

# *Semiconductor Diode Laser*

## **Operator's Manual**



### **Model Numbers:**

**IF-RL05**

**IF-RL08**

**IF-RL30**

**INDUSTRIAL FIBER OPTICS**

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\* \* \*

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## ***Introduction***

*This manual provides information about Industrial Fiber Optics lasers model numbers IF-RL05-635, IF-RL08-635, IF-RL30-635 and IF-RL30-670. It contains all the information you need to operate these lasers safely and knowledgeably, even if you are a novice to laser technology. Please read the manual carefully before operating the laser.*

*As soon as you receive this laser, inspect it and the shipping container for damage. If any damage is found, immediately refer to the section of this manual entitled *Shipment Damage Claims*.*

*Industrial Fiber Optics makes every effort to incorporate state-of-the-art technology, highest quality, and dependability in its products. We constantly explore new ideas and products to best serve the rapidly expanding needs of industry and education. We encourage comments that you may have about our products, and we welcome the opportunity to discuss new ideas that may better serve your needs. For more information about our company and products refer to <http://www.i-fiberoptics.com> on the Worldwide Web.*

*Thank you for selecting this Industrial Fiber Optics product. We hope it meets your expectations and provides many hours of productive activity.*

*Sincerely,*

***The Staff at Industrial Fiber Optics***



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# LASER CLASSIFICATIONS

All manufacturers of lasers used in the United States, must conform to regulations administered by the Center for Devices and Radiological Health (CDRH), a branch of the U.S. Department of Health and Human Services. CDRH categorizes lasers as follows:

Class	Description
I	A laser or laser system which does not present a hazard to skin or eyes for any wavelength or exposure time. Exposure varies with wavelength. For ultraviolet, .2 to .4 $\mu\text{m}$ exposure is less than from .8 nW to .8 $\mu\text{W}$ . Visible light exposure varies from .4 $\mu\text{W}$ to 200 $\mu\text{W}$ , and for near IR, the exposure is < 200 $\mu\text{W}$ . Consult CDRH regulations for specific information.
II	Any visible laser with an output less than 1 mW of power. Warning label requirements — yellow caution label stating maximum output of 1 mW. Generally used as classroom lab lasers, supermarket scanners and laser pointers
IIIa	Any visible laser with an output over 1 mW of power with a maximum output of 5 mW of power. Warning label requirements — red danger label stating maximum output of 5 mW. Also used as classroom lab lasers, in holography, laser pointers, leveling instruments, measuring devices and alignment equipment.
IIIb	Any laser with an output over 5 mW of power with a maximum output of 500 mW of power and all invisible lasers with an output up to 400 mW. Warning label requirements — red danger label stating maximum output. These lasers also require a key switch for operation and a 3.5-second delay when the laser is turned on. Used in many of the same applications as the Class IIIa when more power is required.
IV	Any laser with an output over 500 mW of power. Warning label requirements — red danger label stating maximum output. These lasers are primarily used in industrial applications such as tooling, machining, cutting and welding. Most medical laser applications also require these high-powered lasers.

# GENERAL

Industrial Fiber Optics' family of diode lasers (whose models vary only in their power and output wavelength) utilizes the latest technology in miniaturization electronics and laser science — the same as used in long-distance fiber optic communication networks, CD players and bar code scanners. The technology incorporates semiconductor laser diodes — tiny electronic microchips that operate as lasers.

Semiconductor diode devices offer an important alternative to widely known and used helium-neon-gas (HeNe) lasers. Diode lasers are smaller, more efficient, and offer direct digital and analog modulation capabilities previously unavailable. Exceptional versatility makes this semiconductor technology an essential component of modern science, physics and industrial technology curriculums.

The Industrial Fiber Optics family of lasers offers particular educational value in its ability to increase and reinforce learning via fascination. They also offer more options for internal application and types of modulation inputs. With these lasers, students will readily, enthusiastically learn about physical optics, fiber optics, light propagation, speed of light theory and measurement, laser communications, and much more!

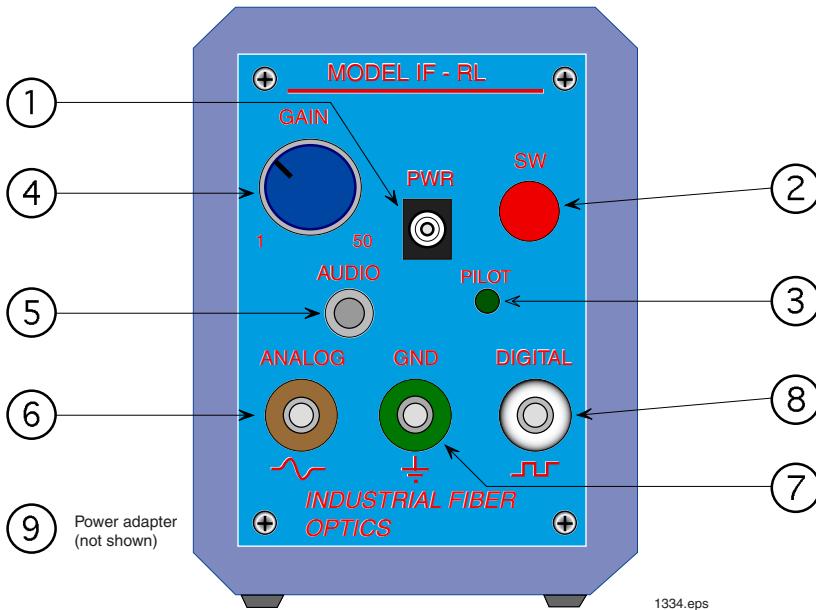
**Table 1. Common abbreviations used in this manual.**

Abbr	Long version	Scientific Notation
<b>mW</b>	milliwatts	$1 \times 10^{-3}$ watts
<b><math>\mu</math>W</b>	microwatts	$1 \times 10^{-6}$ watts
<b>nW</b>	nanowatts	$1 \times 10^{-9}$ watts
<b>mm</b>	millimeters	$1 \times 10^{-3}$ meters
<b><math>\mu</math>m</b>	micrometers	$1 \times 10^{-6}$ meters
<b>nm</b>	nanometers	$1 \times 10^{-9}$ meters

# OPERATIONAL INFORMATION

## ELECTRICAL

All electrical controls are located at the rear of the laser chassis. A diagram of the rear view of the laser appears in Figure 1. Following are descriptions of each item identified in Figure 1:



1334.eps

*Figure 1. Rear view of laser showing electrical inputs and controls.*

### 1. Power Jack (PWR)

All Industrial Fiber Optics lasers use a standard 2.1 mm DC power input jack to provide power to the laser. (An ON/OFF switch controls power from the jack to the electronic circuitry and lasing element.)

Power input to the laser must be applied from a low-voltage DC power source in the range of 10 to 15 volts, such as supplied with the laser. See Item 9 in this section for more information about the power adapter.

## **2. Switch (SW)**

A push-button switch is located immediately to the right of the 2.1 mm power jack. It controls power from the 2.1 mm power jack to the electronic circuitry and lasing element. When the switch is closed it will be slightly depressed, compared to the open position, when the switch will be fully extended.

## **3. Pilot light (PILOT)**

Just below and left of the Switch is the pilot light. It emits a green light when the switch is on and power is applied to the electronic circuitry and lasing element.

## **4. Gain control (GAIN)**

The gain control feature of this laser makes it the most versatile educational laser on the market. The Gain control knob is located on the left side of the front panel. It controls the gain of an internal electrical circuit which amplifies signals from the microphone (AUDIO) and analog (ANALOG) inputs. This feature is particularly useful for ensuring compatibility of the laser with low-level microphone signals as well as larger amplitude signals from cassette and CD players.

Starting with the Gain Control Knob set to 1 (Gain Control Knob turned fully counter-clockwise) the AUDIO and ANALOG signal inputs accept voltage levels up to 50 mv RMS peak before saturating the modulation range of the laser. When you have input signals less than 50 mv RMS peak you can use the Gain Control Knob to increase the signal to the laser modulation. You can now take input signal levels even as low as <1 mv and with the Gain Control Knob turned fully clockwise increase the level 50 times. This allows for maximum laser modulation for improved output detection using a variety of laser receivers.

## **5. 3.5 mm jack (AUDIO)**

This is an industry-standard jack, commonly described as a 3.5 mm audio type. It is compatible with most remote microphones and, with patch-cord interconnections, to cassette and CD players.

The minimum impedance of this input is 1 k ohms. Typically the Gain control is set at about the 2 o'clock position when using a microphone connected to this jack. Turn the Gain control knob fully counterclockwise when patching cassette and CD player outputs into the 3.5 mm jack.

## **6. Analog input (ANALOG)**

This jack is an industry-standard "banana" type as are the GND and DIGITAL inputs. It is located in the lower left portion of the control panel.

The Analog input is an alternate method of inputting signals to utilize this laser's analog modulation capabilities.

The input source and the laser must share a common ground when using the analog banana input jack. Establish the common ground connection for the analog input through the jack labeled "GND," described in the next section.

## 7. Ground Input (GND)

This is the green banana jack located in the lower center portion of the laser control panel. The ground banana jack completes the electrical circuit when the analog and digital banana jacks are signal inputs for modulating the laser beam intensity.

## 8. Digital Modulation Input (DIGITAL)

The white banana jack is the input for digital signals to the laser, to digitally modulate the laser optical beam. Examples of utilizing the laser for such an application would be a computer-to-printer through-the-air link, a digitally coded security system or a long-distance remote TV control.

The digital input to this laser is compatible with standard LSTTL logic, powered by +5 volts. Do not connect the input to any logic with voltage levels greater than +5 volts, or below ground (0 volts). **Table 2** is the truth table describing laser output in response to digital inputs.

**Table 2. Laser Output versus Digital Input.**

Digital Signal	Laser Output
>3.4 volts	High*
<0.7 volts	Low**
Unconnected	High*

\* Output power will equal the laser power rating.

\*\* The laser will still produce a small amount of optical power, less than 20% of high level.

As with analog modulation, the digital source and the laser must share a common ground for you to use the laser's digital modulation capabilities. To establish the common ground, use the "GND" banana jack.

## 9. Power adapter (not shown)

All Industrial Fiber Optics lasers sold in the United States come complete with a power adapter suitable for 60 Hz 110 VAC-to-VDC conversion. Most others come with 50 Hz 220 VAC-to-VDC power adapters. It is strongly recommended that the power adapter furnished with the laser be the *only* supply used.

If you must use another power supply, it **must** be one with voltage output between 10 to 15 volts DC, and minimum current capability of 150 milliamperes. Do not use a power supply which may generate or pass voltage spikes exceeding 36 volts.

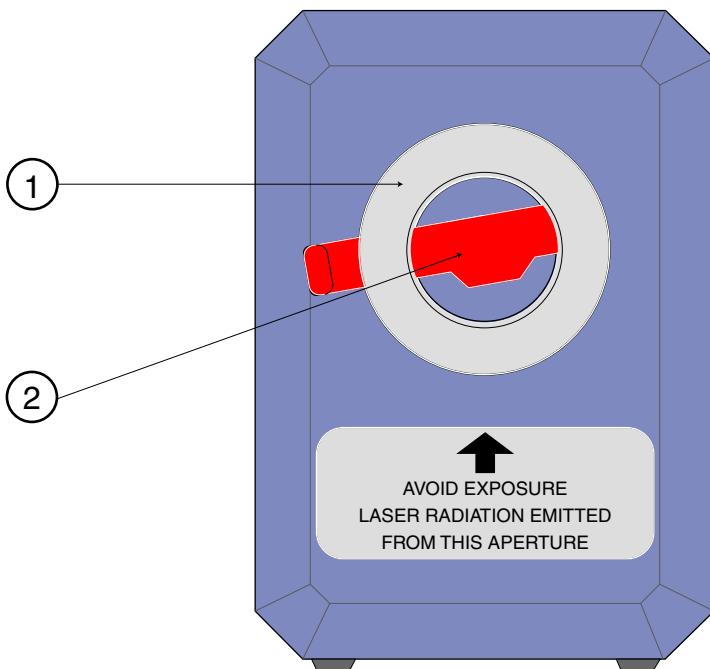
# BEAM CONTROLS

## 1. Optics Mount

The optics mount is a nickel-plated aluminum cylinder with internal diameter of 3/4 inches and with 32 threads per inch. The threads facilitate the use of this laser in many optical experiments using mounted lenses, polarizers and spatial filters, such as Industrial Fiber Optics Laser Optics Kit P/N IF-535.

## 2. Beam Stop

The beam stop (also known as a beam attenuator) is required on lasers by federal regulations. When viewed from the rear of the laser, its handle protrudes from the right side of the optics mount. Its function is to mechanically block the laser beam when the handle is pushed downward. When the handle is pushed upward, the beam stop rotates and allows the laser beam to exit the lasing apparatus.



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*Figure 2. Front View of Laser with Beam Stop Blocking the Laser Beam.*

# SPECIFICATIONS

**Caution:** Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Specifications for laser model numbers **IF-RL05-635<sup>1</sup>**, **IF-RL08-635<sup>1</sup>**, **IF-RL30-635<sup>1</sup>**, and **IF-RL30-670<sup>1</sup>** are shown in Table 3.

**Table 3. Laser Specifications.**

Parameter	Value	Units
<b>Operating</b>		
Input voltage	10 to 15	volts
Input current	60 to 125	milliamperes
Temperature	0 to 40	° C
<b>Optical</b>		
Polarization	Linear	
Wavelength	630 - 675 <sup>1</sup>	nm
Output power	See label <sup>2</sup>	mW
Beam diameter	3.2	mm
Beam divergence, max	2	milliradians
<b>Electrical</b>		
Analog modulation <sup>3</sup>	10 to 500	kHz
Digital modulation <sup>3</sup>	0 to 500	kHz
<b>Storage</b>		
Dimensions	5.6 x 7.5 x 22	cm
Weight	400	grams
Temperature	-20 to 50	° C

<sup>1</sup> The lasing wavelength, in nanometers, is the last three numbers in the part number located on the underside of the laser chassis.

<sup>2</sup> Label is located on the bottom side of the laser.

<sup>3</sup> Refer to the section on electrical controls in this manual for more information.

## Models and Laser Classifications

**Table 4. CDRH Classifications for laser models.**

Laser Model	Classification	Typical power levels
<b>IF-RL05-635</b>	<b>CLASS II</b>	.4 to .6 mW
<b>IF-RL08-635</b>	<b>CLASS II</b>	.75 to .90 mW
<b>IF-RL30-635</b>	<b>CLASS IIIa</b>	2.8 to 3.2 mW
<b>IF-RL30-670</b>	<b>CLASS IIIa</b>	2.8 to 3.2 mW

## OPTICAL

All lasers addressed by this manual emit a visible beam of red light. No infrared, ultra-violet, x-ray or other non-visible radiation is emitted from these products.

This low-power laser cannot be used to burn, cut or drill. Even so, you should use caution, because the beam is concentrated. It could become focused to a pinpoint within the human eye. **Never look directly into the laser beam or stare at its bright reflections — just as you should avoid staring at the sun or other very bright light sources.**

Review the *Rules for Laser Safety* on the back cover of this booklet.

## ELECTRICAL

Included with this laser is a UL-approved VAC-to-VDC adapter for VAC operation. The adapter converts common lab/household voltage to low DC voltage suitable for laser use. Always plug the adapter into a grounded circuit.

This laser is particularly safe because it operates at low wattage and low current levels. However, as when using any electrical device, you must take certain safety precautions:

- Do not touch (or short-circuit) the connection point at which incoming power from the adapter enters the laser housing, as this could damage the power supply.
- Do not open the laser housing under any circumstances, as this will expose you to unshielded electrical connections, violating federal government regulations and voiding the product warranty.

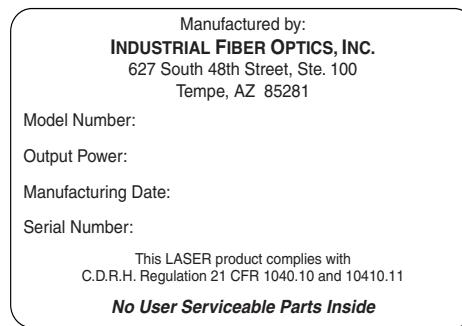
# LASER REGULATIONS

The U.S. Department of Health, Education and Welfare regulates and classifies all laser products sold in the United States. Industrial Fiber Optics lasers comply fully with laser performance standards established by Center for Devices and Radiological Health (CDRH) Regulation 21, parts 1040.10 and 1040.11, Code of Federal Regulations.

Specific labeling is required by Federal Regulations on all laser products. ***For your safety and that of others, do not remove any of the labels.***

## CERTIFICATION/ IDENTIFICATION

Laser certification and identification labeling required by federal regulations have been combined in a single label located on the underside of the laser. A graphic representation of that label is shown in **Figure 3**. It certifies that this laser complies with federal regulations; identifies the manufacturer; and lists the model number and date of manufacture.

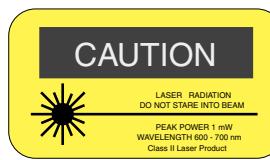


**Figure 3. Laser certification and identification label.**

## CLASSIFICATIONS

All lasers described by this manual fall within the limitations of Class II and Class IIIa of CDRH standards. All lasers covered by this manual will exhibit a label located on the top, rear of the laser chassis as shown in **Figure 7**.

Class II lasers may not exceed 1 milliwatt (1 mW) of output power, must contain a pilot light and a beam attenuator. An example of the "warning logotype" label used for Class II lasers is shown in **Figure 4**.



**Figure 4. Warning logotype label for Class II lasers.**

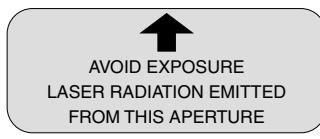
Class IIIa lasers have an output power limitation between 1 and 5 milliwatts, and require a pilot light and a beam attenuator. The "warning logotype" label required for this classification of laser is shown in **Figure 5**.



**Figure 5.** *Warning logotype label for Class IIIa lasers.*

## APERTURE LABELS

Federal regulations also require that the laser emission aperture/port be labeled. A graphic representation of that label is shown in **Figure 6**. Location of this label is shown in **Figure 2**.

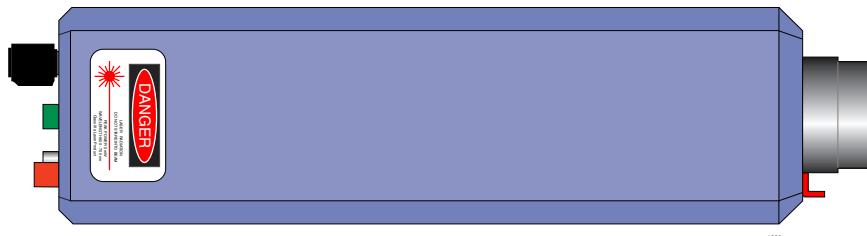


**Figure 6.** *Beam aperture label.*

## ADDITIONAL REFERENCES

For more information about lasers and laser standards, contact your local U.S. Department of Health and Human Services, or write to the agency's headquarters at 1390 Piccard Dr., Rockville, MD 20850.

For U.S. guidelines on laser classifications and health standards, refer to the American National Standards Institute (ANSI) specifications governing lasers and laser safety. The guidelines are published by the Laser Institute of America, 12424 Research Parkway, Suite 130, Orlando, FL 32826.



**Figure 7.** *Top view of laser showing the location of the "warning logotype" label for a Class IIIa laser.*

# OPERATING PROCEDURES

## NON-MODULATION OR CW OPERATION

1. Review the laser safety steps on the back cover of this manual.
2. Point the laser toward a wall or other dull non-reflecting surface.
3. Push the beam stop's handle downward to its closed position.
4. Make sure the laser's ON/OFF switch (SW) is in its OFF position. (The push button should be in its extended position.)
5. Plug the 110\* VAC-to-DC power adapter (provided with the laser) into an AC wall outlet.

### Important!

If you must use a power adapter other than the one supplied with this laser, check the section entitled *Operational Information* in this manual to ensure the power adapter's voltage and current levels are within recommended specifications.

6. Plug the cord from the power adapter into the power jack (PWR) located on the rear of the laser.
7. Depress the ON/OFF switch (SW) on the control panel of the laser until it clicks into the ON position. (The switch should be slightly depressed.)
8. The pilot light (green LED) just to left and below the ON/OFF switch should now be lit, showing that the laser is on.
9. Push the beam stop's handle upward, to its open position.
10. Observe the red beam striking the wall, or other surface, in the direction which the laser is pointed.

\* 220 VAC for most customers outside of North America

# USING LASER WITH MICROPHONE

*We will outline the steps for using a microphone with your Industrial Fiber Optics diode laser. Because we don't know what receiver you will use to convert the optical signal on the laser beam to sound, please refer to that receiver's instruction manual as directed in the procedure below.*

1. Complete Steps 1 through 10 on page 10.
2. Push the beam stop to its closed position, and make sure the laser's ON/OFF switch is OFF. (The button should be extended and the pilot light no longer illuminated.)
3. Plug the 3.5 mm plug on the end of the microphone cord into the 3.5 mm audio jack.
4. Point the laser toward a wall or other non-reflecting dull surface.
5. Set up your laser receiver, referring to its manual for operating procedures.
6. Press the ON/OFF switch (SW) on the control panel of the laser. The laser now should be on, as indicated by the pilot light.
7. Rotate the beam stop's handle upward, to its open position.
8. Target the laser beam on the light detector found on the laser receiver.
9. Position the receiver or laser as needed, so the laser light beam strikes the center of the receiver detector.
10. If a high-pitched squeal is produced by the laser receiver and speaker, reduce the volume at the receiver.
11. Speak into the microphone. If you cannot hear yourself, bring the microphone closer to your mouth and/or increase laser receiver volume.

*Your laser and receiver should now be functioning as a free-space optical voice link. You should be hearing your voice or music from the audio receiver.*



**Figure 8. Class IIIa laser and laser beam aligned with an Industrial Fiber Optics' audio laser receiver for demodulation of the laser beam's modulated signal and producing sound waves.**

# TROUBLESHOOTING

## NO PILOT LIGHT

- Is the laser's ON/OFF switch in the ON position?
- Is the 110 (220) VAC-to-VDC power adapter plugged into the laser and an appropriate wall outlet or extension cord?
- Is there power to the wall outlet?

## NO LASER LIGHT OUTPUT

- Is the ON/OFF switch in the ON position?
- Is the 110 (220) VAC-to-VDC power adapter plugged into the laser and an appropriate wall outlet or extension cord?
- Is there power to the wall outlet?
- Is the pilot light on?
- Is the mechanical beam stop in its open position?

## NO MODULATION FROM RECEIVER

- Is the laser beam positioned properly so its beam hits the receiver detector?
- If you are using an analog or digital input banana jack, is it properly connected, including a "ground" connection?
- Are input signals to the laser of sufficient amplitude? (See microphone, analog and digital portions in the Electrical section of this manual.)
- Slowly move the receiver detector out of the path of the laser beam while continuously monitoring receiver operation. (This would desensitize the receiver in case the receiver is too sensitive for this laser [saturating].)
- Check the troubleshooting section in your laser receiver manual.

Do **not** attempt to troubleshoot the laser beyond the steps listed above. If all your connections are correct, and you are confident that power is being supplied to the laser and any input devices, please return the laser for appropriate inspection/servicing to Industrial Fiber Optics, as described in the section entitled **SERVICE AND MAINTENANCE**.

## **SERVICE AND MAINTENANCE**

Periodic operation, maintenance and service of this laser are not required. The warranty will be voided if entry has been made to the laser housing and/or any screws have been removed.

In the unlikely event this laser malfunctions and you wish to have it repaired, please do the following:

- In writing, describe the problem, person to contact, phone number, and return address.
- Carefully pack the laser, power adapter, manual, and written description in a stout box with sufficient packing material to prevent damage in shipment.
- Ship the package to:

### **INDUSTRIAL FIBER OPTICS**

627 South 48th Street, Suite 100  
Tempe, AZ 85281  
USA

# WARRANTY

Industrial Fiber Optics diode lasers are warranted against defects in materials and workmanship for 4 years. The warranty will be voided if the laser components have been damaged or mishandled by the buyer, including entry to the laser housing and/or removal of screws.

Industrial Fiber Optics' warranty liability is limited to repair or replacement of any defective unit at the company's facilities, and does not include attendant or consequential damages. Repair or replacement may be made only after failure analysis at the factory. Authorized warranty repairs are made at no charge, and are guaranteed for the balance of the original warranty.

Industrial Fiber Optics will pay the return freight and insurance charges for warranty repair within the continental United States by United Parcel Service or Parcel Post. Any other delivery means must be paid for by the customer.

The costs of return shipments for lasers no longer under warranty must be paid by the customer. If an item is not under warranty, repairs will not be undertaken until the cost of such repairs has been approved, in writing, by the customer. Typical repair costs range from \$25 - \$125, and repairs usually take two to three weeks to complete.

When returning items for analysis and possible repair, please do the following:

- In a letter, describe the problem, person to contact, phone number, and return address.
- Pack the laser, power adapter, manual and letter carefully in a strong box with adequate packing material, to prevent damage in shipment.
- Ship the package to:

## INDUSTRIAL FIBER OPTICS

627 South 48th Street, Suite 100  
Tempe, AZ 85281  
USA

## SHIPMENT DAMAGE CLAIMS

If damage to an Industrial Fiber Optics product should occur during shipping, it is imperative that it be reported immediately, both to the carrier and the distributor or salesperson from whom the item was purchased. DO NOT CONTACT INDUSTRIAL FIBER OPTICS.

Time is of the essence because damage claims submitted more than five days after delivery may not be honored. If shipping damage has occurred during shipment, please do the following:

- Make a note of the carrier company; the name of the carrier employee; the date; and the time of the delivery.
- Keep all packing material.
- In writing, describe the nature of damage to the product.
- In cases of severe damage, do not attempt to use the product (including attaching it to a power source).
- Notify the carrier immediately of any damaged product.
- Notify the distributor from whom the purchase was made.

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**Table 5. Metric Prefixes and Their Meanings.**

Prefix	Symbol	Multiple
tera	T	$10^{12}$ (trillion)
giga	G	$10^9$ (billion)
mega	M	$10^6$ (million)
kilo	k	$10^3$ (thousand)
hecto	h	$10^2$ (hundred)
deca	da	$10^1$ (ten)
deci	d	$10^{-1}$ (tenth)
centi	c	$10^{-2}$ (hundredth)
milli	m	$10^{-3}$ (thousandth)
micro	$\mu$	$10^{-6}$ (millionth)
nano	n	$10^{-9}$ (billionth)
pico	p	$10^{-12}$ (trillionth)
femto	f	$10^{-15}$ (quadrillionth)

**When you receive your new laser, please record the information below for future reference:**

Laser model number: \_\_\_\_\_

Serial number: \_\_\_\_\_

Wavelength: \_\_\_\_\_

Date of manufacture: \_\_\_\_\_

Distributor: \_\_\_\_\_

# *Rules for Laser Safety*

- Lasers produce a very intense beam of light. Treat them with respect. Most educational lasers have an output of less than 3 milliwatts, and will not harm the skin.
- Never look into the laser aperture while the laser is turned on! **PERMANENT EYE DAMAGE COULD RESULT.**
- Never stare into the oncoming beam. Never use magnifiers (such as binoculars or telescopes) to look at the beam as it travels — or when it strikes a surface.
- Never point a laser at anyone's eyes or face, no matter how far away they are.
- When using a laser in the classroom or laboratory, always use a beam stop, or project the beam to areas which people won't enter or pass through.
- Never leave a laser unattended while it is turned on — and always unplug it when it's not actually being used.
- Remove all shiny objects from the area in which you will be working. This includes rings, watches, metal bands, tools, and glass. Reflections from the beam can be nearly as intense as the beam itself.
- Never disassemble or try to adjust the laser's internal components. Electric shock could result.