THORLABS

HRP050, HRR050, HRP120, HRR120, HRP170, HRR170

Red HeNe Laser Systems (High Power)

Operating Manual

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Part 1. Safety

WARNING

Laser Radiation – Avoid Exposure to Beam – Class 3B Laser Product

The laser described in this operating manual emits visible light. This laser is safe to operate provided that the user complies with all safety warnings. It is recommended that all personnel who will operate or be in the vicinity of the laser during operation read and be familiar with this manual as well as be made aware of the following safety warnings.

- Never look directly into the laser light source or at scattering laser light from reflective surfaces. Laser light is hazardous to the eyes. Never stare down the beam into the source.
- Install the laser so that the laser beam is not at eye level.
- Whenever the laser is operating and the beam is not in use, block the beam with the shutter on the output aperture. Avoid direct exposure to the laser beam.
- As a precaution against accidental exposure to either the laser beam or its reflection, operators should wear laser safety glasses designed for this type of laser.
- High voltage is present at all times when the key switch on the control box is in the "ON" position.
- Ensure that the laser head is securely connected to the power supply. To prevent faulty operation, be sure that the male connector is fully seated in the back of the power supply.
- The power cord and plug are provided with a ground line. To avoid possible shock, ensure that the plug is properly connected to a ground point at the electrical connection.
- Do not attempt to open the sealed laser housing or the power supply. The power supply and laser are not user accessible and service operations inside the enclosure must only be performed by authorized and trained personnel. Opening the laser or power supply will result in loss of warranty.
- Do not perform any operating or maintenance procedure not described in the user's manual.
- Do not operate this product if the cover has been removed.
- This product is for indoor use only. To prevent potential fire or shock hazard, do not expose the unit to any source of excessive moisture.
- Operating this product in the presence of flammable gases or fumes is extremely hazardous.
- Disconnect the power cord before replacing fuses.
- Clean the laser head and power supply with a dry, soft cloth. Do not use liquids.

WARNING

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. Avoid unnecessary exposure to laser or collateral radiation that exceeds the accessible emission limits listed in the safety regulation guidelines 21 CFR Subchapter J 1040.10 and 1040.11. This federal regulation is administered by the National Center for Devices and Radiological Health under the Food and Drug Administration.

Each Visible Helium-Neon Laser System that is certified to be in compliance with the CDRH regulations is equipped with a key-switch, remote interlock connector, laser radiation emission indicator, time delay relay (built into the power supply), a beam attenuator (a manual shutter located in the front bezel of the laser housing), and all appropriate warning labels. To ensure continued compliance, verify on an annual basis or, if the product has been subjected to adverse environmental conditions, such as fire, flood, mechanical mishandling, or solvent spillage that your system's safety features listed above are available and operational.

For further information and assistance on laser safety, contact the following agencies:

Laser Institute of America

13501 Ingenuity Drive, Suite 128
Orlando, FL 32826
** Safety Guides **

American National Standards Institute, Inc.

25 West 43rd Street
New York, NY 10036
** Safety Guides**

Food and Drug Administration

Center for Devices and Radiological Health
2098 Gaiter Road
Rockville, MD 20850

CE Compliance

For European customers who require a CE-approved laser system, Thorlabs certifies that our laser heads and lab power supplies meet the appropriate CE requirements. In order for the CE regulations to be met, all Thorlabs power supplies must be used with an input line cord with a length of less than three meters. The factory-included line cord has a length of approximately two meters. Other cords may be used, but they must have a length of no longer than three meters in order for the laser system to remain CE compliant.

Part 2. Description

Thorlabs' line of cylindrical, high-power, red (632.8 nm) Helium-Neon gas lasers have stable output powers from 10.0 to 25.0 mW and a fundamental Gaussian beam. Depending on the model chosen, the output beam will be either linearly polarized or randomly polarized (unpolarized). The state of polarization in a randomly polarized laser beam is not truly an unpolarized source, but rather a single state of polarization that changes on a nanosecond time scale.

Laser Head

This laser head comes equipped with a manual shutter installed in the front bezel of the laser housing (see Figure 1 below). The front bezel has four #4-40 UNC holes to secure the optional accessory mounting ring and other industry standard HeNe accessories. This laser also comes with a 3 ft long, high voltage cable for connecting to the power supply. This particular laser head is designed to operate at an optimum performance level when used with the required Thorlabs power supply.

Figure 1 Laser Head

Laser Power Supply

The laser includes a power supply that is specially designed to be used with the HeNe laser and is CE-certified. The power supply is enclosed in a protective housing and is CDRH compliant with a built-in 3 to 5 second time delay, an Alden high-voltage connector (see Figure 2 below), a key lock switch with two removable keys, a power on indicator[1], a fuse access point, a remote interlock connector, and a removable input power cable. The power supply can be set up for 120 VAC or 240 VAC[2].

Figure 2 High Noltage Alden plug

[1] *The "Laser On" indicator will come on when the key is turned on. It does not indicate the laser is on, lasing, or the power supply is working. It only indicates that there may be power going to the laser head.*
[2] *Use 120V setting with 100 to 130 VAC. Use 240V setting with 200 to 260 VAC.*

HeNe Laser Overview

A helium-neon laser, typically called a HeNe laser, is a small gas laser with many industrial and scientific uses. The primary wavelength they are used at is 632.8 nm, in the red portion of the visible spectrum.

The gain medium of the laser is a mixture of helium and neon gases in a 5:1 to 20:1 ratio that is contained at low pressure in a sealed glass tube. The excitation source for these lasers is a high voltage electrical discharge through an anode and cathode at each end of the glass tube. The optical cavity of the laser consists of a flat, high-reflecting mirror at one end of the laser tube, and an output coupler mirror with approximately 1% transmission at the other end.

HeNe Applications

- Metrology
- Cleanroom Monitoring Equipment
- Food Sorting
- Flow Cytometry
- Confocal Microscopy
- Imaging and Medical Equipment
- Opacity Monitoring
- Alignment
- Maritime Visual Guidance Systems

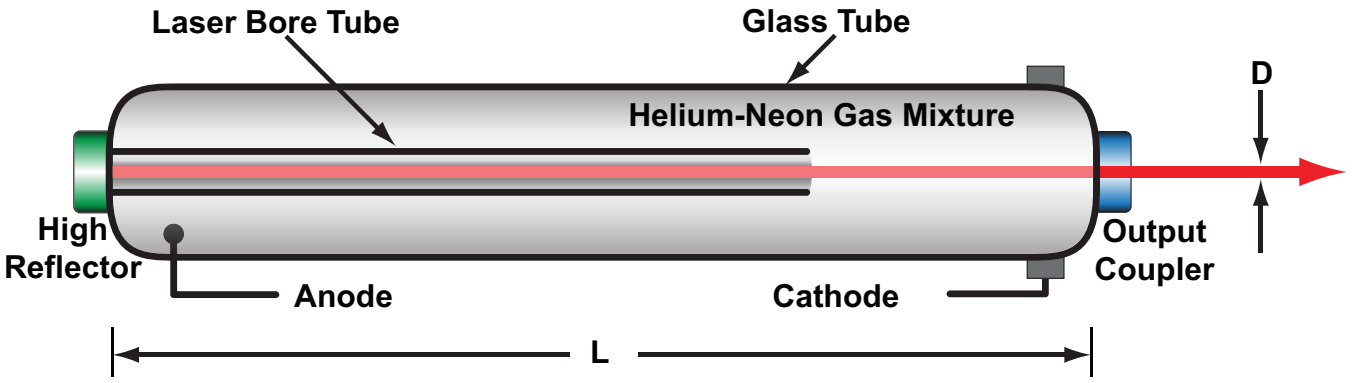

Figure 3 Optical Resonator Cavity

Typical HeNe Parameters	
Beam Diameter (D)	1 mm
Cavity Length (L)	0.15 m (0.5 mW) to 1 m (50 mW)
Reflectivity at High Reflector (HR)	>99.99%
Transmission at Output Coupler (OC)	~1%

HeNe lasers tend to be small, with cavity lengths of around 15 cm up to 0.5 m and optical output powers ranging from 1 mW to 100 mW. Thorlabs offers output powers up to 50 mW.

HeNe Linewidth

A red HeNe laser wavelength is 632.816 nm in air, though it is often reported as either 632 nm or 633 nm. The wavelength gain curve is actually made of several longitudinal modes that fluctuate within the range due to thermal expansion of the cavity and other external factors.

The linewidth of a HeNe laser is specific to the application. The axial mode structure of the HeNe laser is characterized by the number of modes, the free spectral range (FSR), and the Doppler width (see Figure 4 below). The linewidth of individual axial modes is usually small (~kHz) and is primarily

determined by external factors and measurement timescales rather than fundamental laser parameters. In most interferometric applications, the most relevant parameter is the coherence length, which is determined by the axial modes that are furthest apart. For a red HeNe laser, the coherence length is approximately 30 cm.

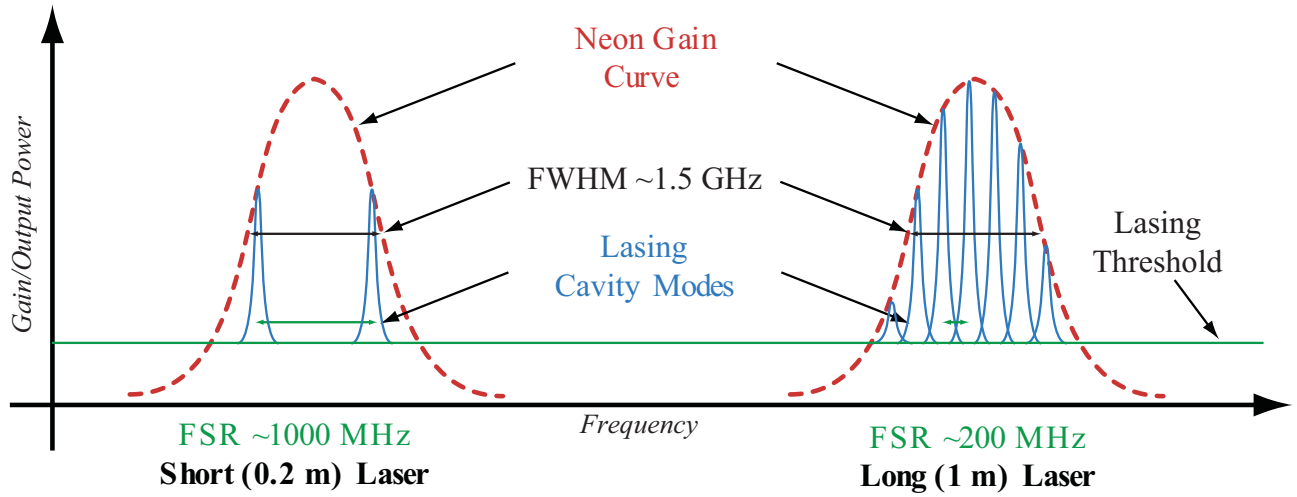

Figure 4 HeNe Gain Curve Showing Cavity Modes

The laser process in a HeNe laser starts with the collision of electrons from the electrical discharge with the helium atoms in the gas. This excites helium from the ground state to a long-lived, metastable excited state. Collision of excited helium atoms with ground-state neon atoms results in excited neon electrons.

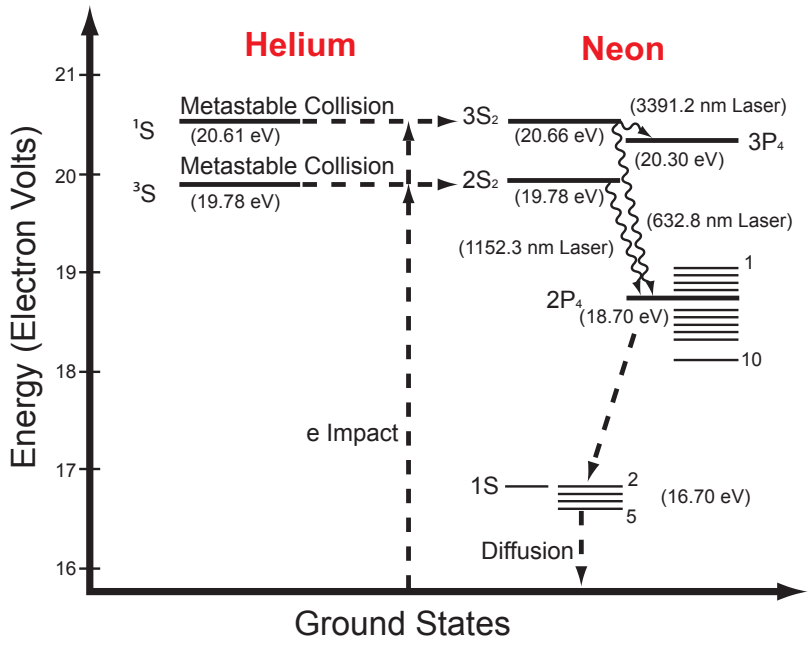

Figure 5 HeNe Energy Levels

The number of neon atoms entering the excited states builds up until population inversion is achieved. Spontaneous and stimulated emission between the states results in emission of 632.82 nm light along with other emission wavelengths. From these states, the electrons quickly decay to the ground state. The HeNe laser's power output is limited because the neon upper level saturates with higher current, while the lower level varies linearly with current.

The laser cavity can be designed with the correct mirrors and length to promote other wavelengths of laser emission. There are infrared transitions at 3.39 µm and 1.15 µm wavelengths, and a variety of visible transitions, including a green (543.365 nm, sometimes called GreeNe laser), a yellow (593.932 nm), a yellow-orange (604.613 nm), and an orange (611.802 nm) transition. The typical red, 633 nm wavelength output of a HeNe laser actually has a much lower gain compared to other wavelengths, such as the 1.15 µm and 3.39 µm lines.

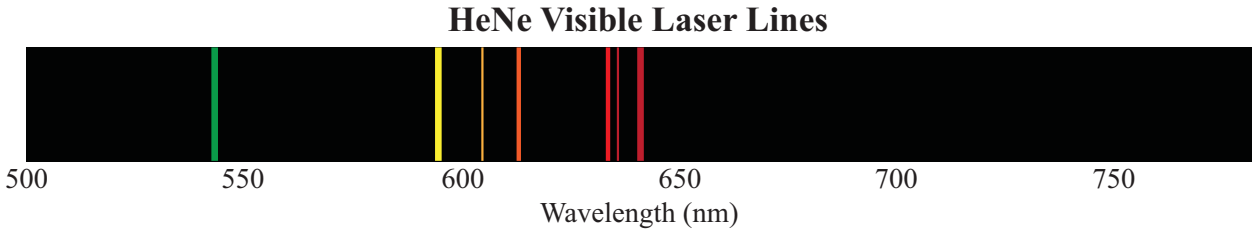

Figure 6 HeNe Visible Laser Lines

HeNe Polarization

Unpolarized (Randomly Polarized) Beam

The output of an unpolarized HeNe laser consists of a rapidly fluctuating, linearly polarized beam whose polarization orientation changes on a nanosecond time scale. Unpolarized lasers are ideal for applications where there are no polarizing elements in the beam path. Depending on the time scale of an application, large power fluctuations are possible.

Polarized Beam

The state of polarization in a polarized HeNe laser beam is linear, making these lasers ideal for polarization-sensitive applications.

Part 3. Unpacking

3.1. Unpacking

Inspect the packing container for any damage that may have occurred during shipment. Contact your local Thorlabs customer service office for assistance. Packing materials are specifically designed to protect against shipping damage. Please keep this container and reuse if your system needs to be returned to Thorlabs for service or evaluation.

Carefully remove the laser system from the packing container. Inspect for damage, including dents and scratches. There should not be anything rattling around inside the laser head. Rarely during shipping, the glass tube may break.

Figure 7 Laser System

Shipping Inventory

The equipment included in this shipment should match the packing slip attached to the box. Verify that the correct product was shipped to you by matching the item number on the box. If the shipment is incomplete, or if an incorrect item was shipped to you, please notify Thorlabs immediately.

This package should contain:

- Cylindrical Laser Head
- Power Supply
- 2 Keys for Power Supply
- Remote Interlock for Power Supply
- Fuse Assembly
- Voltage Selection Blade
- Manual and Quick Start Selection Guide

Part 4. Set-up

4.1. Mounting the Laser Head

The cylindrical construction of the laser head allows for easy mounting in ring clamps, V-blocks, or similar mounting hardware without affecting the laser's alignment. Use caution when clamping onto the laser, as too much pressure can damage the aluminum housing or cause misalignment. The front bezel has four #4-40 UNC holes to secure standard HeNe optional accessories. The laser head should always be secured in place and not allowed to move freely. Not only can the laser roll off the worksurface and break, but the laser emission can be a health hazard.

See the table below for the recommended number of mounting points. It is preferred to use V-block mounts (see figure to the right). Thorlabs offers fixed and kinematic mounts

HeNe Laser Length	No. of V-block Mounts	No. of Ring Clamps
7 – 16.75"	1	2
21"+	2	3

4.2. Assembly

It is suggested that the HeNe Laser Quick Start Guide be used to assemble the laser system. Below are the steps needed to assemble the laser system.

1) This laser system includes a 120/240 VAC manual selection power supply. The power supply must be manually set for the appropriate regional current. The proper mains voltage cord must also be used. **The unit should have been set up at the factory with the correct fuse setting, however, it is highly recommended that the user double check that the fuse is properly set before use.**

2) Plug the high-voltage cable from the laser into the front of the power supply. Confirm that the Alden plug is well-seated. The first few times the plug is inserted, it may require more force than expected. Failure to plug the connector all the way in can result in the laser failing to lase or arching and damage to the power supply or laser head.

3) Insert the phono plug remote interlock connector into the back of the power supply. The LED light on the front of the power supply will light even if the interlock is not inserted.

4) Insert the key into the front panel of the power supply.

Part 5. Operation

To operate the laser system, follow the following procedures.

1) Make sure the laser is pointing safely away from people and is securely mounted.

2) Turn the key switch on the power supply on. The "Laser On" LED indicator will light. NOTE: There is a 3 to 5 sec CDRH safety delay before the voltage turns on.

3) Open the aperture by turning the screw 90° in either direction using a flat head screwdriver.

Shutter Control Screw
The shutter is closed when screw is perpendicular to tube as shown in picture.
The shutter is opened when screw is turned 90° so the slot is parallel with tube.

Figure 8 Laser Shutter Control, Picture shows the Shutter CLOSED.

4) Some models may take up to 60 seconds to begin to lase (typically the 7" versions). If the laser has not started lasing 20 sec after turning the power key on, , you can turn the power supply off and then back on again. This will not damage the laser or power supply. Be sure to give enough time to allow the CDRH safety delay to elapse before turning the system off and on.

5.1. HeNe Power Supply

Introduction

The HeNe Control Unit (HCU) is a turn-key power supply for HeNe laser tubes that incorporates all of the appropriate safety features required by US federal regulations. This unit is RoHS compliant.

Changing the Line Voltage

WARNING

Use only 250 V, 5 A, slow-blow fuses with this product.

The input line voltage selector, a component within the fuse assembly, configures the correct input line voltage for the local environment. This can be accomplished by sliding the input line voltage selector into the side of the fuse assembly. The desired input line voltage can be seen right-side up in the window on the face of the fuse assembly. See the figure on the following page for the proper voltage selection in your region of the world.

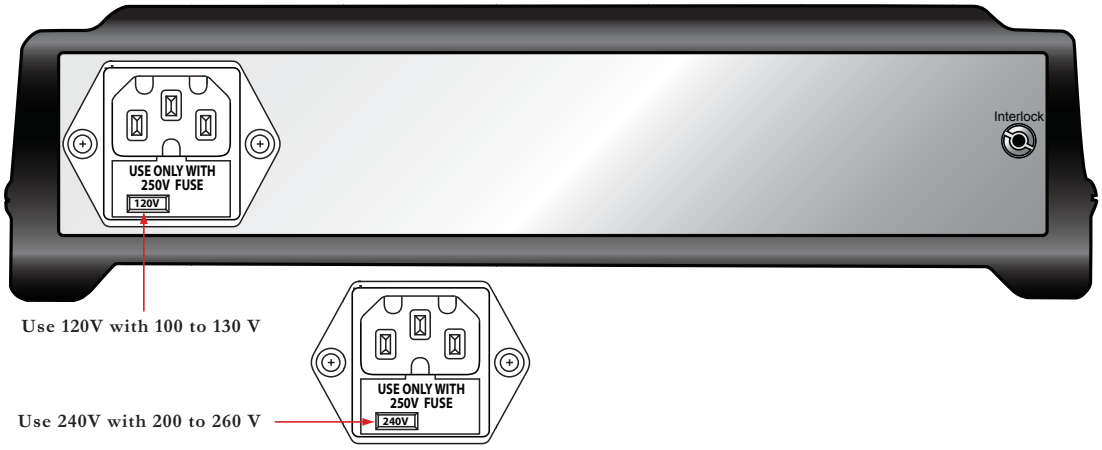

Figure 9 Voltage Selection

WARNING

Failing to select the correct input line voltage will result in damage to the unit and will void the warranty.

Once the correct line voltage is selected, insert the fuse assembly into the power cord connector located on the back of the unit. The fuse assembly will be flush with the face of the AC connector when properly installed. Once the fuse assembly and voltage selector are correctly installed, insert the supplied UL rated, female to nema 5-15P power cord into the HCU power unit. To ensure proper and optimal laser operation, only use the HCU power supply that is included with the HeNe laser system.

Fuse Replacement

Make sure power supply is turned off and unplugged from the AC outlet.

To remove the fuse assembly, insert a flat blade screw driver into the groove on top of the fuse assembly and gently pry it from the power cord connector. Remove the fuse and replace with a 250 V, 5 A slow-blow fuse (fuse type 2AG). While replacing the fuse assembly as described above, ensure that the input voltage selector is still properly configured.

Remote Interlock Operation

To use the remote interlock connector, remove the shorting conductor from the connector provided. The connector may then be wired into the user's interlock system. The circuit is designed to activate the laser output when the two contacts of the connector are shorted together. This can be achieved via a simple switch or with relay contacts.

The voltage on this connector is 5 VDC and is generated internally within the HCU. The connector voltage is completely isolated from the AC line voltage. **Do not apply a voltage across the interlock connector!** Failure of the remote interlock feature due to improper application of external voltages is not covered by warranty.

WARNING

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

Figure 10 Front of the Power Supply Module

Figure 11 Back of the Power Supply Module

Maintenance and Service

The HCU power supply contains no user-serviceable parts. Return the HCU to Thorlabs for service.

Part 6. Troubleshooting

6.1. Technical Failures

Problem	Fix
No light being emanating from the laser	Make sure that aperture is open
	Check to make sure: • the power supply is set to the correct voltage, • is plugged into a working outlet, • the power cord is fully seated into the power supply, • the Alden plug is firmly seated into the power supply (it may take more force to push the plug in all the way the first few times), • the interlock connector is plugged in and fully seated, and • the aperture is open.
	The laser can take up to 30 seconds to lase. 7" lasers can take up to 60 sec to begin to lase. Turning the power off then on again can speed up the start time without damaging the laser. **Note: there is a built in CDRH safety delay of 4 - 5 seconds.** Be sure to wait longer than 5 seconds to turn the laser off then on.
The laser does not work and there is something rattling around inside the laser head tube	The glass gas tube may have broken during shipping. Please contact your local tech support office for help.
The power supply does not turn on	Make sure the power supply is plugged in.
The power supply Laser On Indicator does not light	Make sure the voltage line selector is set to the correct voltage. If the unit is set to 120 VAC but was used at 220 VAC, the power supply has been damaged and must be sent back.
There is a clicking noise in either the power supply or laser	Arcing in the laser head or the power supply can result in a flickering laser or the laser not igniting at all. Turn off the power and contact your local tech support office immediately.
The laser has low output power	The laser requires 30 minutes to meet published specifications. Make sure to let it warm up.
	Make sure the laser is mounted correctly. See page 11 for proper mounting techniques.

6.2. Application Trouble Shooting

Some sources of trouble of a HeNe laser do not come from the laser failing or being out-of-spec. Instead, these laser are not suited to the application. One common mis-application comes from a HeNe laser, especially a low power one (0.5 mW) being used in a metrology application.

Environment is an important consideration as well. Dirty environments can cause the optics to become contaminated and the power output to drop below expected levels. Unstable output beams can be caused by noisy environments with large sources of vibrations. Proper mounting on an optical table can reduce the effects of ambient vibrations. Temperature is also a factor. If the environment where the laser is being used fluctuates in temperature, the output power can experience a large amplitude change. Even blowing on the laser tube can cause the output power to fluctuate significantly.

Randomly polarized lasers are actually rapidly changing, single polarization lasers. Averaged over time, these lasers appear as randomly polarized light. However, any polarization optics in the path (intentional

or unintentional) can cause large variations in the output power. These applications should only be used with a polarized laser.

While a HeNe laser is less sensitive to variations caused by back reflections, they are not immune to it. Large retro-reflections back into the laser can cause unpredictable power changes. A free-space isolator can be used to reduce or eliminate these effects. If possible, only a small angular deviation is needed to eliminate the back reflections.

These HeNe lasers are ill suited to any application or experiment where single frequency or long coherence length is required.

Noise, Oscillations, and Fluctuation Sources

There are many sources of noise, oscillations and fluctuations of the output of a HeNe laser. One of the most common is from longitudinal modes drifting into and out of the gain curve. The frequency of these fluctuations vary from very slow, less than a hertz to as much as several kHz depending on the stability of the environment.

Other, more constant sources of fluctuations are from the following (with corresponding frequencies):

- Line noise from AC high voltage power supplies (50/60 Hz, 100/120 Hz, etc)
- Switching noise from DC high voltage power supplies (40 kHz)
- Plasma oscillation (tens of MHz)
- Transverse mode beat notes (hundreds of Mhz)
- Axial mode beats (at FSR, hundreds of MHz)

Part 7. Specifications

Common Specifications	
Wavelength	633 nm
Beam Drift[3]	<0.2 mrad
Long Term Beam Drift	<0.05 mrad
Series Resistors in Housing	94 KΩ
Operating Current	5.25 mA
Shock	15 g for 11 msec
Weight	600 g
CDRH/CE Classification	IIIb/3B

Item #	HRP050	HRR050	HRP120
Min Output Power	5.0 mW	5.0 mW	12.0 mW
Maximum Output Power	10.0 mW	10.0 mW	15.0 mW
Polarization	Linear > 500:1	Random	Linear > 500:1
Mode Structure	TEM00 > 99%		
Beam Diameter	0.80 mm	0.80 mm	0.88 mm
Beam Divergence	1.01 mrad	1.41 mrad	0.92 mrad
Longitudinal Mode Spacing	441 MHz	1082 MHz	316 MHz
Noise (30 Hz – 10 MHz)	<1% rms	<5% rms	<1% rms
Starting Voltage	<10 kV (DC)		
Operating Voltage (DC)	2400 V	2400 V	3000 V

Item #	HRR120	HRP170	HRR170
Min Output Power	12.0 mW	17.0 mW	17.0 mW
Maximum Output Power	15.0 mW	25.0 mW	25.0 mW
Polarization	Random	Linear > 500:1	Random
Mode Structure	TEM00 > 99%		
Beam Diameter	0.88 mm	0.98 mm	0.98 mm
Beam Divergence	0.92 mrad	0.820 mrad	0.820 mrad
Longitudinal Mode Spacing	316 MHz	252 MHz	252 MHz
Noise (30 Hz – 10 MHz)	<1% rms	<1% rms	<1% rms
Starting Voltage	<10 kV (DC)		
Operating Voltage (DC)	3000 V	3500 V	3500 V

[3] *After 30 minute Warm-Up*

Part 8. Mechanical Drawing

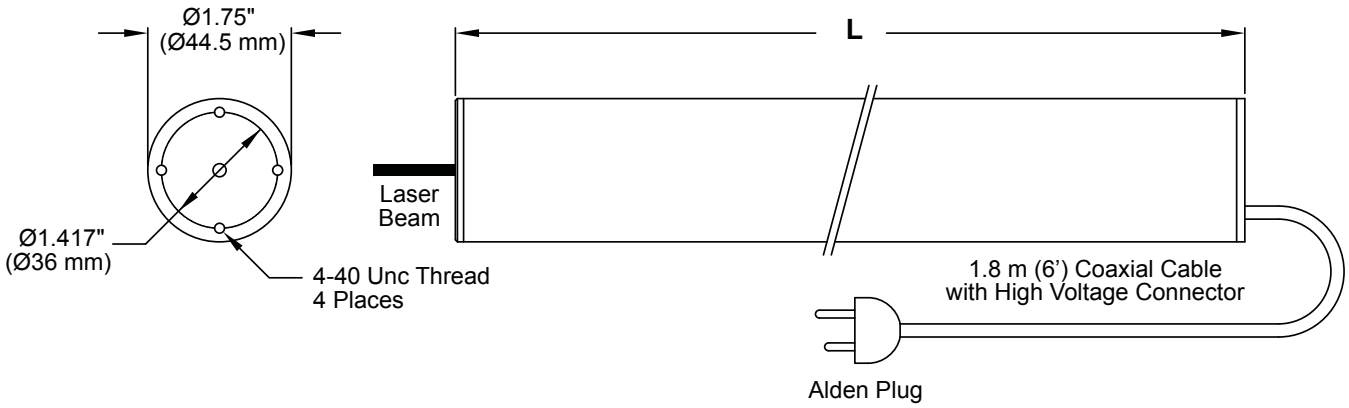

Figure 12 Dimensional Drawing

Dimensions

Item #	HRP050	HRR050	HRP120	HRR120	HRP170	HRR170
Length (L)	16.75" (425.45 mm)	16.75" (425.45 mm)	21.0" (533.4 mm)	21.0" (533.4 mm)	26.0" (660.4 mm)	26.0" (660.4 mm)
Diameter	Ø1.76" (Ø44.5 ± 0.5 mm)					

Part 9. Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return "end of life" units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out "wheelie bin" logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated

ı Logo

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

9.1. Waste Treatment is Your Own Responsibility

If you do not return an "end of life" unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

9.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

Part 10. Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.

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Thorlabs, Inc.
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www.thorlabs.com

HeNe Laser Quick Start Guide

THORLABS

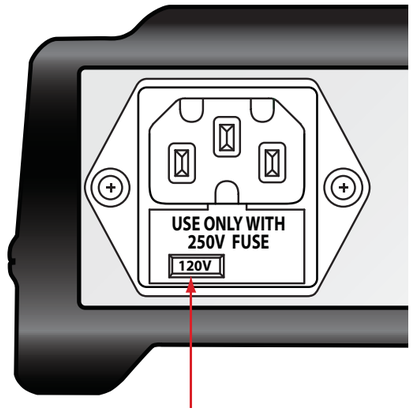
1. Unpack the Laser and Power Supply

a. Carefully unpack the laser head, and place it securely on your work surface. DO NOT ALLOW THE TUBE TO ROLL freely.
b. Carefully unpack the power supply and set down near the laser head.
c. Unpack and read ALL documentation CAREFULLY!

What's in the Box?

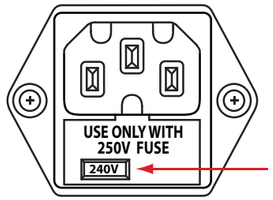
1 Laser Head
1 Power Supply
1 Manual and Quick Start Guide
1 Fuse Kit and Mains Voltage Selector (Installed)
2 Power Switch Keys
1 Interlock Connector

2. Select the Proper Line Voltage and Fuse Setting



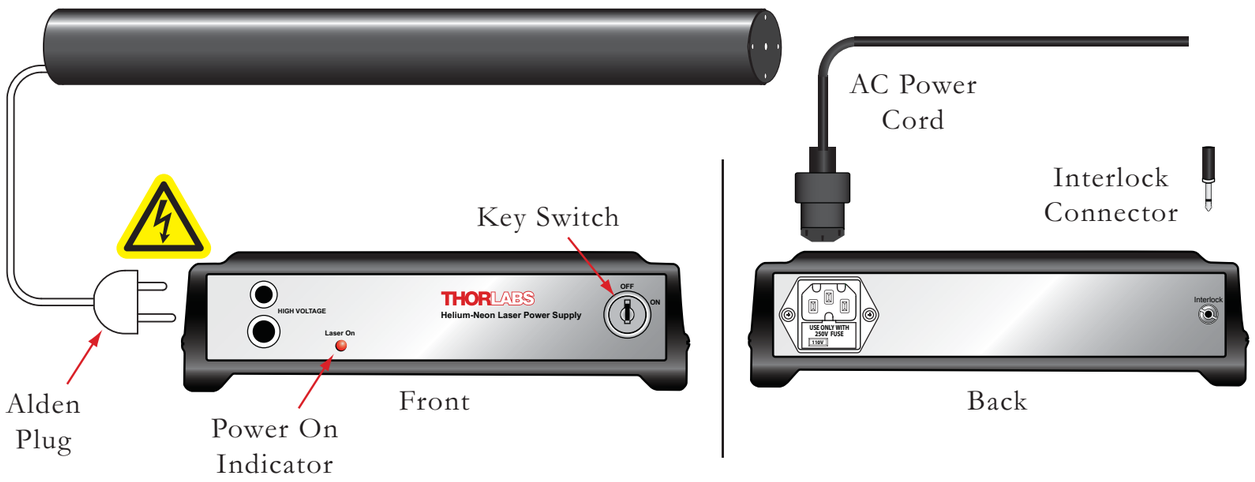
Use 120V with 100 to 130 V

a. Your laser should be ready with the correct line voltage for your area, 115 VAC (100 - 120 VAC) or 220 V (220 - 230 VAC).
Before you plug the power supply in, make sure the fuse is set to your local voltage and the power cord is the correct one for your area.



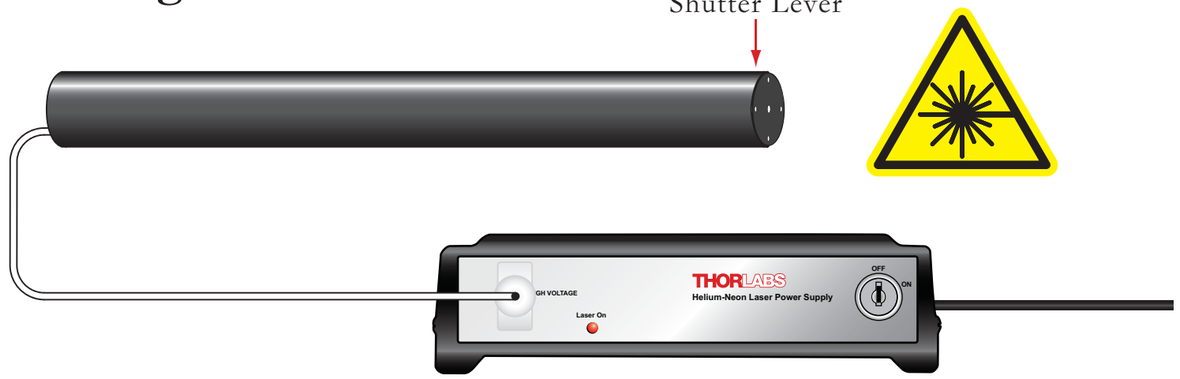
Use 240V with 200 to 260 V

3. Make the Connections



a. Connect the AC cord to the powers supply.
b. Plug the Alden plug into the power supply. Make sure the plug is pushed in all the way. The laser may not lase if the plug is not securely in place.
c. Insert the interlock connector into the back of the power supply.

4. Turning on the Laser



a. Make sure the laser is pointing safely away from people and is securly mounted. See the manual for mounting directions.
b. Turn the key switch on the power supply on. Power light will light up red. There is a 4 to 5 sec CDRH safety delay before the power supply comes on.
c. Slide the aperture open.
d. Some models may take up to 60 seconds to begin lasing. After 20 sec you may try turning the power off then on again. This will not hurt the power supply or the laser.

If you are experiencing an issue, please refer to the troubleshooting section of the manual before contacting your local Tech Support Office.