Universal Laser Receiver

Operator's Manual and Voice Transmission Project Instruction

Model Number:
IF LSL-SA1

INDUSTRIAL FIBER OPTICS

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INTRODUCTION

This manual provides product specifications and operating instructions about Industrial Fiber Optics' Universal Laser Receiver. It also contains information needed to set up and operate the Laser Voice Transmission Project safely and knowledgeably, even if you are a novice to laser technology. Please read the manual carefully before beginning.

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 CLAIM.

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 Internet.

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

Sincerely,

The Industrial Fiber Optics Team

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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 µm exposures is less than from 8 nW to 8 µW. Visible light exposure varies from 4 µW to 200 µW, and for near-IR, the exposure is < 200 µW. 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.

PREFACE

Laser beams! Dazzling, powerful, mysterious pencil-thin shafts of colored light flashing through space. Angels, or demons? Are lasers something straight out of science fiction — the science of the future?

Lasers may seem futuristic, but working laser systems have been part of our world for many years. Today, nearly every business, school and home has a laser in the form of a copier, laser printer, CD or DVD disk player. Lasers have truly made a positive difference in our lives.

Laser technology, powerful though it is, still requires complementary technology to create some of the high-tech "miracles" that you have read about, studied and witnessed in person. One of the those complementary technologies has been packaged in the product that this manual describes – the Universal Laser Receiver.

The Universal Laser Receiver is a versatile and economical device for anyone using lasers for demonstration and practical purposes. Essentially, it is a combination of opto-electronics, electronics and audio components working together to demodulate, or decode, information present on a light beam. It is self-contained and easy to use. All the hard work is done internally in the receiver. To demonstrate voice transmission over a laser beam, one simply plugs a microphone into a suitable laser and aligns the laser beam with the receiver detector. The light beam is absorbed by the receiver's photodetector and processed to reconstruct the audible sounds heard by our ears. Voila!

Other examples of using a laser and the Universal Laser Receiver for specific purposes range from measuring the speed of light and demodulating the signal for black and white television transmission and digital computer transmission.

GENERAL

Electrical

A diagram of the Universal Laser Receiver's top panel appears in Figure 1. Following are descriptions of each item identified in the figure.

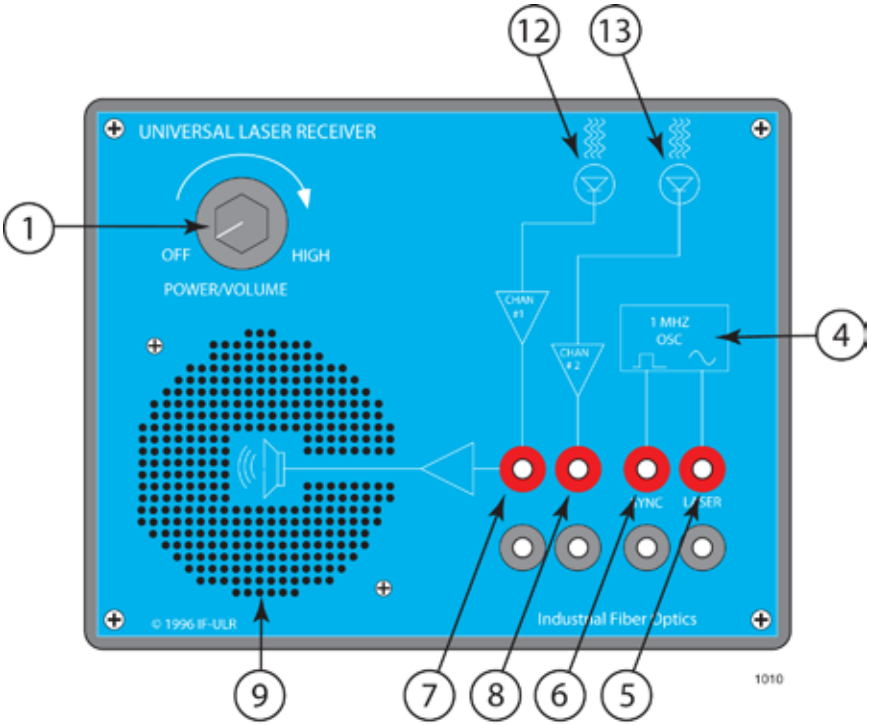

Figure 1. Top panel of the Universal Laser Receiver.

1. Power/Volume

The POWER/VOLUME switch is located in the upper left portion of the panel. Turning this switch clockwise from the off position, shown in Figure 1, connects power from the power jack to the receiver's internal electronics.

This switch also controls internal amplification from the detected signal at Photodetector #1 to the speaker. Turning the knob fully clockwise, to the 6 o'clock position, maximizes loudness.

2. Channel # 1 (CHAN #1)

On the laser receiver face panel is a schematic representation of Channel #1 to signify operation and aid in equipment set up. The schematic symbols for Channel #1 represent a photodetector and amplifier, both of which are located inside the chassis. For more information about this photodetector see Item 12 below. The amplifier is composed of two sub-elements, a preamplifier to amplify the small current from the photodiode, and a buffer circuit to send the amplified signal to the banana jacks. Electrical and optical specifications of these elements are listed in Table 1.

3. Channel # 2 (CHAN #2)

The face panel also bears a schematic representation of Channel #2 to signify operation and aid in equipment set up. Schematic symbols for Channel #2 also represent a photodetector and amplifier, both of which are inside the chassis. For more information about this photodetector see item 13 below. As with Channel #1, the amplifier is composed of two sub-elements, a preamplifier to amplify the small current from the photodiode, and a buffer circuit to send the amplified signal to the banana jacks. Electrical and optical specifications of these elements are listed in Table 1.

4. 1 MHZ OSC

The Universal Laser Receiver contains an electronic frequency generator operating at 1 Megahertz (MHz). The frequency generator creates two 1 MHz coherent waveforms: a square wave and a sine wave. The square wave is output to the two banana jacks located above and below the letters “SYNC” on the lower right portion of the laser receiver top panel. This output is a TTL level signal whose low level is less than 0.7 volts and whose high level is greater than 3.4 volts. The sine wave output is a 1-volt peak-to-peak voltage that is AC-coupled to the red and black banana jacks above and below the word LASER.

5. Laser

LASER is printed between two industry-standard banana jacks in the lower right portion of the receiver control panel. The two banana jacks — a red and a black one — are the positive and negative connections for the 1 MHz sine wave originating from the frequency generator.

6. Synchronization (SYNC)

The abbreviation SYNC is also printed between two banana jacks in the lower right portion of the receiver control panel. These two jacks — also a red and a black one —are similarly the positive and negative connections for the 1 MHz square wave originating from the frequency generator.

7. Channel #1 Banana Jacks

In the schematic, another line connects the output of the Channel #1 (CHAN #1) amplifier to one of the red banana jacks. This banana jack is the positive connection for the demodulated and amplified signal received at Channel #1. The black banana jack just below it is the negative or ground jack for Channel #1's output.

8. Channel #2 Banana Jacks

On the face panel panel is a schematic diagram of the internal photodetectors and amplifiers. In the schematic, a line connects the output of the Channel #2 (CHAN #2) amplifier to one of the red banana jacks. This banana jack is the positive connection for the demodulated and amplified signal received at Channel #2. The black banana jack just below it is the negative or ground jack for Channel #2's output.

9. Speaker

In the lower left portion of the front panel is a perforated area approximately 7.5 cm (3 inches) in diameter. Below the perforation, and inside the receiver chassis, is a 7.5 cm (3-inch), 8-ohm speaker. This speaker is driven by an audio amplifier which is electrically connected to Channel #1's electronic amplifier and photodetector. The speaker's function is to convert the demodulated optical/electrical signals to audio waves which can be heard by our ears, as in activities such as the Voice Transmission Project.

10. Power Jack (PWR)

The Universal Laser Receiver obtains electrical power through a standard 2.1 mm DC power jack shown in Figure 2. (The POWER/VOLUME switch controls the power from the power jack to the receiver's electronic circuitry.)

Electrical power to the receiver must be applied from a low-voltage DC power source with an output from 12 to 20 volts, such as supplied with this receiver. See Item 11 in this section for more information about the Power Adapter.

11. Power Adapter (not shown)

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

If you do 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 spikes exceeding 36 volts.

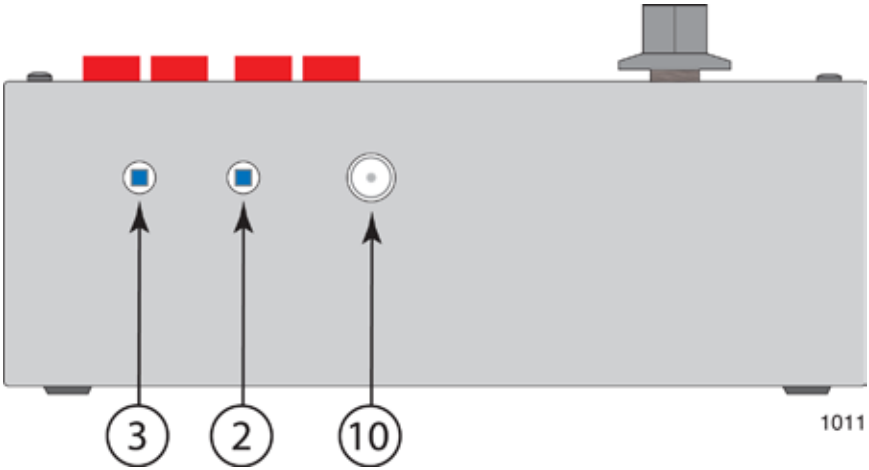

Figure 2. Front view of the Universal Laser Receiver.

12. Photodetector #1

On the top panel of the laser receiver (See Figure 1) is the schematic representation of Channel #1's photodetector — a pin photodiode (a circle with a triangle inside of it). The pin photodiode is both a durable and sensitive device that is responsive to wavelengths of light ranging from 400 to 1100 nm. It is located inside the receiver chassis, but is visible from the front of the laser receiver through one of the access holes, as can be seen in Figure 2.

13. Photodetector #2

The characteristics of Photodetector #2 are identical to those of Photodetector #1.

OPTICAL

The Industrial Fiber Optics Universal Laser Receiver was designed to operate with diode or semiconductor lasers and Helium Neon (HeNe) lasers which produce a beam of visible light with internal modulation capabilities. Industrial Fiber Optics suggests using a laser with output power of 5 milliwatts or less, or as classified by CDRH regulations, a Class II or Class IIIa. Any other modulatable laser producing laser radiation with a wavelength between 400 and 1100 nm will work equally well with this receiver, but please – for your welfare and that of others – think SAFETY. If in question about safety see the sources listed in the section entitled SAFETY.

Applications of this laser receiver include:

- voice or audio transmission laser projects;
- speed of light measurements in which the laser beam is split into two components, each portion traveling across a known distance, demodulated by the laser receiver and displayed on an oscilloscope;
- reception of laser beams being modulated with black and white television signals;
- serving as a receiver for any laser or light beam application requiring one megahertz of analog bandwidth; and
- serving as the optical receiver for a computer-to-printer digital simplex communication link.

PRODUCT SPECIFICATIONS

Table 1. Universal Laser Receiver product specifications.

Parameter	Value
Operating	
Input voltage	12 to 20 volts
Input current	30 to 150 milliamperes
Temperature	0 to 40° C
Optical	
Photosensitivity Spectral Range (S=10% of S_{max})	400 - 1100 nm
Detector Sensitive Area	.5 mm2 (2.65 x 2.65 mm)
Detector Half Angle	± 60 Degrees
Electrical	
3 dB Bandwidth[1]	2 kHz to 2 MHz
Output maximum	2 volts peak-to-peak
Impedance	50 ohms
Storage	
Dimensions	13.3 x 15.9 x 7.6 cm
Weight	600 grams
Temperature	-20 to 50° C

1 At 1 volt peak-to-peak output voltage

SAFETY

Optical

Do not poke fingers or any other objects through the access holes on the Universal Laser Receiver. If the photodetectors have dust on them, see the section entitled SERVICE AND MAINTENANCE.

Any laser should be used with caution, because the beam can be focused to an extremely powerful pinpoint of radiant energy. When aligning the laser with the laser receiver 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. Stand over or back from the laser when aligning it, keeping at least 40 cm (15 inches) between your body and the equipment.
If this is your first experience using a laser, review the "Rules for Laser Safety" on the back cover of this booklet.

If in question about the safety of your laser, contact the laser manufacturer; your local U.S. Department of Health, Education and Welfare office; or write to the agency's headquarters at 1390 Piccard Dr., Rockville, MD 20850.

Electrical

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

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

- Do not touch (or short-circuit) the electrical connection points on the adapter, as this could damage the power adapter.
- Do not open the receiver housing or remove any of the screws under any circumstances, as this will expose you to unshielded electrical connections and void the product warranty.

VOICE TRANSMISSION PROJECT

To complete the Voice Transmission Project you will need the Universal Laser Receiver, its power adapter, a modulatable laser producing visible radiation (light), a power adapter (if required) and a microphone. Two types of microphones – crystal and dynamic – are used with audio-modulatable Class II or Class IIIa Helium Neon and semiconductor diode lasers. See Table 2 for microphone selection as it applies to your laser. Both dynamic and crystal microphones are available from Industrial Fiber Optics. Contact one of our distributors or the factory for more information (see address on page 14).

Table 2. Laser and microphone selection chart.

Manufacturer	Laser Type	Microphone Type
Elanco	HeNe	Crystal
Industrial Fiber Optics	HeNe	Dynamic
Industrial Fiber Optics	Diode	Dynamic
Meredith Instruments	Diode and HeNe	Dynamic
Metrologic (now manufactured by Industrial Fiber Optics)	HeNe	Crystal
Scientific Laser Connection	Diode and HeNe	Dynamic

Following is the set-up procedure for demonstrating voice/audio transmission using an Industrial Fiber Optics laser with the Universal Laser Receiver. Slight modifications to this procedure may be required when using the Universal Laser Receiver with other lasers such as Metrologic's Helium-Neon (HeNe) lasers which utilize a slightly different mechanical beam stop and power cord.

Rigging the Laser

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 laser's beam stop 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 (220) VAC-to-12 VDC power adapter (provided with the laser) into a 110 (220) VAC wall outlet.
6. Plug the 2.1 mm plug on the end of the power adapter cord 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, compared to its "OFF" position.)
8. The pilot light (green LED) on the control panel of the laser should now be lit, indicating that power is being delivered to the laser.
9. Move the beam stop handle upward, to its open position.
10. Observe the red light beam striking the wall, or other surface, in the direction which the laser is pointed.
11. Push the laser 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.)
12. Plug the 3.5 mm plug on the end of the microphone cord into the jack marked "MIC" on the rear of the laser.
13. Turn the Gain Control knob on the laser to the 12 o'clock position.

Getting the Receiver Ready

14. Locate the items labeled Photodetector #1, Photodetector #2 and the power jack shown in Figure 2 of this manual on the laser receiver.
15. Plug the 110 (220) VAC-to-12 VDC power adapter (provided with the receiver) into a 110 (220) VAC wall outlet.
16. Plug the 2.1 mm plug on the end of the power adapter cord into the hole on the laser receiver designated for the power jack as shown in Figure 2.
17. Arrange the power adapter cord so it will not visually interfere with the access hole for Photodetector #1.
18. Align the laser receiver and laser so they face each other as shown in Figure 3.
19. Depress the laser ON/OFF switch, and open the laser beam shutter.
20. Align the laser and receiver to maximize the laser beam's light upon Photodetector #1. It may be necessary to place small books, cardboard or paper under the laser or receiver to obtain the proper elevation for the laser beam to illuminate the detector.

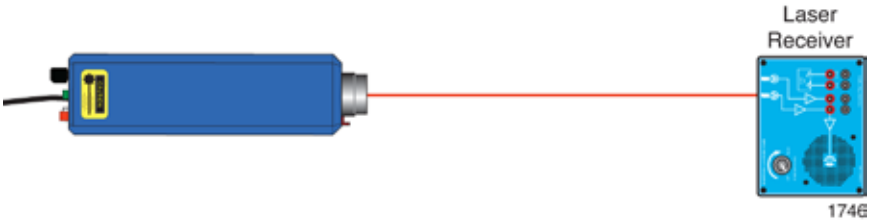

Figure 3. Laser and Universal Laser Receiver alignment.

“On the Air”

21. Move the microphone mouthpiece as far away as possible from the receiver.
22. Turn the Universal Laser Receiver’s Power/Volume knob clockwise to the 12 o’clock position.
23. Speak into the microphone mouthpiece. You should now be able to hear your voice being amplified by the speaker. If not, turn the receiver’s volume control knob or the Gain Control knob on the laser 1/4 turn clockwise.
24. Adjust the gain on the laser or laser signal source as required to increase or decrease the signal from the receiver.

If you now hear the sound of your voice coming from the receiver, it’s time to congratulate yourself on a job well done. This seemingly simple voice transmission demonstration is actually the result of many years of theoretical, laboratory and manufacturing effort. Almost a hundred years ago, scientist Max Planck proposed that light consisted of tiny units of “quanta.” His theory (which was greeted with skepticism by many in the scientific community) was followed by Albert Einstein’s even more controversial theory of modern physics. Support for both of these theories was found when Gordon Gould, a Columbia University student, conceived the operation of the laser. Gould’s ideas were later confirmed by Theodore Maiman at Hughes Research Laboratories, with a demonstration of the first ruby laser. Today, visible diode lasers are mass-produced almost as simply as electronics components. We encourage you to consider a career in the fast-growing field of laser technology. One day perhaps you, yourself, will stand on the shoulders of the early scientific giants and etch your own name in the annals of scientific history.

If you wish to modulate the laser beam using the output from a CD player or AM/FM radio, use a patch cord with appropriate terminations to connect the audio signal to the laser and reduce the gain on the laser and/or the receiver. If the resulting sounds are distorted, reduce the gain on the receiver and laser further.

TROUBLESHOOTING

High-pitched Squeal Coming from Receiver

- Move the microphone away from the receiver's speaker.
- Decrease the volume on the receiver.

No Sound from Receiver

- Is the receiver's POWER/VOLUME switch in the 12 o'clock position?
- Is the 110 (220) VAC-to-VDC power adapter plugged into a wall outlet? Is there power to the wall outlet?
- Is the 2.1 mm power plug on the power adapter cord inserted all the way into the receiver power jack?
- Is the laser beam positioned properly so the beam is illuminating the center of Photodetector #1? (See Figure 2.)
- Is the laser beam illuminating the correct detector? (See Figure 3.)
- Is the microphone's jack plugged into the laser?
- Increase the gain of the laser receiver or, on the laser, by turning the control or volume knobs clockwise.
- Move the microphone closer to your mouth or speak louder.
- Try a different microphone.
- Slowly move the receiver so Photodetector #1 does not pick up as much of the laser beam as you speak continuously into the microphone. (This will desensitize the receiver in case the laser is overpowering the detector/amplifier and causing them to saturate, thus preventing them from demodulating the laser beam.)
- With the laser receiver plugged in and the volume turned all the way up, point Photodetector #1 toward a fluorescent light (not an incandescent bulb). You should be able to hear a 120 Hz hum from the receiver. (In reality, fluorescent bulbs turn on and off 120 times a second. Our eyes do not respond to that high a frequency.) If you do not hear any noise, the laser receiver needs to be repaired.

Do not attempt to troubleshoot the laser or receiver 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 receiver and/or the laser for appropriate inspection/servicing to Industrial Fiber Optics, as described in the section entitled SERVICE AND MAINTENANCE.

WARRANTY

Industrial Fiber Optics products are warranted against defects in materials and workmanship for 90 days. The warranty will be voided if any of the components have been damaged or mishandled by the buyer, including entry to the receiver 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 items 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. Repairs typically cost from $50 - $75 and 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
1725 WEST 1ST STREET
TEMPE, AZ 85281-7622

SERVICE AND MAINTENANCE

Periodic operation, maintenance and service of this component are not required. Dust accumulation on the photodetectors is not harmful and will not significantly affect receiver performance. If you wish to clean them, use a cotton swab and isopropyl alcohol. Do not remove screws to gain access to internal electronics. Product warranty will be voided if entry has been made to the receiver housing.

In the unlikely event that any of these components 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 receiver, 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
1725 WEST 1ST STREET
TEMPE, AZ 85281-7622

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.

Notes:

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.