Operating Instructions: HRM Heat Resistant Laser Module

Introduction

The Heat Resistant Module, or HRM, is an extended-temperature-range, waterproof, constant-power laser module designed for operation in elevated-temperature environments.

The HRM is designed to operate in constant power mode. In this mode, the laser diode back-facet photodiode is used as feedback to regulate output power at the level specified for the ordered model. Standard HRM models are configured for constant-power operation.

The HRM is designed for IP67 environments and has been tested for operation underwater at up to 30 meters in depth. The HRM can also be configured without waterproof features for applications requiring easier access to the focus adjustment or USB-C cable.

Standard HRM models are configured by wavelength and output power. All standard HRM models use glass optics, a USB-C connector cable, a selected laser diode, and are collimated at 175 ft before shipment.

Figure 1. Primary Connector Pinout

Pin	Name	I/O	Function
A4, A9, B4, B9	VIN	Input	Supply voltage positive
A1, A12, B1, B12	Ground	Input	Supply voltage negative
A7, B7	Gref	Output	Ground reference for monitor measurements, inhibit input, & I2C
A2, B2	SCL	Input	I2C clock
A11, B11	SDA	I/O	I2C data
A8, B8	INH	Input	Inhibit input. High = laser diode off. Internal 1 kΩ pull-down.
A6, B6	Imon	Output	Laser diode current monitor
A10, B10	Pmon	Output	Laser power monitor
A3, B3	Tmon	Output	Laser temperature monitor

Figure 1: Primary connector pinout and signal identification for supply voltage, ground, inhibit, monitor outputs, and PTI calibration communication.

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Figure 2. Outline Drawing

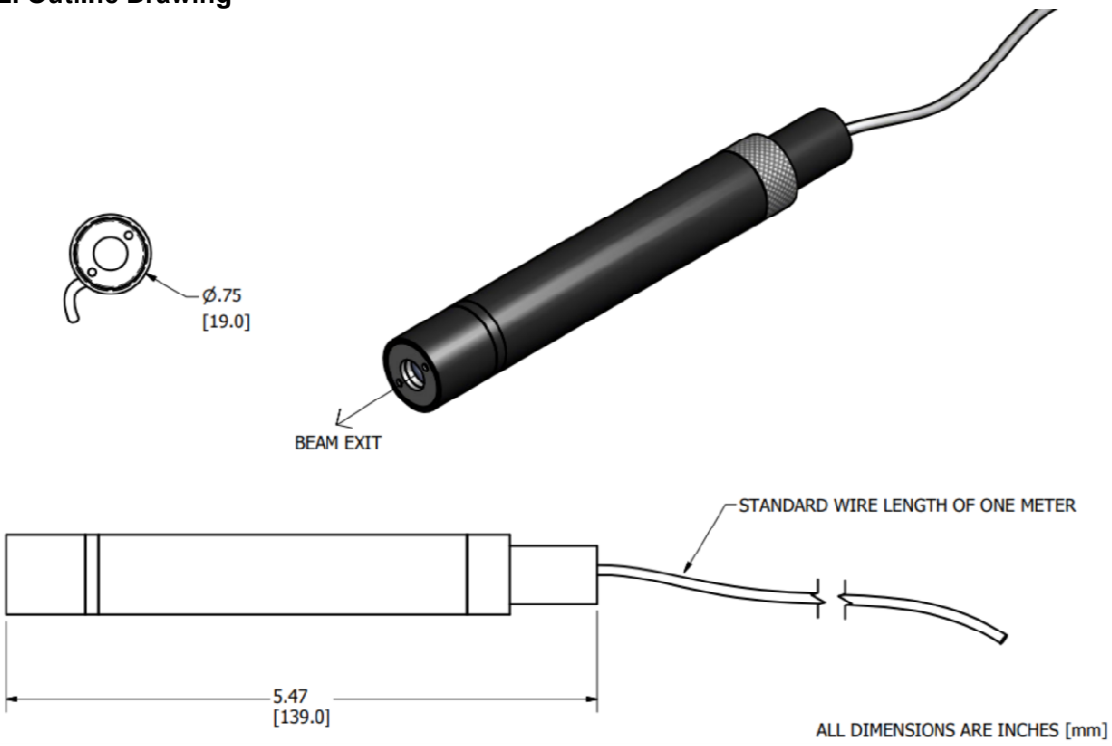


Figure 2: HRM mechanical outline showing nominal body diameter, length, beam position, optical output location, connector/cable location, and mounting interface.

Installation

Mount the HRM to a thermally conductive surface. Do not mount the module in an insulating clamp or other thermally insulating fixture. Proper thermal mounting or heatsinks are required for best performance, output stability, and laser diode reliability at maximum operating temperature.

The HRM is designed for elevated-temperature operation, but the maximum permitted operating temperature depends on the installed laser diode and model configuration. Refer to the model-specific maximum temperature listed for the ordered HRM model.

The general operating temperature range is 0°C to 100°C. Maximum case temperature is 105°C. Storage temperature range is -30°C to 105°C. Maximum humidity is 100% RH.

Before operating the module, verify that the laser output is aligned with the intended optical path or target. Standard HRM models are collimated at 175 ft before shipment.

Apply the specified operating voltage through the primary connector. The HRM is designed to operate from 5 to 8 VDC. Violet, blue, and green standard models use a PTI standard voltage of 8 VDC. Red, IR, and NIR standard models use a PTI standard voltage of 5 VDC.

The module supply current is 500 mA maximum. The module will tolerate reverse voltage application; however, correct wiring should always be verified before power is applied.

Operating Procedure & Control Description

The HRM operates in constant power mode. When power is applied, the module regulates the laser output using feedback from the laser diode back-facet photodiode.

During power-on or after a power glitch, an internal supervisor disables laser emission until the input voltage settles. The module then slews to within 5% of rated constant output power within 300 ms and settles into the specified tolerance within 5 seconds.

The HRM has one active user input: the Inhibit input. The HRM has three user monitor outputs: laser diode current monitor, laser power monitor, and laser temperature monitor.

Startup Procedure

- Confirm that the module model, wavelength, output power, and maximum operating temperature match the intended application.
- Confirm that the module is securely mounted to a thermally conductive surface.
- Confirm that the laser aperture is directed toward the intended target or beam path.
- Confirm that the power supply is off.
- Connect supply ground to the Ground pins.
- Connect positive supply voltage to the VIN pins.
- If monitor signals will be used, connect the measurement reference to Gref.
- If external inhibit or modulation will be used, connect the control signal to INH.
- Apply the specified supply voltage.
- If INH is left disconnected or held low, the laser will be enabled after the internal power-on delay.
- If the INH input is driven high laser emission is disabled and the laser diode remains OFF.
- Allow up to 5 seconds for the module to settle to rated output power.
- Verify expected operation using optical output, Imon, Pmon, and/or Tmon as required.

Shutdown Procedure

- Disable laser emission by pulling INH high, if an inhibit control is connected.
- Turn off the input supply voltage.
- Disconnect control and monitor connections only after the system is de-energized, unless the application wiring is designed for live connection.
- Allow the module to cool before handling if it has been operating at elevated temperature.

Inhibit Input and Modulation

The Inhibit input disables laser emission when pulled high. The input accepts 3.3 V TTL, 5 V TTL. Option inputs include 3.3 VDC or 9 to 15 VDC. The input has an internal 1 kΩ pull-down resistor, so the laser is enabled when the Inhibit input is left disconnected.

The Inhibit input may also be used to slowly modulate the output. Inhibit modulation is supported up to 250 kHz and is limited by photodiode response.

Laser Diode Current Monitor

The Imon output provides a signal proportional to laser diode current. For most HRM configurations, the scale factor is 1 mV per 1 mA of laser diode current. For example, 220 mV represents 220 mA of laser diode current.

For low-current laser diodes under 100 mA, the current monitor may report 10 mV per 1 mA. Refer to the individual module documentation or calibration record for the correct Imon scale factor.

Measure Imon with a high-impedance meter referenced to Gref.

Laser Power Monitor

The Pmon output provides a signal proportional to laser output power. Pmon is calibrated so that 1 VDC represents 100% of the module's rated optical power.

When Inhibit is active and laser emission is off, Pmon may not drop to zero volts. Depending on the laser diode and calibration, the off-state Pmon voltage may be between approximately 0.4 V and 0.95 V. For this reason, Pmon should be interpreted using the module-specific off-state and full-power values when precise output percentage is required.

For example, if a 60 mW module has Pmon = 1.00 V at 100% output and Pmon = 0.85 V when inhibited, an operating Pmon value of 0.925 V represents approximately 50% of rated output power, or 30 mW.

Measure Pmon with a high-impedance meter referenced to Gref.

Laser Temperature Monitor

The Tmon output provides a voltage proportional to module temperature. The temperature measurement is within approximately ±2°C of the laser emitter.

Use the following formula to convert Tmon voltage to temperature:
Temperature in °C = (TmonV - 0.395) / 0.0062

Measure Tmon with a high-impedance meter referenced to Gref.

Temperature Compensation and Overtemperature Protection

The HRM uses internal temperature sensing for monitoring, photodiode temperature compensation, current-limit temperature compensation, and laser diode overtemperature protection.

The constant-power circuit maintains output power over temperature by adjusting laser current as needed. The current-limit circuit is temperature compensated to reduce available laser current when cold and increase available current when hot, while preventing overcurrent conditions.

The laser diode overtemperature protection circuit uses module-specific temperature limits determined by the installed laser diode. When the measured temperature exceeds the TMAX setting, the maximum laser diode current is reduced. If the measured temperature exceeds TMAX by approximately 5°C, maximum laser diode current is reduced further. The temperature sensor includes approximately 4°C of hysteresis to prevent oscillation near the trip points.

If output power decreases at elevated temperature, check Tmon and verify that the module is operating within the maximum temperature limit for the specific HRM model.

Optical Adjustment

Standard HRM models are collimated at 175 ft before shipment. Custom calibration is available for OEM customers.

Adjustment of focus, beam centering, or front-window components may affect waterproof performance, optical alignment, laser safety classification, and warranty coverage. These adjustments should only be performed by qualified personnel or returned to PTI unless the individual product documentation authorizes customer adjustment.

Standard Product Configurations

HRM models are standardized by wavelength and output power. All standard HRM models have the following features:

- Glass optics
- USB-C connector cable
- Collimation at 175 ft before shipment
- Constant-power operation
- Model-specific output power as indicated in the model name

Custom power levels may be set during calibration for a standard PTI bench fee.

Maintenance & Service

This laser product contains no user-serviceable parts.

Depending on environmental conditions, the optics may require occasional cleaning. Clean, compressed air is recommended to blow the optics clean. If compressed air fails, clean the lens carefully with alcohol and a lint-free rag or cotton swab.

Do not remove the front window, adjust focus, adjust beam-centering screws, replace the USB-C cable, or modify waterproof components unless specifically authorized by PTI. Unauthorized adjustment or disassembly may affect optical alignment, waterproof sealing, laser safety classification, and warranty coverage.

Warranty and Repair Return Policy

No return of merchandise will be accepted by PTI without an RMA, Return Material Authorization, number issued by the factory and prominently displayed on the return package.

No return shipments will be accepted Collect or COD. On warranty returns, PTI will pay shipping charges for return of merchandise to the customer.

When contacting the factory for an RMA number, have the following information available:

- Model number
- Serial number
- Description of the problem
- Operating voltage
- Operating temperature
- Description of installation and mounting method
- Inhibit/control signal condition, if applicable

Laser Safety

Class 3b and 4 lasers are not intended for use in surveying, leveling, alignment, or medical applications.

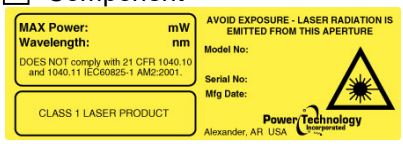
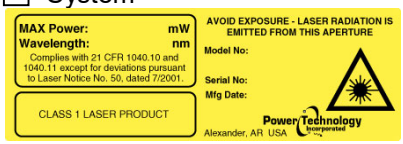
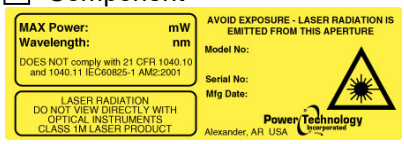
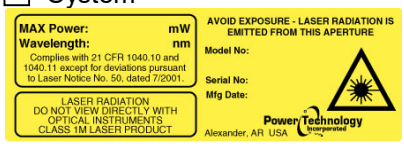
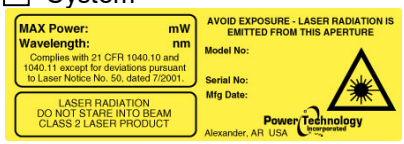
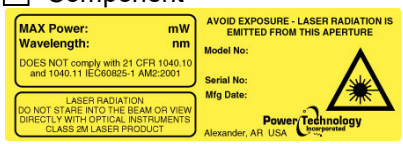
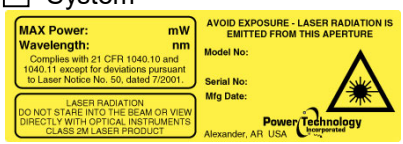
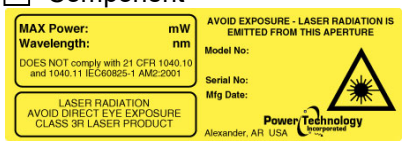
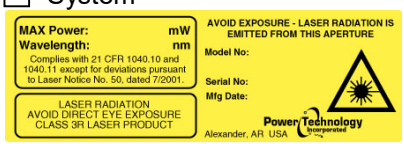
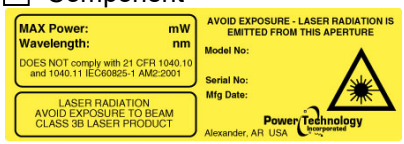
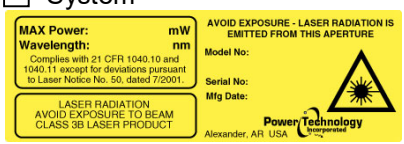
Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Caution: The use of optical instruments with this product will increase eye hazard.

Do not shine laser in the direction of other people or at reflective surfaces that might cause exposure to the human eye. Do not mount the laser at eye level.

Modifications, that affect any aspect of the product's performance or intended functions will require re-certification and re-identification of the product in accordance with the provisions of 21CFR 1040.10 and 1040.11. A copy of 21CFR 1040.10 and 1040.11 can be downloaded from www.powertechnology.com.

The product labels shown below can typically be found near the output optics:

Class 1 Laser: Class 1 Laser Product	Class 1M Laser: Laser Radiation, Do not view directly with optical instruments	Class 2 Laser: Laser Radiation, Do not stare into beam
☐ Component  ☐ System  One of the above labels is attached to the laser head.	☐ Component  ☐ System  One of the above labels is attached to the laser head.	☐ Component  ☐ System  One of the above labels is attached to the laser head.
Class 2M Laser: **Laser Radiation, Do not stare into the beam or view directly with optical instruments**	**Class 3R Laser:** **Laser Radiation,** **Avoid direct eye exposure**	**Class 3B Laser:** **Laser Radiation,** **Avoid exposure to beam**
☐ Component  ☐ System  One of the above labels is attached to the laser head.	☐ Component  ☐ System  One of the above labels is attached to the laser head.	☐ Component  ☐ System  One of the above labels is attached to the laser head.

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