

OPTICAL FIBER COUPLING AND COUPLER ALIGNMENT GUIDE

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Safety Information

Always take appropriate safety precautions when working with Class 3B or Class 4 lasers. Failure to do so could result in irreparable retinal damage or other serious injury. Laserglow Technologies advises that all operators and/or personnel who could potentially be exposed to laser radiation review the various jurisdictions, standards, legislation, and government regulations that define appropriate safety measures for the types of lasers that are being operated. Laserglow also strongly recommends the appointment of, and guidance by, a certified Laser Safety Officer when using any lasers in the workplace.

In the North America, operators are advised to review the following safety standards:

- ANSI Z136.1 - Safe Use of Lasers
- ANSI Z136.3 – Safe Use of Lasers in Health Care Facilities
- ANSI Z136.4 – Recommended Practice for Laser Safety Measurements for Hazard Evaluation
- ANSI Z136.5 – Safe Use of Lasers in Educational Institutions
- ANSI Z136.6 – Safe Use of Lasers Outdoors
- ANSI Z136.7 – Testing and Labeling of Laser Protective Equipment

In Europe:

- EN 207 – Eye Protection Requirements
- EN 208 – Beam Alignment Goggle Requirements

In other regions, consult your local government for information regarding the use of lasers.

Laserglow urges all users to exercise caution when using lasers and laser devices. In this guide, a 100mW visible laser is used. Remember to take special precautions when using invisible wavelengths or very high powers.

Optical Fiber Coupler Overview

Optical fiber couplers are designed to allow a free-space laser beam to be coupled into an optical fiber. A focusing optic is used to reduce the beam to as small of a diameter as possible, and the input aperture of the optical fiber is located at the focal point so that the greatest possible amount of optical power enters the fiber core. While there are many different kinds of fibers and fiber couplers, this guide will focus on couplers and fibers available from Laserglow Technologies.

The three basic elements of a fiber coupler are the coupler body which attaches to the aperture of the laser module, the focusing optics located inside the fiber coupler body, and the fiber port platen held in place by three hex cap screws on the outermost surface of the coupler. The fiber port is integrated into the fiber port platen and should not be removed.



Figure 1 - An optical fiber coupler

Fiber Coupler Alignment

To maximize the amount of laser light entering the fiber, the coupler will need to be aligned. Laserglow aligns all fiber couplers prior to shipping but couplers may become misaligned during shipping and when used or stored in areas with vibration or large changes in temperature. If your laser is not producing the expected level of output at the terminal end of the optical fiber, realignment may be required.

To realign the fiber coupler:

Required:

Laser optical power meter
2mm (5/64") hex key or driver

Be sure to read this procedure completely before beginning.

1. If your laser is Class IIIb/IV, ensure that all persons in the area are wearing laser safety goggles appropriate for the wavelength and power level of your laser. Suitable goggles can be purchased from



Figure 2 - A Laserglow Technologies 473nm LabSpec laser module with optical fiber coupler attached

Laserglow.

2. Remove the optical fiber from the coupler, but leave the coupler attached to the laser.
3. Point the laser at a safe beam dump. This should be made of a non-reflective and non-flammable material.
4. Turn the laser ON at full power. The laser output will be highly divergent due to the focusing optic inside the coupler. (Figure 3)
5. Allow the laser to warm up by running it at full power for at least 5 minutes. 10-15 minutes is recommended. Be sure to dump the output beam in a safe manner using a beam stop. If you observe the output of the coupler in this state (using low density goggles) you may notice small circular or elliptical spots or other distortions. This is completely normal and will not affect the coupling efficiency of the laser in any way.
6. Using a laser power meter, check the output power of the laser without the optical fiber attached. Ensure the laser is producing close to (or more than) the output power provided in the laser system specifications and printed on the laser itself (Figure 4).
7. Attach the optical fiber to the coupler. Ensure the fiber safety covers have been removed from each end before affixing fiber to a coupler or transmitting laser light through the fiber. Never touch the tip of an optical fiber or allow the fiber ends to touch any surface.
8. Using a laser power meter, observe the power level at the output of the fiber. Leave this power meter at the fiber aperture for the remainder of the alignment procedure (Figure 5).
9. Slightly loosen the three cap screws using a 2mm (5/64") hex key or driver by turning them counter-clockwise.

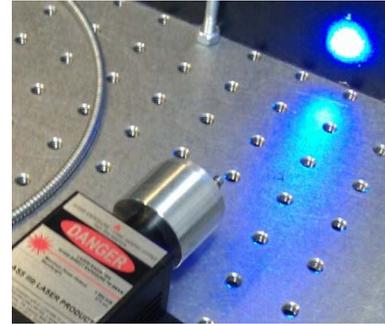


Figure 3 - Measuring laser output power with and without fiber

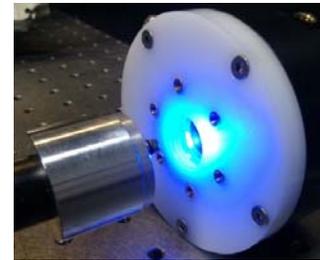


Figure 4 - Measuring laser output power with and without fiber

10. Using your fingers, slide the coupler plate over the base until optical output is observed from the aperture of the fiber (Figure 6). Gently slide the plate left, right, up and down to achieve maximum output (Figure 7). The fiber will have the greatest output when the center of the fiber is located exactly at the focal point of the laser beam. Please note that this may not be exactly in the center of the coupler.

11. Once maximum output is achieved, carefully tighten the three cap screws to secure the plate into place. The screws should be tight, but avoid using excessive force on them or the coupler may be damaged. When tightening the cap screws, the movement of the screws may cause small alterations in plate alignment. It is recommended that the screws be tightened in several steps of increasing torque, confirming alignment at each step.



Figure 5 – Adjusting the coupler plate

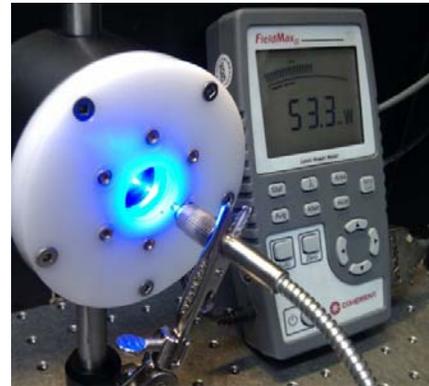


Figure 6 - Alignment Completed

Focusing Optic Alignment:

WARNING

Focusing optic alignment is best performed while the laser is running at full power without ever switching it off. This means that once the coupling plate is removed, the full power of the laser will be exposed. Since the coupling plate is machined aluminum, there is a VERY HIGH chance that you will be exposed to specular reflections when attaching or removing this plate. Furthermore, in order to rotate the focusing plate, you may need to look into the front of the laser. ALWAYS wear appropriate laser safety goggles while following this procedure and avoid letting the laser beam enter your eyes. Lastly, the laser will be focused to a very fine point near the front face of the coupler. Be sure to keep your fingers and flammable materials away from this area, as the energy density in this region is large enough to start a fire or burn your skin, even with low powered lasers.

If the expected output still cannot be achieved, the focusing optic may not be positioned such that the focal point of the beam is on the same plane as the face of the fiber. This is unlikely, but possible. Laserglow strongly recommends that all other options be exhausted before attempting focusing optic adjustment, as this procedure may take some time and can be hazardous if safety precautions are not taken.

To align the focusing optic:

Required:

Laser optical power meter
2mm (5/64") hex key or driver
Pointed tool with <1mm tip

Be sure to read this procedure completely before beginning.

1. The focusing optic is located on a threaded plate in the center of the coupler. To access the focusing plate, remove the coupling plate from the coupler base by completely removing the three cap screws. Be sure not to touch the optical elements.



Figure 7 - Focusing optic plate

2. Turning the focusing optic plate (Figure 7) will thread it forwards or backwards. Turn the plate half a turn in either direction, and then repeat the alignment procedure. If the maximum power achieved is greater than before, turn the plate half a turn in the same direction and repeat. If the maximum power achieved is less than before, turn the plate half a turn the opposite direction and repeat.

You may find it easier and faster to not reattach the cap screws every time you make an adjustment to the focusing optic. If you have steady hands you may be able to hold the coupling plate to the face of the laser while aligning it, which may save time.

3. If turning the plate in either direction results in a lower maximum power, the focusing optic is aligned.
4. Once the plate location for maximum power is achieved, Laserglow recommends applying a small drop of epoxy at the threading interface between the rotating optical plate and the inner threaded surface of the coupler housing. Do not use other glues or adhesives as they may produce invisible gas while curing which may permanently damage the optical components.

Alignment Tips:

- The smaller the core diameter of the fiber, the more difficult it will be to align.
- Single mode fiber (<10 μ m core) will be very difficult to align using the standard fiber coupler and will very easily become misaligned during shipping. Laserglow typically will epoxy the coupler and fiber in place prior to shipping so as to minimize this risk.
- Fiber couplers can be removed from the laser head by gently unthreading them counterclockwise.
- Sometimes by tightening the cap screws, the plate will move slightly causing further misalignment. Be sure to tighten the cap screws gently. It may be easier to have a second person tighten the cap screws for you while you hold the plate in place.
- Tightening the cap screws only partially will allow the plate to be moved without falling out of place when you let go. If rough alignment has been made, consider partially tightening the screws and making fine adjustments before tightening the screws fully.
- Extremely fine adjustments can be made by lightly tightening the cap screws and then gently tapping the plate from the top, bottom, or sides using a solid plastic object such as a screwdriver. Each tap will cause the plate to move by fractions of a micrometer which can prove quite useful when aligning single-mode fiber. Do not use metal objects to tap the fiber port platen or the vibration and shock could damage the optics or electronics of the laser.

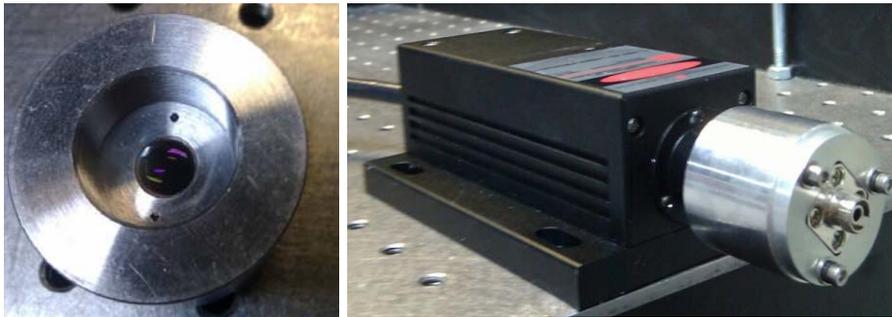
- Damaged fiber may produce the same symptoms as a misalignment. If problems persist try replacing the optical fiber.
- Due to the very small size of the optical path of a laser, small amounts of debris such as dust, hair, or other materials on the optical surfaces can cause significant power loss, therefore all procedures should be done in a clean, dust-free environment.

Attaching a Fiber Coupler

If your laser does not already have the fiber coupler attached to the output aperture you may need to attach it yourself. Each Laserglow ‘M’, ‘F’, or ‘H’ series laser has an aperture tube upon which is mounted a small aperture cover. The aperture cover must be loosened and unscrewed. Other models may require an adaptor (‘W’, ‘N’, etc) whereas several diode models must have coupling affixed at the time of construction (retrofitting is not possible).

The form factor of your laser is noted in the 10th character of the model name: LRS-0473-PFM-00100-03 indicates an “M” form factor.

The internally threaded component of the fiber coupler is then screwed onto the exposed aperture tube threads, being careful to not cross-thread the coupler as this causes serious damage. If you wish to design your own coupler mount, the threading on the inside of the coupler is M18.5 x 0.5 mm.



Revision #	Date	Associated documents	Author
I	June 2011		T. Grainge
II	July 2011		S. Browes
III	February 6, 2012		S. Browes
IV	October 4, 2013		J. Hosaki