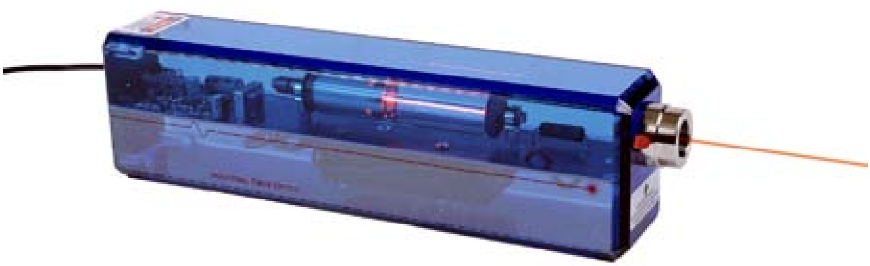
Helium Neon Laser

Operator's Manual



Model Numbers:

IF HN05	IF HN20
IF HN08	IF HN35
IF HN08M	IF HN50
IF HN15M	

Industrial Fiber Optics

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INTRODUCTION

This manual provides information about Fiber Optics' family of Helium Neon Lasers. It contains all the information needed to set up and 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.

UT-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 Fiber Optics product. We hope it meets your expectations and provides many hours of productive activity.

Sincerely,

The Ultrafast Technology/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.

GENERAL

The helium-neon laser is probably the most familiar of all lasers. The least-expensive gas laser, it has long been the standard choice for demonstrating laser physics in schools, colleges and museums. In its most common form, the “He-Ne” emits a fraction of a milliwatt to tens of milliwatts (mW) of red light at 632.8 nanometers (nm). As such, it has a long history as the most common and economical visible laser.

The He-Ne laser was among the first lasers demonstrated (1961), and was the first gas laser. Initial versions emitted radiation at 1152.3 nm, which is infrared, but researchers soon noticed that the same gas mixture could lase in the red region (632.8 nm). Other laser lines have been produced in the laboratory, but the 632.8-nm red version has been the most important because it made upwards of 50 mW available at a visible wavelength. Sales of the helium neon laser peaked around 1990, with more than a half-million sold.

Other visible wavelengths have been produced from He-Ne lasers. Green, yellow and orange helium-neon lasers, as well as multiline versions, are being offered commercially. Infrared lasers are also produced. Output powers are lower than with the usual red variety, but the other wavelengths offer advantages for certain applications.

Table 1.
Common wavelengths of light that can be obtained from a helium neon laser tube.

Color	Wavelength (nm)
Green	543.5
Yellow	593.9
Orange	611.8
Red-orange	632.8
Near-infrared	1152.3
Mid-infrared	3391.3

Basic Physics

The active medium in a helium-neon laser is a mixture of helium and neon at total pressures from a fraction of a torr to several torr. (Atmospheric pressure is typically 760 torr.) The best working pressure depends on discharge-tube diameter. Typically the gas mixture contains five to 12 times more helium than neon.

The energy in a helium-neon laser comes from an electrical discharge which passes a few milliamperes (mA) through the laser tube at a couple of thousand volts when the laser is in steady operation. (An ignition voltage of 5 to 10 kilovolts (kV) is needed to start laser operation.) Current passing through the active medium collides with both helium and neon atoms, raising their electrons to excited levels. The more abundant helium atoms collect most of the energy, then transfer that energy readily to neon atoms, which have excited states at about the same level as the helium atoms. The neon atoms then lose their excitation energy and drop to several possible lower energy levels. As the excited electrons fall to lower energy levels they emit a photon whose wavelength is determined by the energy difference between two energy levels. By design, any light within the laser beam must pass through the laser's internal mirrors or optical filters. In this process certain wavelengths pass through and others are rejected. It is through passing and rejection of the optical filters that the color or wavelength output of a helium-neon laser is determined.

Internal Structure

A helium-neon laser is a gas-filled tube with internal electrodes for exciting the gas so it emits light. The highly reflective mirrors on each end of the tube define the laser cavity. The electrical discharge passes from the cathode (–) at one end of the laser tube to the anode (+) at the other end while going through a capillary bore one to a few millimeters in diameter. The capillary tube concentrates the discharge, thus improving overall efficiency. The small bore diameter also helps control laser beam diameter and beam divergence. Much effort goes into selecting electrode shape to make the discharge uniform. The outer glass tube is much larger, as you can see by examining your laser.

The laser tube in this laser is of a "hard seal" design, in which the glass is bonded directly to metal at high temperatures. Typically in modern-day mass-produced He-Ne lasers the mirrors are bonded directly to the glass laser tube without the use of epoxies. This hard seal design reduces the helium leak rate to under .01 torr per year and makes contamination from water vapor and other materials insignificant.

Table 1. Common abbreviations used in this manual.

Abbr	Long version	Scientific Notation
mW	milliwatts	1×10^{-3} Watts
μW	microwatts	1×10^{-6} Watts
nW	nanowatts	1×10^{-9} Watts
mm	millimeters	1×10^{-3} meters
μm	micrometers	1×10^{-6} meters
nm	nanometers	1×10^{-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, with descriptions of each item.

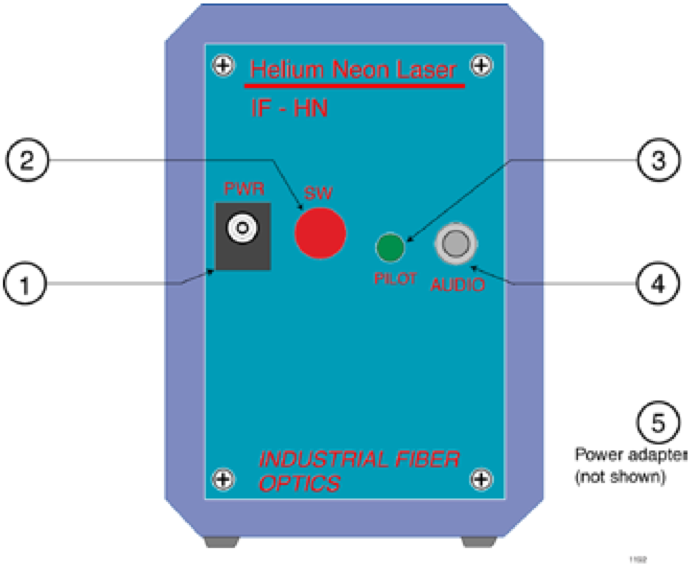

Figure 1. Rear view of Helium Neon Laser.

1. Power Jack (PWR)

All Fiber Optics lasers use a standard 2.1 mm DC power input jack to provide electrical 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 12 to 18 volts, as supplied with the laser. See Item 5 in this section for more information about the power adapter.

2. Switch (SW)

The push-button switch is located immediately to the right of the 2.1 mm power jack. It controls electrical 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)

Immediately to the right of the switch is the pilot light which indicates when the laser is on, as required by CDRH regulations. It is a semiconductor LED that emits a green or yellow light when the switch is turned on and power is applied to the internal electronic circuitry and lasing element.

4. 3.5 mm Audio Jack (optional)

This jack is found only on laser models with modulation capability. It is an industry-standard jack, commonly described as a 3.5 mm audio type. It is compatible with most remote microphones and, with a patch-cord, connects to cassette and CD players. It will accept mono or stereo 3.5 mm plugs. Only half or one channel of a stereo input will be modulated onto the laser beam.

The minimum impedance of this input is 50 k ohms. Typical inputs to the jack include dynamic and crystal microphones and electrical signals from AM/FM radios, cassette tape players and CD players. When using microphones the laser's internal electronics are designed to accommodate the dynamic range without any user adjustments.

To connect an AM/FM radio, CD or MP3 player, or other electronic devices to the laser, use a 3.5 mm electrical patch cord, which can be purchased at most electronics stores. More detailed instructions about using the laser with these electronic devices are listed on page 12.

5. Power Adapter (not shown)

All of our lasers 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 be the only supply used.

If you must use another power supply, it must be one with voltage output between 12 to 18 volts DC and minimum current capability of 750 milliamperes. Do not use a power supply or power adapter which generates voltage spikes exceeding 36 volts, or with an AC output.

6. Tripod Mount (not shown)

A tripod mount has been provided for all lasers except for IF-HN35 and IF-HN50. This mount is a SAE 1/4-20 thread hole.

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.

2. Beam Stop

The beam stop (also known as a beam attenuator) is required on lasers by federal health and safety regulations as a means of blocking the beam when the laser is electrically powered. 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 laser chassis.

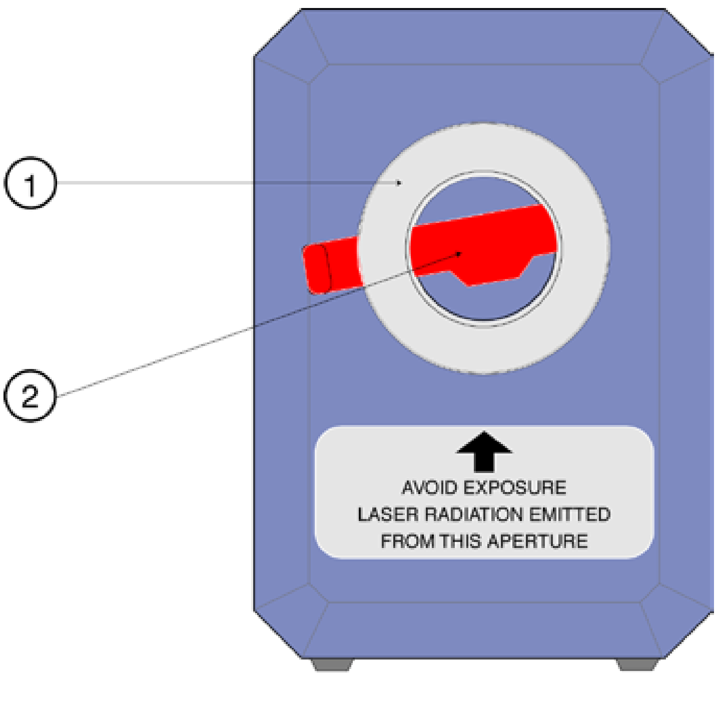

Figure 2. Front view of laser with beam stop blocking the laser beam.

SPECIFICATIONS

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

Table 3. Laser specifications.

Parameter	IF-HN05 IF-HN08 IF-HN08M IF-HN20 IF-HN15M	IF-HN35 IF-HN50
Operating		
Input voltage	12 to 18 Volts	12 to 18 Volts
Input current	650 milliamperes	750 milliamperes
Temperature	0° to 40° C	0° to 40° C
Optical		
Polarization	random	random
Wavelength	632.8 nm	632.8 nm
Output power	see Table 4	see Table 4
Beam diameter (at aperture)	1.0 mm	1.0 mm
Beam divergence (half angle maximum)	2.0 milliradians	2.0 milliradians
Electrical		
Analog bandwidth, 3 dB	.6 to 20 kHz	N/A
Storage		
Dimensions	5.8 x 8.7 x 36.2 cm	6.5 x 9.4 x 45.1 cm
Weight, chassis	.82 kilograms	1.27 kilograms
Weight, power adapter	.47 kilograms	.47 kilograms
Temperature	-20° to 50° C	-20° to 50° C

Model Laser Classifications

Table 4. CDRH classifications for laser models.

Laser Model	Classification	Typical Power Levels
IF HN05	CLASS II	.4 to 1.0 mW
IF HN08	CLASS II	.6 to 1.0 mW
IF HN08M	CLASS II	.6 to 1.0 mW
IF HN15M	CLASS IIIa	.95 to 1.75 mW
IF HN20	CLASS IIIa	1.5 to 3.0 mW
IF HN35	CLASS IIIa	3.0 to 4.0 mW
IF HN50	CLASS IIIa	4.0 to 5.0 mW

SAFETY

While lasers are valuable sources of light for exciting demonstrations, laboratory experiments and industrial use, one must treat lasers and high voltage power supplies with the utmost respect. One should never diassemble a product without proper training.

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. Common sense dictates that one should avoid direct skin and eye exposure to laser energy as well as surface reflections.

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

Laser

Inside the acrylic laser case is a switching power supply that converts the low voltage DC input from the 2.1 mm power jack to the 10 kilovolt starting and 2 kilovolt operating voltage required for the laser tube.

- Do not open the laser housing under any circumstances. This will expose you to unshielded high voltage electrical connections, possible electrical shock, and violate federal government regulations, as well as void product warranty.

Power Adapter

Included with this laser is a VAC-to-VDC adapter for use with common VAC electrical power. The standard adapter shipped with all lasers is a 110 VAC UL-approved power adapter. Power adapters with 220 VAC output and other electrical certifications are furnished upon customer or distributor request. Electrical precautions to be taken with this and all power adapters include:

- Do not touch (or short-circuit) the connection point on the 2.1 mm plug, as this could damage the power supply.

LASER REGULATIONS

The U.S. Department of Health, Education and Welfare regulates and classifies all laser products sold in the United States. For more information about compliance with federal laser performance standards and regulations, please refer to the 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/Indentification

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.

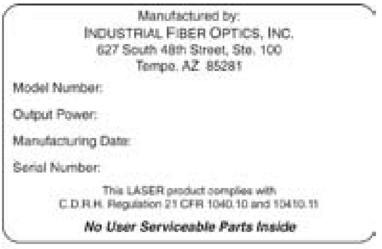

Figure 3. Laser certification and identification label.

Classifications

All lasers described by this manual fall within the limitations of Class II and Class IIIa of CDRH standards. Each laser is marked or labeled to designate its classification. These laser classification labels are commonly known and specified as the "warning logotype" by CDRH regulations. The warning logotype label location for these lasers is on the top, rear of the laser chassis as shown in Figure 7.

Class II lasers may not exceed 1 milliwatt (1 mW) of 632.8 nm output radiation, 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. This label is yellow with black printing.

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. This label has a white background, black printing and a bright red oval surrounding the word DANGER. The simulated laser beam is also in red.

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.

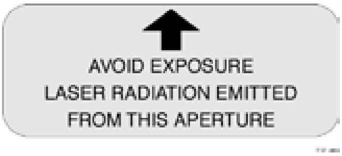

Figure 6. Beam aperture label.

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 II 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.)

> **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.

5. Plug the 110* VAC-to-DC power adapter (provided with the laser) into an AC wall outlet.
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 or yellow LED) should glow, 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 the laser is pointed.

* 220 VAC for most customers outside of North America

Using Laser with a Microphone

We will outline the steps for using a microphone with your Fiber Optics Helium Neon 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 UT-Fiber Optics' audio laser receiver for demodulation of the laser beam's modulated signal and producing sound waves.

Using with Radio or Tape Player

Here we outline the steps for using an AM/FM radio, tape player or CD disk player to modulate the laser beam. In the steps below it will be assumed that you know that a tape or CD player can be substituted for all steps that refer to the AM/FM radio. Because we don't know what receiver you will use to convert the optical signal on the laser beam, 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 longe illuminated.)
3. Turn on the AM/FM radio and tune to any clear radio station. Note the volume control setting that gives a comfortable listening level.
4. Turn the volume to a minimum and then turn the electrical power off on the AM/FM radio.
5. Plug one end of the 3.5 mm audio patch cord into the 3.5 mm jack on the radio and the other end into the laser 3.5 mm audio jack.
6. Point the laser toward a wall or other non-reflecting dull surface.
7. Set up your laser receiver, referring to its manual for operating procedure.
8. Press the ON/OFF switch (SW) on the laser control panel. The laser now should be on, as indicated by the pilot light.
9. Turn on the power to the AM/FM radio and set the volume control to the comfortable listening level you had in Step 3.
10. Rotate the beam stop's handle upward, to its open position.
11. Target the laser beam on the light detector found on the laser receiver.
12. Position the receiver or laser as needed, so the laser light beam strikes the center of the receiver detector.
13. Adjust the volume on the AM/FM radio or laser receiver as required for the laser receiver to produce clear audio signals.

Your laser and receiver should now be functioning as a free-space optical communications link. The output from the laser receiver should be voices or music from the radio station that you tuned to in Step 3.

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

- Check pilot light. If not on, go to the previous Troubleshooting step.
- Is the mechanical beam stop in its open position?
- Damaged or inadequate power adapter.
- Low voltage to the wall outlet.

No Modulation from Receiver

- Is the laser beam positioned properly so its beam hits the receiver detector?
- Are the electrical plugs inserted all the way into the jacks?
- Are input signals to the laser of appropriate amplitude? (Turn the volume up or down on the AM/FM radio, CD or MP3 player, or other electronic device.)
- Damaged or open electrical circuit in the 3.5 mm electrical patch cord.
- 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 [saturating] for this laser.)
- 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 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 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 strong box with sufficient packing material to prevent damage in shipment.

WARRANTY

Fiber Optics Helium Neon lasers are warranted against defects in materials and workmanship for 2 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.

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.

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 $50 - $150 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.

SHIPMENT DAMAGE CLAIMS

If damage to an 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 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.

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

Laser Model Number: ______________________________________

Serial Number: ______________________________________

Optical Power: ______________________________________

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.