



## LASER DIODE TO FIBER COUPLER - RECEPTACLE STYLE

### Features:

- Proven design and manufacture
- Variety of standard packaging options
- 375–2000nm
- Single mode, multimode or polarization maintaining fiber
- Rugged design
- Custom design for diodes
- High-power version

### Applications:

- Fiber Optic Communications
- Optical Alignment Systems
- Process Control
- Optical Sensor Applications
- Medical Apparatus
- Imaging Systems
- Test and measurement systems

### Product Description:

OZ Optics offers a complete line of laser diode to fiber couplers, offering optimum coupling in a small, rugged package. They may be purchased prealigned, with the diode already in place, or as a kit that can be assembled by the customer using their own diode. The complete assembly procedure is quite straightforward. A DVD assembly and operating instruction, showing the alignment process, is available. In addition, a complete alignment kit is available, which includes the laser diode collimation wrench, multimode fiber assembly, centering lens, and video instructions.

Diode source couplers are available for a variety of diode case sizes, and for diode wavelengths from 375nm to greater than 2000nm. These source couplers work with multimode, single mode, and polarization maintaining fiber. One of the main advantages of using the OZ Optics tilt adjustment technique is, should the diode ever fail, it can easily be replaced while reusing the rest of the coupling optics. The source coupler can then be realigned for optimum coupling.

There are two versions of tilt adjustable laser diode to fiber couplers; receptacle style couplers, and pigtail style couplers. Connector receptacle style couplers have a female receptacle, such as NTT-FC, or AT&T-ST, etc. at the output end. This allows the user to connect any optical fiber with a matching male connector to the diode. Pigtail style laser diode to fiber couplers are also offered, with the fiber pigtailed directly onto the coupler (please see the Pigtail Style Laser Diode to Fiber Coupler data sheet). The pigtail style laser diode to fiber coupler provides higher coupling efficiencies and lower backreflection levels than receptacle style couplers, as well as better stability. The output fiber can be left unterminated for fusion splicing onto another fiber, or be terminated with different output connectors.

Laser diode to fiber couplers are available in different diameters. The standard diameter package is 0.79" in diameter. This size fits almost all standard laser diode packages, and is available for both receptacle style and pigtail style couplers. The larger 1.3" diameter housing provides best coupling efficiencies as it supports larger and higher quality lenses. This housing size is also used with large diode case sizes, such as TO-3 or H1 package sizes.



**HULD-53**  
10mm OD OEM version FC receptacle



**HULD-13**  
0.79" OD flange tilt adjustable version  
with FC receptacle



**HULD-23**  
1.3" OD flange tilt adjustable version  
with FC receptacle



**HULD-33**  
0.59" OD laser diode to fiber coupler  
with FC receptacle

One misconception about tilt adjustable laser diode couplers is the belief that the number of tilt and locking screws make the coupler sensitive to temperature or vibration. In fact, tilt adjustable source couplers can be used over a temperature range of -25°C to 60°C, and have been vibration tested. Higher temperature versions are available on request.

OZ Optics also offers a special, low cost, miniature receptacle style laser diode to fiber couplers for OEM applications. These packages use just a single lens to couple light from the laser diode into the fiber. They do not use OZ Optics tilt adjustment technique. This package features a compact, rugged housing, at a lower cost. The housing diameter is typically 10mm. Coupling efficiency into single mode and multimode fibers is typically 10 percent and 35 percent, respectively.

A variety of options are available for laser diode to fiber couplers. One such option is a coupler with a built in isolator (for wavelengths higher than 1300nm). Isolators can reduce the effects of backreflection by up to 60dB. This is accomplished by using coated optics and angled polished fibers and is very useful for applications where the intensity and wavelength stability of the output light from the diode are critical.

Another option for laser diode to fiber couplers is a blocking screw to attenuate the output beam. This allows the user to precisely control the output power entering the fiber, without having to change the diode current. Another option is laser diode to fiber couplers with polarizer or polarization rotator in the middle.

Bar Code	Part Number	Description
35806	HULD-13-685-M-70-35LD	685nm laser diode to MM fiber coupler (20mm OD housing) with a FC receptacle (compatible with flat, super and ultra polished FC connectors), and 70% coupling efficiency into 62.5/125µm Graded Index, 0.27NA multimode fiber.
31215	HULD-13-1310-S-30-5LD	1310nm laser diode to SM fiber coupler (20mm OD housing) with a FC receptacle (flat, super and ultra FC connectors), 30% coupling efficiency into 9/125 single mode fiber.
31216	HULD-13-1550-S-30-5LD	1550nm laser diode to SM fiber coupler (20mm OD housing) with a FC receptacle (flat, super and ultra FC connectors), 30% coupling efficiency into 9/125 single mode fiber.
33171	ALIGN-03-DVD-IRVIS	Alignment kit for laser diode to fiber couplers with FC receptacles. The kit includes a collimating wrench, multimode fiber assembly, instruction manual and an instructional DVD.

#### Standard Product Specifications:

Coupling efficiency (%)	10–75	Depends upon the laser diode characteristics and the fiber into which the light is to be coupled.
Return loss (dB)	15–40	Depends on the type of polish on the input and output connector.
Wavelength (nm)	375–2000	Discrete wavelength steps.
Wavelength accuracy (nm)	±5 to ±30	Depends on the laser diode.

#### Ordering Examples For Standard Parts:

A customer needs to couple light from a 635nm laser diode into an FC receptacle and a 4/125 SM fiber. They require 30% coupling and want to do the alignment themselves.

Bar Code	Part Number	Description
20487	HULD-13-635-S-30-PO	635nm laser diode to SM fiber coupler (20mm OD housing) with an FC receptacle, 30% coupling efficiency from a 635nm laser diode into a 4/125, single mode fiber.
33171	ALIGN-03-DVD-IRVIS	Alignment kit for laser diode to fiber couplers with FC receptacles. The kit includes a collimating wrench, multimode fiber assembly, instruction manual and an instructional DVD.

#### Ordering Information For Custom Parts:

OZ Optics welcomes the opportunity to provide custom designed products to meet your application needs. As with most manufacturers, customized products do take additional effort so please expect some differences in the pricing compared to our standard parts list. In particular, we will need additional time to prepare a comprehensive quotation, and lead times will be longer than normal. In most cases non-recurring engineering (NRE) charges, lot charges, and a 25 piece minimum order will be necessary. These points will be carefully explained in your quotation, so your decision will be as well informed as possible. We strongly recommend buying our standard products.

## Description

### Laser Diode to Fiber Coupler - Receptacle Style

## Part Number

**HULD-AX-W-F-C**

#### A = Package size<sup>1</sup>:

- 1 = 20mm OD cylindrical housing
- 2 = 33mm OD cylindrical housing
- 3 = 15mm OD cylindrical housing
- 4 = 12.5mm OD cylindrical housing
- 5 = OEM 10mm OD cylindrical housing
- 6 = OEM Right Angle PCB mountable housing
- 7 = OEM Front Panel mountable housing
- T3 = 1" square base housing for TE cooling

#### X = Connector receptacle:

- 2.5U = 2.5mm universal receptacle (for FC, ST, or SC).
- 3 = FC/PC
- 3A = FC/APC receptacle
- 3AF = FC/AFC receptacle
- 5 = SMA905
- 8 = AT&T-ST
- SC = SC

#### C = Coupling efficiency<sup>2</sup>:

- 10 = 10%
- 20 = 20%
- 30 = 30%
- 40 = 40%
- 75 = 75% (multimode fiber only)

#### E = Fiber type:

- M = Multimode Fiber
- S = Single mode Fiber
- P = Polarization Maintaining Fiber

#### W = Wavelength<sup>3</sup>:

- 375, 400, 445, 473, 488, 515, 635, 650,
- 670, 685, 750, 780, 810, 830, 850, 980,
- 1064, 1310, 1480, 1550, 1625, 2000nm

- <sup>1</sup> Note that due to limitations in the size and the optical characteristics of the laser diode being used, not all package sizes are available for every laser diode.
- <sup>2</sup> Note that due to variations in the optical characteristics of the laser diode being used, not all coupling efficiencies are available for every laser diode for every fiber type.
- <sup>3</sup> These are standard center wavelength values. The tolerance may vary depending on both wavelength and the laser diode manufacturers tolerance. (Typical values range from  $\pm 10\text{nm}$  to as high as  $\pm 30\text{nm}$ ).

Options: Add "-DR" if OZ Optics is to provide the laser diode driver circuit or module for the laser diode. Add "-PS" if OZ Optics is to provide the power supply to operate the laser diode driver.

Add "-#LD" if OZ Optics is to provide the laser diode (where # is the LD output power, IE: -5LD). Add "-BL" if OZ Optics is to provide a manual blocking screw to control the laser diode output power.

### Ordering Examples For Custom Parts:

A customer needs to couple light from a 780nm laser diode into an FC receptacle and a 50/125 MM fiber. They require >60% coupling and a manual backup attenuator.

Bar Code	Part Number	Description
7836	HULD-13-780-M-70-BL	780nm laser diode to MM fiber coupler (20mm OD housing) with a FC receptacle (compatible with flat, super and ultra polished FC connectors) and a blocking screw (BL). 70% coupling efficiency into multimode fiber.

### Questionnaire For Custom Parts:

Please refer to the "Laser Diode / LED to Fiber Delivery System Questionnaire" on our website. This will help us choose the best components for your system. We can also email the questionnaire to you.

### Frequently Asked Questions (FAQs)

**Q:** If I am getting a PM fiber coupler, what will the polarization direction be coming out of the receptacle?

**A:** OZ Optics normally orients the "E" field of the laser diode (which is parallel to the plane of the junction) to the keyway on the receptacle, this is usually the "slow" axis of the PM fiber. OZ can orient the laser diode to either one of the fiber's polarization axes.

**Q:** What type of laser diode should I choose for my application?

**A:** Normally, the choice of laser diode wavelength, output power, line width, and modulation rate will drive your choice in choosing a laser diode. The remaining information can be found from the diode manufacturer's data sheets. In choosing between similar diodes, keep the following points in mind:

- Diode can size: Ideally, the can dimensions should be as small as possible. The critical dimension is the distance between the laser diode chip and the outside of the optical window on the can. For maximum flexibility, this distance should be less than or equal to 1.1mm. Diodes with longer separations can be used, but this means using longer focal length lenses, which will affect the package size.
- Emitter Dimensions: The smaller the emitter area is, the easier it is to couple the light into a fiber. Most diodes have emitting areas of the order of 1 x 3 microns in size. It is usually easy to get good coupling efficiency into a singlemode fiber with this chip size. However some diodes, particularly very high power diodes, have much larger dimensions (1 x 100 microns, for instance). These diodes can only be efficiently coupled to multimode fibers with similar or larger core sizes.

- Far field divergence angles/Astigmatism: These two properties are closely related. Ideally, the divergence angles should be as small as possible. Typical divergence angles are about 10° by 30°. Furthermore, the difference between the two angles, which is limited by the diode's astigmatism, should be as little as possible.
- Pointing Stability: Some diodes show changes in the pointing direction of their output over time. This could be a serious problem when coupling the laser diode output into a singlemode fiber. Contact the diode manufacturer for information about their diode's specifications.

**Q:** If the diode fails, do I have to throw out the whole assembly?

**A:** No. This is one of the main advantages of the OZ Optics adjustable tilt design. The lenses and optical fibers can be easily reused. Simply put the new diode into a new laser diode holder, collimate it using the old collimating lens assembly, and focus the collimated beam into the fiber using the old focusing optics.

**Q:** Can the level of back-reflected light going back into the laser diode cavity be reduced without having to use an isolator?

**A:** Yes. First, the laser diode chip should be positioned slightly off center with respect to the collimating lens assembly. This prevents reflections from traveling straight back into the cavity. Secondly, The input end of the fiber can be polished at an angle. Finally, the output end of the fiber can be angle polished, or index-matching gel can be used on the output end of the fiber. By combining these techniques, typical backreflection levels of up to -40dB can be achieved. In addition, backreflection levels as low as -60 dB are possible by applying an AR coating to the fiber tips.

**Q:** Does the diode chip have to be centered with respect to the outer diode housing?

**A:** No. This is one of the advantages of the OZ Optics design. There is no need for tight tolerances on the diode chip location, as small offsets in the lateral position of the laser diode chip can be easily compensated for at the focusing optics, using the patented tilt adjustment technique.

**Q:** I have a laser diode mounted on an open chip carrier. How can I use a laser diode to fiber coupler with it?

**A:** The laser diode chip must first be attached to a laser diode holder. The laser diode and laser diode holder can then be attached to the collimating lens assembly and focusing optics. NOTE: OZ Optics has several different type of laser diode holders already in stock, and custom diode holders can be manufactured to meet your needs. Contact OZ Optics for further information.

**Q:** I want to convert the output from a laser diode into a Gaussian beam. Can I do this without using cylindrical lenses or anamorphic prisms?

**A:** Yes. Couple the light into a singlemode or polarization maintaining fiber using a laser diode to fiber coupler. The fiber acts as an excellent spatial filter, giving an almost ideal Gaussian output beam. Wavefront distortion can be as low as  $1/50$ . The fiber output can then be easily collimated using a lens. OZ Optics offers a wide variety of fiber optic collimators for this purpose.

**Q:** Can optical amplifiers be pigtailed as well as laser diodes?

**A:** Yes. Optical amplifiers emit a little light in both directions when operated at low currents. This light can be collimated, and then coupled into an optical fiber. By doing this on both sides of the coupler, the amplifier can be pigtailed.

## Application Notes:

### Types of connectors/receptacles

One can often find SMA style (IE: SMA905 or 906) connectors used for high power multimode fiber applications, while for singlemode or PM fiber applications FC, ST, SC or similar style connectors are used. The main differences are the tolerance on the ferrule and mating sleeve, and where the tip of the ferrule stops when inserted into the sleeve.

SMA style connectors have looser tolerances on the ferrule and mating sleeve. They also use a "shoulder" on the back of the ferrule as a "mechanical stop" to stop the ferrule at a set location. The drawback to this is if a ferrule that was over polished were used, the fiber will not be at the focal point of the lensing system, therefore reducing the coupling efficiency. Also, when mating two fibers, any gap would be seen as a separation loss.

The other connectors have tighter tolerances on the ferrule and mating sleeve. They utilize some type of spring motion to keep the ferrule tip in intimate contact with either another fiber or a mechanical stop, located at the focal point of a lensing system. The advantage to this is smaller fiber core sizes can then be used without a significant insertion loss. Also, when mating two fibers, having no gap would eliminate a separation loss.

The bottom line is that SMA style connectors are not recommended for fiber core sizes <100µm.

### Emitter size vs. fiber size

A common question is, "Why can't I get good coupling from some diodes into small core fibers?" When coupling light from a source into an optical fiber one has to consider the size of the emitter and its emission angle, as well as the core size of the fiber and its respective acceptance angle (NA). It is usually just a matter of simple imaging.

When imaging at a 1:1 ratio, the object and the image, as well as the angle of the rays to/from them, are identical. When imaging at a 2:1 ratio (magnifying), the image becomes twice as large, but the angle of the rays to the image are cut in half.

A simplified example: A 1310nm laser diode has an emitter that is 1x3µm and has an emission angle of 25° FWHM. It is required to couple it into a standard 9/125 fiber (NA=0.11). To image the 1x3µm emitter onto the 9µm core, a maximum magnification of three would be required. Any light

not imaged onto the fiber core will be lost. This would produce a 3x9µm image on the end of the fiber, as well as reducing the angle of the emitted rays from 25° to 8.3° (NA~0.14). Any light not captured by the acceptance angle of the fiber will be lost as well.

Try this same calculation only using a 1x100µm emitter (typical "stripe" laser diode) or a 300x300µm emitter (typical indicator LED) and see the percentage of light that may be coupled into the fiber.

NOTE: There are some lenses available that will reduce the effect.

### Laser diode drivers

There are basically two types of laser diode drivers, constant current and constant power. There are advantages and disadvantages to both, depending on what your ultimate goal is. Some of these main points are outlined below.

Also, you may well ask, "What is the simplest laser diode driver?" The simplest laser diode driver is a battery and a variable resistor (potentiometer), but it offers no type of protection or control. The problem with this is that the internal resistance of the laser diode decreases with an increase in temperature, and with this decrease it will draw more current. This cycle will continue until the device either reaches thermal equilibrium, or fails due to excessive current.

In constant current drivers, the current through the laser diode is sensed by some circuitry and adjusted to provide a constant current to the laser diode. This adjustment compensates for the internal resistance change of the laser diode. The advantage of this is the fact that the laser diode is less likely to "mode hop" due to the input current changing. The disadvantage of this is the laser diode output power will decrease until the device reaches a thermal equilibrium.

In constant power drivers, a photodiode (back facet monitor) in the rear of the laser diode package is used to sense the relative output of the laser diode. This output is then fed to some circuitry to adjust the current through the laser diode in order to provide a constant output power. The advantage of this is, of course, you maintain a constant output power from the device. The disadvantage of this is the laser diode output power will decrease until the device reaches a thermal equilibrium. Be advised though, that the feedback loop of the driver must be properly chosen to match the photodiode current range of the device.

### What is ESD?

ESD, or Electrostatic Discharge, is basically the discharge of electrons previously stored up on an insulator. Modern electronic components like computer chips, electronic assemblies and circuit boards are sensitive to static electrical charges, and laser diodes are no exception. Many of these components can be damaged beyond repair by an electrical discharge as low as 20 volts. Also, the failure may not be evident until much later in the device's lifetime as there are two types of failure modes, catastrophic and latent.

When a catastrophic failure occurs, the electronic device that was exposed to an ESD event will no longer function. In the case of a laser diode, the surge current races across the surface of the device (laser facet) damaging the crystalline structure, resulting in an expensive LED.

Latent failure on the other hand is more insidious. The device may work for days, or even months before any sign of failure is noticed. Even then, it may fail suddenly, or begin to degrade slowly over time. As you can see, a latent defect is difficult to detect, especially if the device has been working for a while. A product using devices with latent defects may experience failure for no apparent reason.

The best way to avoid these failure modes is to prevent them from happening in the first place. There are many preventative measures that one can take, several of which are given below:

- Use the static sensitive devices on a static dissipative surface or mat. (A static dissipative surface is one where the surface resistivity is 1x10<sup>5</sup> - 1x10<sup>12</sup> ohms/sq, or the volume resistivity is 1x10<sup>4</sup> - 1x10<sup>11</sup> ohm-cm.) This will ensure that there is no build up electrons to discharge.
- Always make sure that you are grounded through an appropriate resistance (500k ohm to 1M ohm). This will ensure that any static charges that would normally build up on you, do not.
- Test your wrist strap and grounding cord twice daily. Also, just wearing a wrist strap does not mean that you are grounded. Dry skin, for instance, can prove to be an insulator, and lead you to believe that you are grounded when you are not.
- Maintain an ESD control and awareness program, and stick to it!

Examples of Static Electricity Voltage Levels Generated by Various Routine Tasks		
Means of Generation	10–25% RH	65–90% RH
Walking across a carpet (or rubbing your "lucky" rabbits foot)	35,000V	1,500V
Walking across a vinyl tile floor	12,000V	250V
Worker just sitting at a bench	6,000V	100V
Picking up a poly bag from a bench	20,000V	1,200V
Sitting in or rising from a chair with urethane foam padding	18,000V	1,500V