting of the fiber coupler - if necessary - is performed in the following steps:



Figure 23:

Slightly loosen the lens by the loosening the two grub screws. Use the screwdriver type 9D-12.

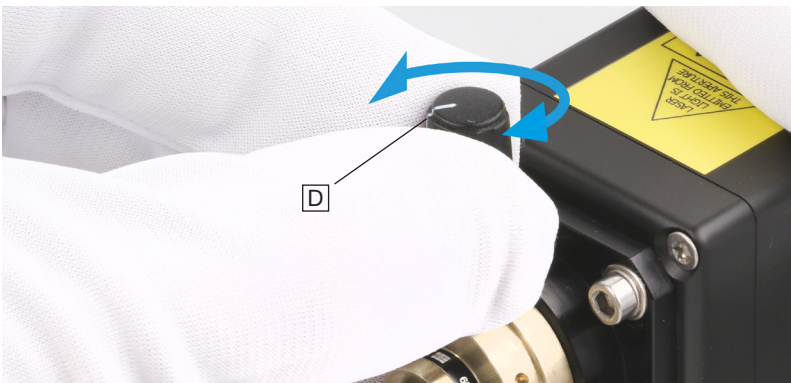


Figure 24:

Use the eccentric key type 60EX-4 or 60EX-5 for fine-adjusting the focus setting. Point the index D into the direction of the fiber.

Turn the eccentric key slightly in both directions. There is a range in which the radiation coupled to the fiber does not decrease. Adjust the focus setting to one edge of this range. Preferably, use the setting where the index of the eccentric key points into the direction of the fiber.



Figure 25:

Finally, lock the focus setting by fixing the two grub screws using the screwdriver type 9D-12.

8. Accessories



Figure 26:
Adapter type 60A19-5-F.
Other adapter types are available.

9. Adjustment Tools

For assembling and adjusting the fiber couplers series 60FC-A19.5 you need the following tools:



Figure 27:
Screw driver type 9D-12, hex key 50HD-15, and eccentric key type 60EX-4 or type 60EX-5.



Figure 28:
Aperture 13H and as an alternative the adjustable iris diaphragm 13BL1-13.

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