



HNL Series Red HeNe Lasers

User Guide



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Chapter 1 Warning Symbol Definitions

Below is a list of warning symbols you may encounter in this manual or on your device.

Symbol	Description
	Direct Current
	Alternating Current
	Both Direct and Alternating Current
	Earth Ground Terminal
	Protective Conductor Terminal
	Frame or Chassis Terminal
	Equipotentiality
	On (Supply)
	Off (Supply)
	In Position of a Bi-Stable Push Control
	Out Position of a Bi-Stable Push Control
	Caution: Risk of Electric Shock
	Caution: Hot Surface
	Caution: Risk of Danger
	Warning: Laser Radiation
	Caution: Spinning Blades May Cause Harm

Chapter 2 Safety



WARNING



Laser Radiation – Avoid Exposure to Beam – Class IIIa/Class 3R or Class IIIb/Class 3B depending on Laser Product.

2.1. Safety Information

2.1.1. Safety Summary

As defined by the Federal Register 21 CFR 1040.10 Laser Safety Standard, Thorlabs' Helium Neon laser heads are classified according to output power and wavelength. In compliance with this standard, certain performance features and laser safety labels are provided on the product.

The American National Standards Institute publishes a laser safety standard for users, entitled American National Standard for the Safe Use of Lasers (ANSI Z136.1). Thorlabs strongly recommends that laser users obtain and follow the procedures described in this ANSI standard.

Copies may be obtained from:

A.N.S.I. Washington, DC. Headquarters

1819 L Street, NW (between 18th and 19th Streets), 6th floor
Washington, DC 20036
Tel: (202) 293-8020
Fax: (202) 298-9287
www.ansi.org

Laser Institute of America

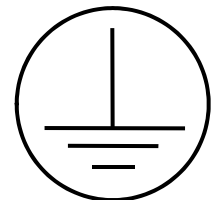
13501 Ingenuity Drive, Suite 128
Orlando, FL 32826
Toll Free: (800) 345-2737
Telephone: (407) 380-1553
Fax: (407) 380-5588
www.laserinstitute.org

2.1.2. Safety Information

Classification

These laser heads do not connect directly to the mains, they are considered Installation Category Type I. The included power supplies do connect directly to the mains, they are considered Installation Category Type II.

The power supply provides protective earthing as one of the means of shock protection. The following symbol is used to indicate a protective conductor terminal inside the unit.



Disconnecting from Line Power

The power supply power cord must always be accessible from the AC line-power source (receptacle). If the unit is installed in a cabinet, the operator must be able to disconnect the unit from the line power by the system's line-power switch.

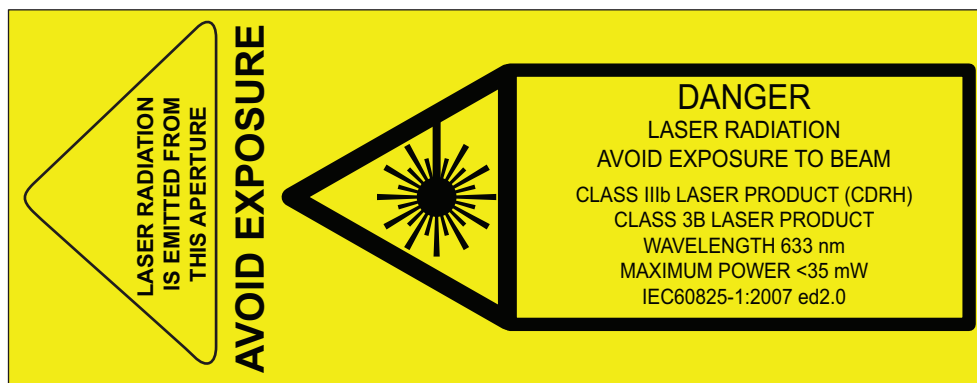
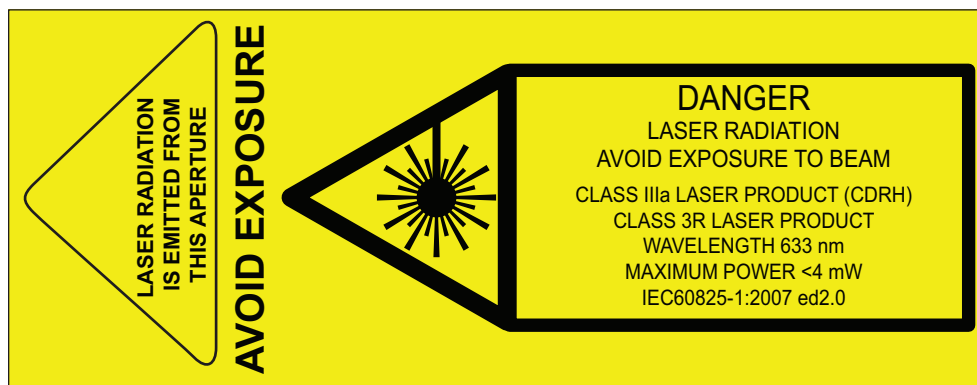
Power Supply Line Power Requirements

The unit can operate from any single-phase AC power source that supplies 100 to 240 VAC at a frequency range of 50 to 60 Hz. The maximum power consumption is 40 VA.

Laser Safety Parameters

The parameters for the laser system are outlined in the table below, followed by classification warning labels. See specification tables for classifications specified by the Center for Devices and Radiological Health (CDRH), a division of the Food and Drug Administration (FDA).

Item #	HNL008RB HNL008LB	HNL020RB HNL020LB	HNL050RB HNL050LB
Wavelength	632.8 nm		
Laser Classification	Class IIIa (CDRH)/3R (IEC)		Class IIIb (CDRH)/3B (IEC)
Min Output Power	0.8 mW	2.0 mW	5.0 mW
Beam Diameter (TEM ₀₀ , 1/e ² points ±3%)	0.48 mm	0.63 mm	0.81 mm



2.2. Safety Instructions



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 acceptable 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.

The following safety instructions must be observed whenever the unit is operated, serviced, or repaired. Failure to comply with any of these instructions or with any precaution or warning contained in the user's manual is in direct violation of the standards of design, manufacture, and intended use of the unit. Thorlabs' assumes no liability for the customer's failure to comply with any of these safety requirements.

Before Initializing and Operating the Unit

- Inspect the unit for any signs of damage, and read the user's guide thoroughly.
- Install the unit as specified in the Setup section on page 10.
- Ensure that the unit and any devices or cords connected to it are properly grounded.

Laser Safety Precautions

It is recommended that all persons who use or are near lasers be aware of the potential hazards.



WARNING



The starting and operating voltages of the laser head are lethal and are specified herein. Ensure that the power supply is turned off and unplugged before attempting to connect or disconnect the lasers.

Do not access the interior of the power supply.
The lasers and the power supplies are not serviceable units.

**WARNING**

**To avoid the risk of injury or death,
always observe the following precautions before initializing the unit:**

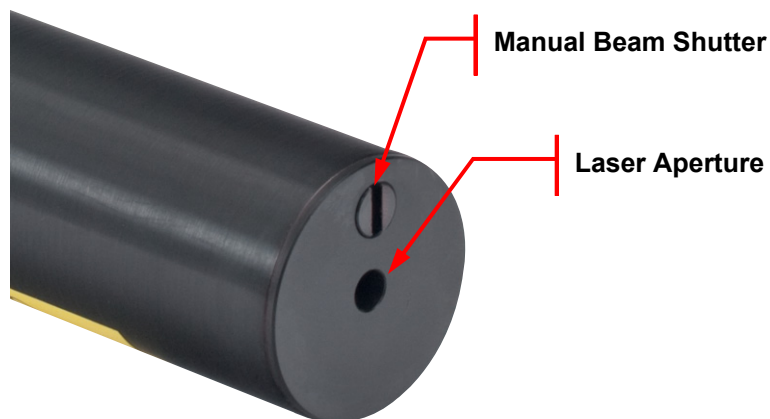
- Never look into the end of an optical cable connected to an optical output device that is operating. Laser radiation is invisible, and direct exposure can severely injure the human eye.
- Eye and skin exposure to direct or scattered laser radiation is hazardous and is considered potentially extremely harmful.
- Install the laser in an enclosed area with access restricted to trained personnel. Clearly label the area and mark the entrance with the class of laser (Class II, IIIa, or IIIb).
- Never leave the laser on and unattended.
- If the laser has a key switch on the power supply front panel, the key must be inserted and turned to enable the laser to operate. The key is captive in the operational position. Remove the key from the laser when not in use or unattended. Store the key in a safe place.
- Limit access to the laser to personnel who are familiar with the equipment. Ensure that the laser is not assembled, operated, or repaired by inexperienced or untrained personnel.
- Ensure that all mirrors and optics used are securely positioned and fixed to prevent movement. Prevent stray reflections from surfaces at all times.
- Do not allow reflective objects to be placed in the laser beam. Laser light scattered from a reflective surface can be as damaging as the original beam. Objects such as rings, watchbands, and metal pens or pencils can be hazardous.
- Install the laser so that the laser beam is not at eye level.
- Terminate the laser beam path with a suitable power meter or non-reflecting beam stop. Enclose beam stops where possible. Consult a power meter or the beam stop manufacturers' operating manual for proper usage.
- Suitable eye protection must be worn at all times when laser output is possible.
- Connect the power cord only to a power outlet equipped with a protective earth contact. Never connect to an extension cord that is not equipped with this feature.
- Do not interrupt the protective earth grounding. Any such action can lead to a potential shock hazard that can result in serious personal injury.
- Disconnect the power cord from the unit before adding or removing any components. Do not rely on electrical safety devices or interlocks.
- Some electrical components within the products may maintain electrical charge even when unplugged.
- After unplugging products from the ac mains, wait a minimum of 1 minute before disconnecting the laser head from the power supply. The emission indicator on the power supply should be off.
- **WARNING:** When disconnecting a laser head from a power supply there may be a residual charge remaining within the laser head and present at the exposed tips of the HV connector. Release any excess charge by shorting the tips of the connector to a metal surface before additional handling.
- Do not use the unit outdoors. To prevent potential fire or shock hazard, do not expose the unit to any source of excessive moisture.
- Operating the unit in the presence of flammable gases or fumes is extremely hazardous.
- Never remove covers or panels from the units.
- Do not perform any operating or maintenance procedure that is not described in the user's manual.

Chapter 3 Description

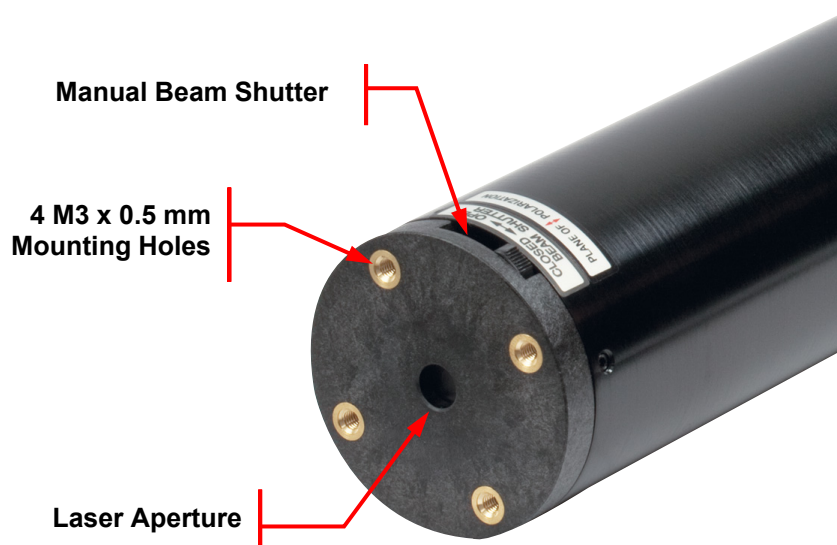
Thorlabs' line of cylindrical, low-power, red (632.8 nm) helium-neon (HeNe) gas lasers have stable output powers from 0.5 to 5.0 mW and a fundamental Gaussian beam. Depending on the model chosen, the output beam will be either linearly polarized or randomly polarized (unpolarized). The state of polarization in a randomly polarized laser beam is not truly an unpolarized source, but rather a single state of polarization that changes on a small timescale.

3.1.1. 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 face has a manual beam shutter screw that is turned to open and close the beam shutter. This laser also comes with a 6 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.



For HNL008RB(LB) Only



All Other Models

Figure 1 Laser Head

3.1.2. 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 indicator¹, and a remote interlock connector. The power supply has an IEC connector and accepts 100 to 240 VAC, 50 – 60 Hz.



Figure 2 High Voltage Alden Plug

3.1.3. 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

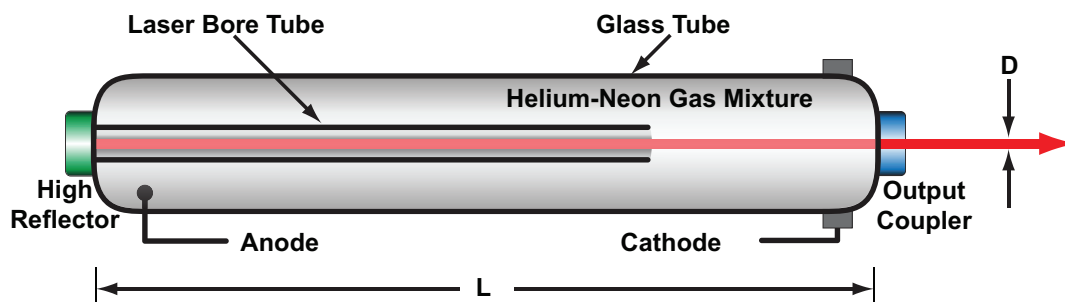


Figure 1 Optical Resonator Cavity

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%

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.

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 22.5 mW.

3.1.4. 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 2 on page 7). 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.

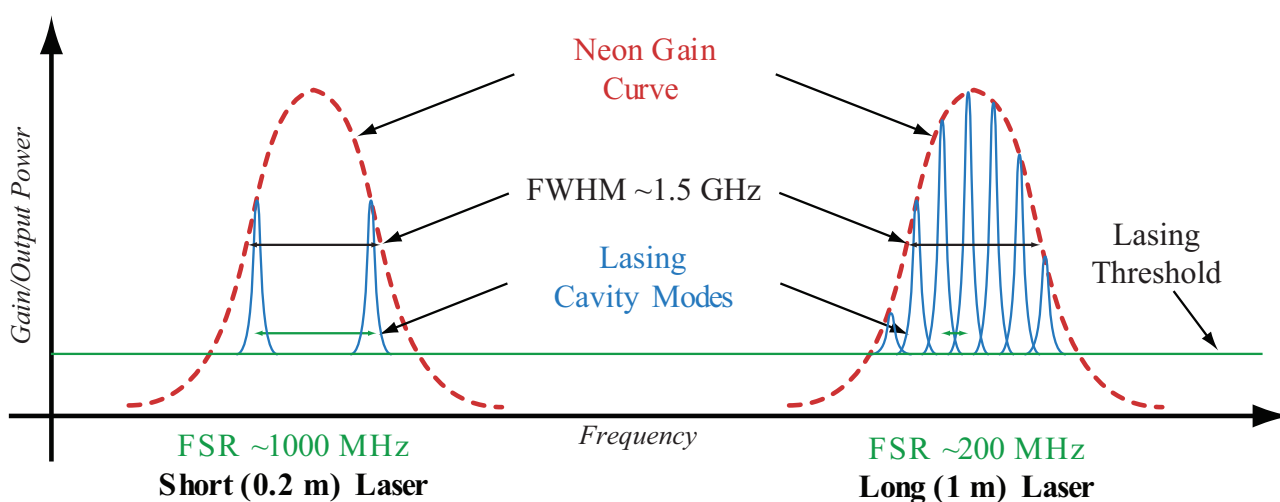


Figure 2 HeNe Gain Curve Showing Cavity Modes

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.

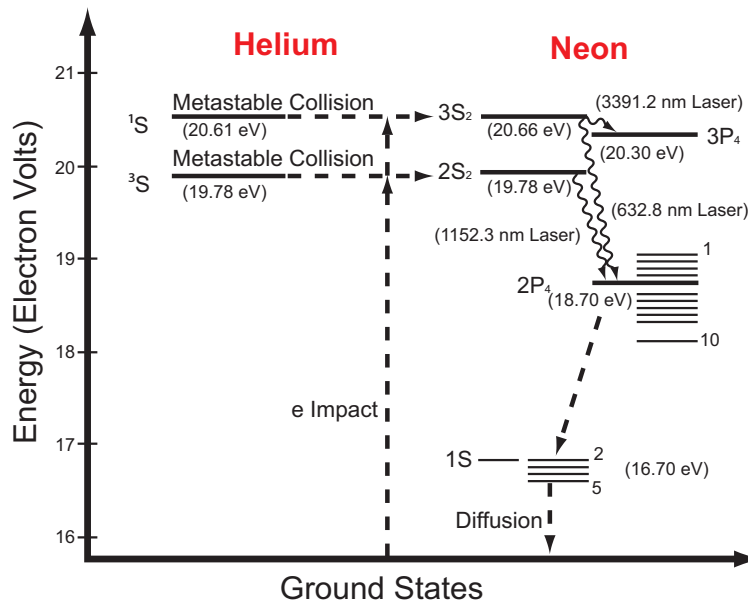


Figure 3 HeNe Energy Levels

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.

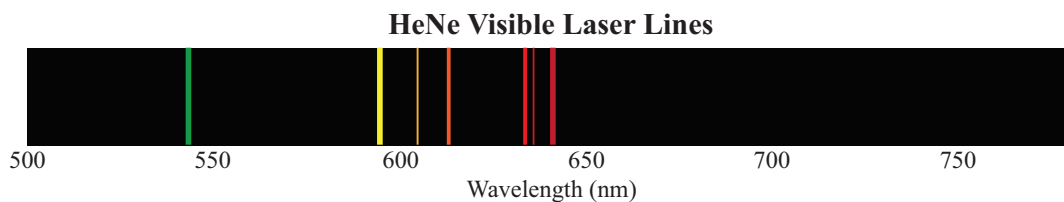


Figure 4 HeNe Visible Laser Lines

3.1.5. 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.

Linear Polarized Beam

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

Chapter 4 Setup

4.1. 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 it 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.

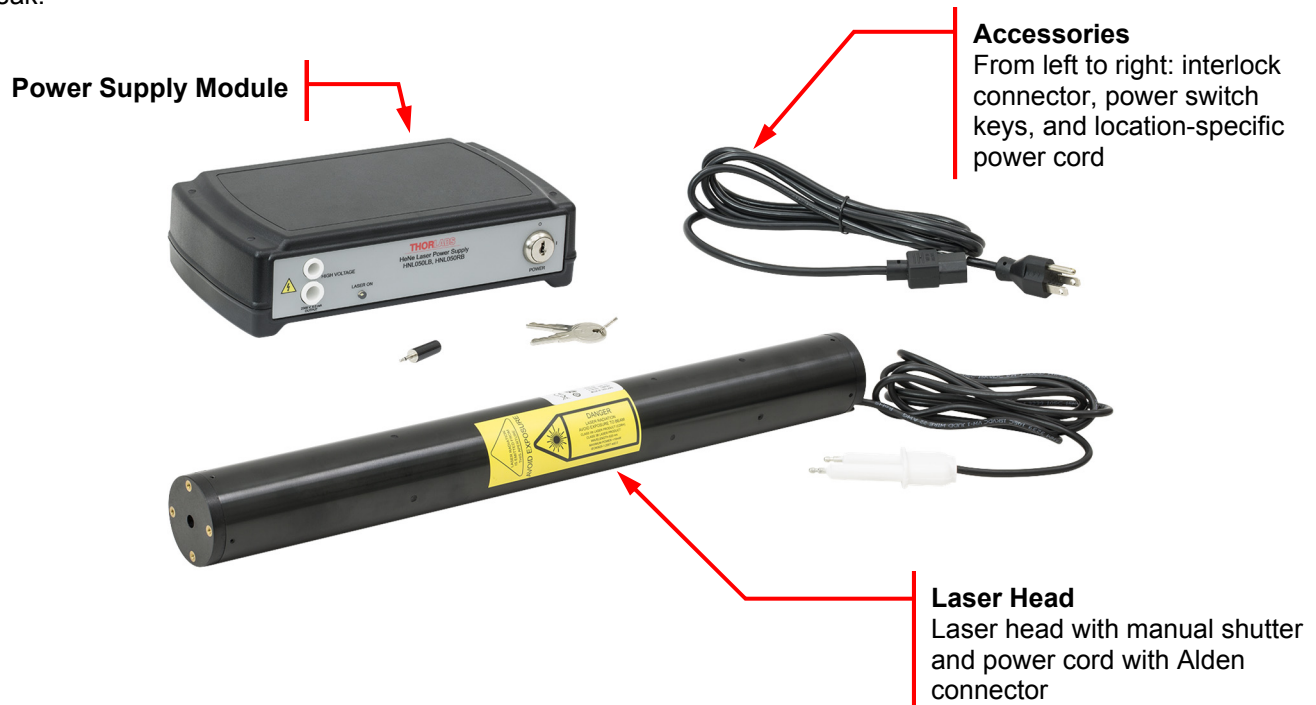


Figure 3 Laser System

4.1.1. 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 identifying 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
- User Guide and Quick Start Guide

4.2. 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 laser head should always be secured in place and not allowed to move freely. Not only can the laser roll off the work surface and break, but the laser emission can be a health hazard.

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

HeNe Laser Length	Number of V-block Mounts	Number of Ring Clamps
7 – 16"	1	2
16"+	2	3



HNL008LB in C1513
Post Kinematic V-Clamp

4.3. Assembly

It is suggested that the *HeNe Laser Quick Start Guide* (a separate document found enclosed with the laser) be used to assemble the laser system. Listed below are the steps needed to assemble the laser system.

This laser system includes power supply with an IEC connector that accepts 100 to 240 VAC, 50 – 60 Hz. The proper mains voltage cord must be used.



WARNING



Never remove the Alden plug from the power supply while the power supply is plugged into the mains. Doing so may result in arcing that could damage the laser head or power supply.

- 1) Make sure the laser head is secured to your work surface and pointed safely away from people and directed into a beam block, beam dump or similar nonreflective surface.
- 2) Plug the high-voltage cable from the laser into the rear 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 arcing and damage to the power supply or laser head.
- 3) Insert the shorting remote interlock connector into the back of the power supply. Also note that the LED light on the front of the power supply will not light if the interlock is not inserted.



- 4) Plug the AC connector into the mains outlet.
- 5) Insert the key into the front panel of the power supply, leave in the off position.

Chapter 5 Operation

To operate the laser system, follow the following procedures:

- 1) With the key switch off, make sure that the laser is pointing safely away from people and is securely mounted and directed into a beam block, beam dump or similar nonreflective surface.
- 2) Open the aperture by turning the screw 90° in either direction using a flat head screwdriver (HNL008RB or HNL008LB only) or sliding the shutter switch to the left (all other HNL series lasers).

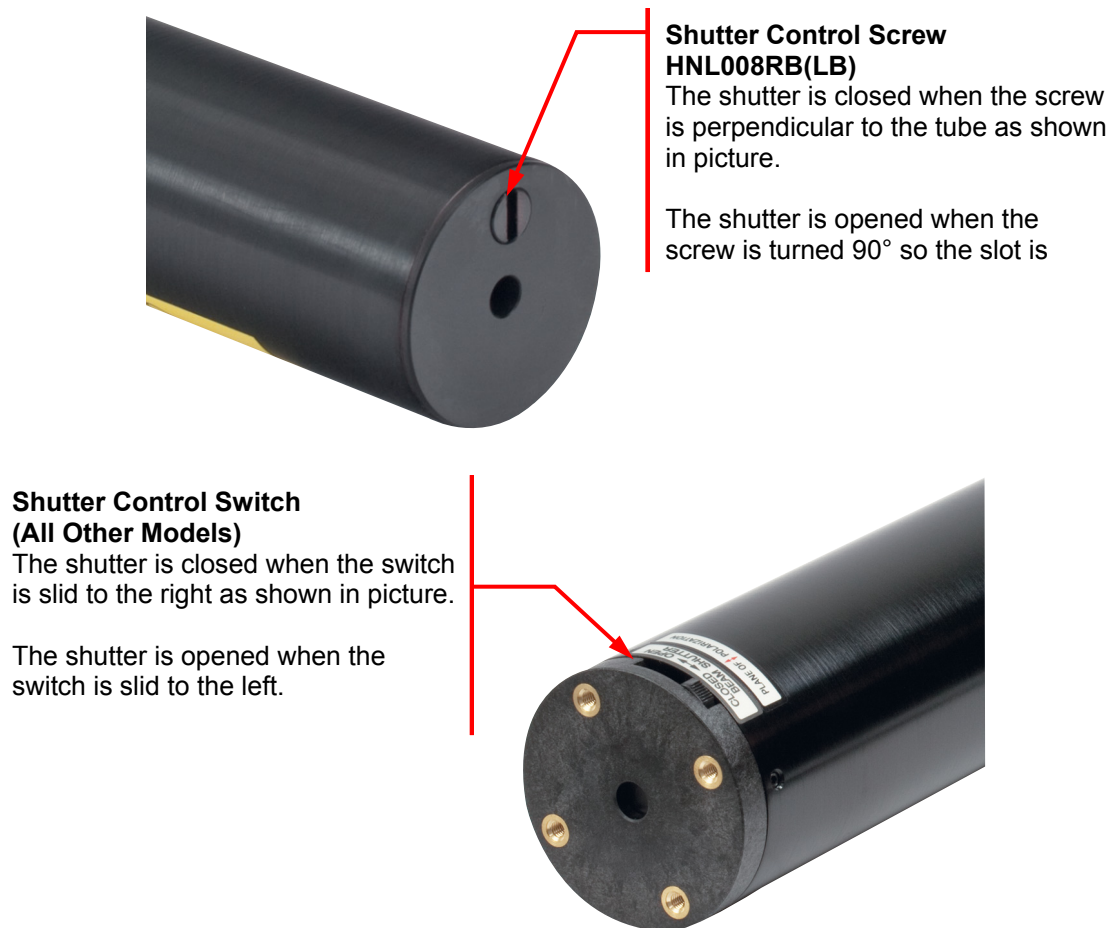


Figure 4 Laser Shutter Control, Picture shows the Shutter CLOSED.

- 3) Turn the key switch on the power supply on. The “Laser On” LED indicator will light.
Note: There is a 3 to 5 second CDRH safety delay before the voltage turns on.

5.1. HeNe Power Supply

5.1.1. Introduction

The HeNe power supply is a turn-key power supply for HeNe laser tubes that incorporates all of the appropriate safety features required by US federal regulations. **Note that the power supply that came with your HeNe laser is specifically designed to be used with the models of HeNe lasers included on the front label and is not compatible with other HeNe laser models.**

This unit is RoHS compliant.

5.1.2. Remote Interlock Operation

To use the remote interlock connector, the black cover need to be unscrewed, and the shorting conductor from the connector removed. The connector may then be wired into the user's interlock system. Be sure to thread the interlock wire through the black plastic cover before wiring and to screw it back into place before use. The interlock is at AC line potential and proper care must be taken to use the correct wire gauges, insulation types, etc.

The voltage on this connector is the same as the AC line voltage of your pre-configured power supply. Only the provided connector should be used as an interlock and never anything else. Please contact your local tech support office for a replacement connector.

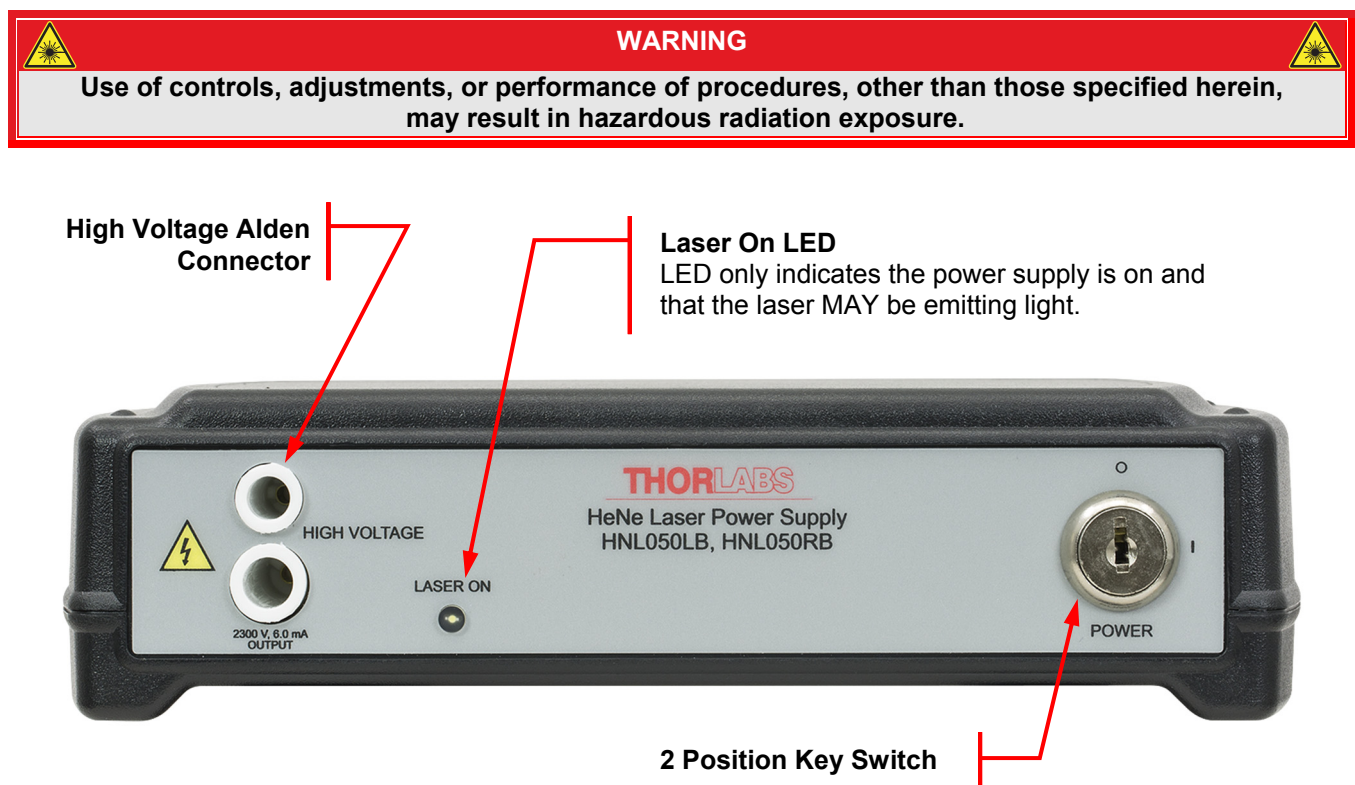


Figure 5 Front of the Power Supply Module

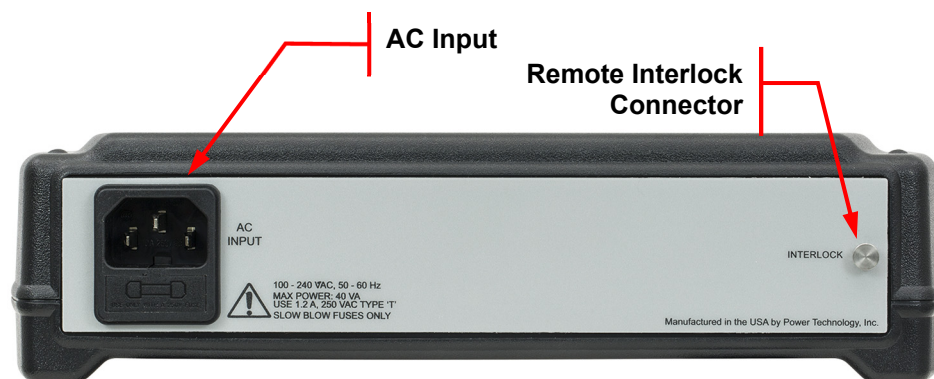


Figure 6 Back of the Power Supply Module

5.1.3. Maintenance and Service

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

Chapter 6 Troubleshooting

6.1. Technical Failures

Problem	Fix
No light is being emanating from the laser.	Make sure that the aperture is open.
	Check to make sure that - 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, - the power supply is plugged into a working outlet, and - the aperture is open.
	Note: There is a built in CDRH safety delay of 4 - 5 seconds before the laser starts to lase after turning the key switch
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 or the power supply Laser On Indicator does not light.	Make sure the power supply is plugged in.
The laser has low output power.	The laser requires 10 minutes to meet published specifications. Make sure to let it warm up.
	Make sure that 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. In some cases, these laser are not suited to the application. One common mis-application comes from a HeNe laser, especially a low power laser (~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. When averaged over time, the light emitted from these lasers appears randomly polarized. However, any polarization optics in the path (intentional or unintentional) can cause large variations in the output power. Only polarized lasers should be used in applications that involve polarization optics.

While HeNe lasers are less sensitive to variations caused by back reflections, they are not immune to them. 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 a single frequency or long coherence length is required.

6.2.1. 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 less than a Hz to as high 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)

Chapter 7 Specifications

Item #	HNL008RB		HNL008LB		HNL020RB		HNL020LB		HNL050RB		HNL050LB	
Laser Specifications												
Wavelength	632.8 nm				632.8 nm				632.8 nm			
Min Output Power (TEM ₀₀ , 633 nm)	0.8 mW				2.0 mW				5.0 mW			
Min Polarization Ratio	Random		500:1		Random		500:1		Random		500:1	
Beam Diameter (TEM ₀₀ , 1/e ² points + 3%)	0.48 mm				0.63 mm				0.81 mm			
Beam Divergence (TEM ₀₀ , + 3%)	1.7 mrad				1.3 mrad				1.0 mrad			
Mode Purity (TEM ₀₀)	>95%				>95%				>95%			
Longitudinal Mode Spacing	1090 MHz				730 MHz				435 MHz			
Max Noise (RMS) (30 Hz to 10 MHz) ²	0.1%				0.1%				0.2%			
Max Drift with Respect to Mean Power, Over 8 hr	±2.5%				±2.5%				±2.5%			
Max Mode Sweeping Contribution	10%				3%				2%			
Beam Pointing Stability (25 °C)												
From Cold Start	N/A				<0.10 mrad				<0.10 mrad			
After 15 min Warm-up	N/A				<0.02 mrad				<0.02 mrad			
Operating Voltage (±100 V)	1250 VDC				1800 VDC				2300 VDC			
Operating Current (±0.1 mA)	4.0 mA				6.5 mA				6.0 mA			
Max Starting Voltage	10 kVDC				10 kVDC				10 kVDC			
Physical/Mechanical Characteristics												
Maximum Warm-Up Time (95% Power)	10 minutes				10 minutes				10 minutes			
Expected Operating Lifetime	>20,000 hours				>30,000 hours				>40,000 hours			
Storage Lifetime	Indefinite (Hard-Sealed)				Indefinite (Hard-Sealed)				Indefinite (Hard-Sealed)			
Static Alignment	Center to Outer Cylinder within ±0.01" Parallel to Outer Cylinder within ±1 mR											
Laser Head Weight	0.46 lbs (0.21 kg)				0.92 lbs (0.42 kg)				1.3 lbs (0.59 kg)			
Environmental Specifications												
Operating Temperature	-40 to 70 °C											
Non-Operating Temperature	-40 to 150 °C											
Operating Altitude	0 to 10,000 feet											
Non-Operating Altitude	0 to 70,000 feet											
Relative Humidity (Non-Condensing)	0 to 100%											
Shock	25 g for 11 ms; 100 g for 1 ms											
Safety Specifications												
CDRH/IEC 60825-1 Class	IIIa / 3R				IIIa / 3R				IIIb / 3B			

² TEM₀₀ version only.

Chapter 8 Mechanical Drawing

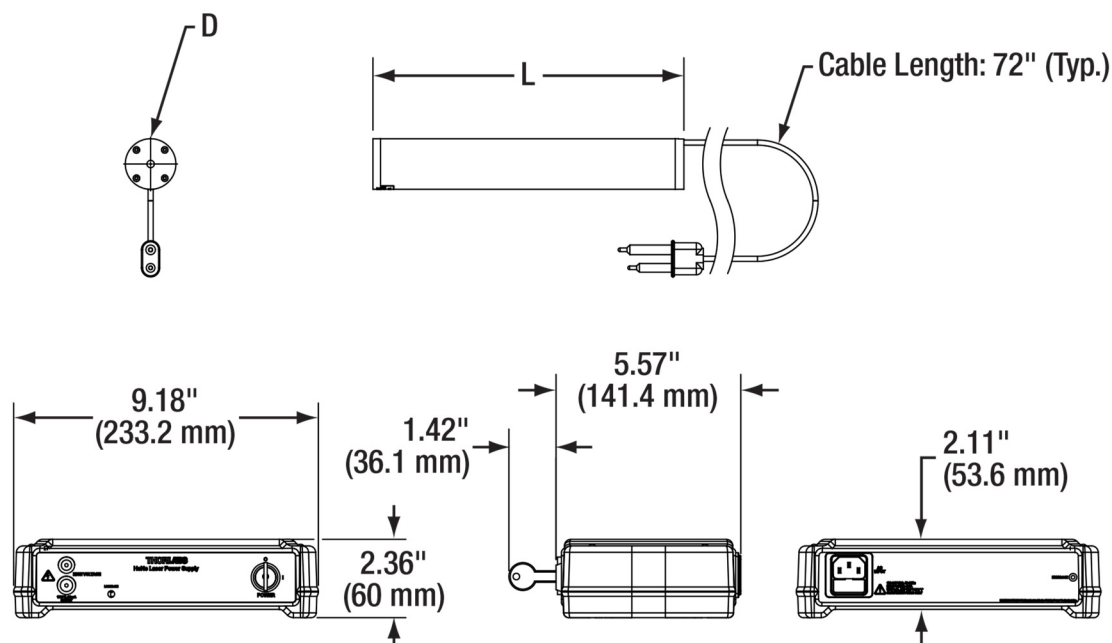


Figure 7 Dimensional Drawing

Item #	Diameter (D)	Length (L)
HNL008LB / HNL008RB	1.245" (31.6 mm)	6.905" (175.4 mm)
HNL020LB / HNL020RB	1.74" (44.20 mm)	10.70" (271.78 mm)
HNL050LB / HNL050RB		15.77" (400.56 mm)

Chapter 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



Wheelie Bin 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.

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.

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.

Chapter 10 Thorlabs Worldwide Contacts

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