

PowerMax[®]-Pro 15mm Sensor

User Manual

**USER MANUAL
FOR
POWERMAX[®]-PRO
15 MM SENSOR DEVELOPER'S KIT**





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PREFACE

This is the User Manual for the PowerMax[®]-Pro 15 mm Sensor manufactured by Coherent, Inc.

Anyone setting up or operating the Sensor must first read and understand how safety information is presented prior to beginning any tasks.

This documentation may contain sections in which particular hazards are defined or special attention is drawn to particular conditions. These sections are indicated with signal words in accordance with ANSI Z-535.6 and safety symbols (pictorial hazard alerts) in accordance with ANSI Z-535.3 and ISO 7010.



WARNING!

Use of controls or adjustments or performance of procedures other than those specified in this manual may result in exposure to hazardous radiation.

Safety Warnings

This section provides information about signal words and safety symbols that you need to know before you begin to use the PowerMax-Pro 15mm Sensor.

Signal Words

Four signal words are used in this documentation: **DANGER**, **WARNING**, **CAUTION** and **NOTICE**.

These signal words designate the degree or level of hazard when there is the risk of injury, as described in Table 1:

Preface Table-1. Signal Words





SIGNAL WORD	DESCRIPTION
DANGER	Indicates a hazardous situation that, if not avoided, WILL result in <i>death or serious injury</i> . This signal word is to be limited to the most extreme situations.
WARNING	Indicates a hazardous situation that, if not avoided, COULD result in <i>death or serious injury</i> .
CAUTION	Indicates a hazardous situation that, if not avoided, could result in <i>minor or moderate injury</i> .
NOTICE	Indicates information considered important, but not hazard-related. The signal word “NOTICE” is used when there is the <i>risk of property damage</i> .

Messages relating to hazards that could result in both personal injury and property damage are considered safety messages and not property damage messages.

Symbols

The signal words **DANGER**, **WARNING**, and **CAUTION** are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level. The icons are intended to alert the operator as described in Table 2:

Preface Table-2. Safety Symbols

ICON	ALERTS THE OPERATOR TO...
	Important notes or instructions for operation and maintenance.
	Danger of exposure to hazardous visible and invisible laser radiation.
	Dangerous voltages when working with other equipment may be of sufficient magnitude to constitute a risk of electric shock.
	Danger of susceptibility to Electro-Static Discharge (ESD).

Export Control Laws

It is the policy of Coherent to comply strictly with export control laws of the United States of America (USA).

Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations (ITAR).

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by laws in the USA, clarification must be obtained from Coherent or an appropriate agency of the U.S. Government.

For products manufactured in the European Union, Singapore, Malaysia, Thailand: These commodities, technology, or software are subject to local export regulations and local laws. Diversion contrary to local law is prohibited. The use, sale, re-export, or re-transfer directly or indirectly in any prohibited activities are strictly prohibited.

Declaration of Conformity

Declaration of Conformity certificates are available upon request.

SECTION ONE: PRODUCT INTRODUCTION

This section introduces the PowerMax-Pro 15mm Sensor, offered as fully integrated and calibrated Development Kit sensors as well as uncalibrated OEM detectors.

This Sensor is fully calibrated and operational. The primary difference between this and other Coherent sensors is that the PowerMax-Pro 15mm Sensor is modular, intended to be taken apart and reconfigured for testing in an Original Equipment Manufacturer (OEM) application. Developers may also design their own amplifier to use with this sensor.

Various configurations of the PowerMax-Pro 15mm Sensor are shown in Figure 1-1. The sensor is not a laser, but is used in a laser environment. Follow all laser safety practices; see “Appendix A: Safety and Compliance” for details.



Figure 1-1. Sensor Configurations

The PowerMax-Pro 15mm Sensor is available in Developer’s Kits, as well as individual OEM detectors. This section describes:

- “Key Features” (p. 1-2)
 - “Compatibility” (p. 1-2)
 - “Applications” (p. 1-2)
- “Developer’s Kits” (p. 1-5)
 - “OEM Detectors” (p. 1-7)
 - “Standard Accessories” (p. 1-8)
- “Technology Comparison” (p. 1-2)
- “Specifications” (p. 1-14)

Key Features

The PowerMax-Pro 15mm Sensor offers the following key features:

- High-speed 10 microsecond response time (varies by OEM detector)
- High-power handling up to 9 W (when used with a Heat Sink)
- Supports lasers from 400 nm to 11 microns wavelengths
- Broadband coating available with flat spectral response
- Large 15 mm square active area

Compatibility

The PowerMax-Pro 15mm Sensor is compatible with the LabMax-Pro SSIM meter, with software available for both desktop and mobile platforms.

Table 1-1 lists the different measurement modes supported by the PowerMax-Pro 15mm Sensor, as well as the compatible sensors and meters from Coherent:

Table 1-1. Meter Compatibility Matrix

MEASUREMENT MODE	COMPATIBLE WITH METER
Basic, High-Speed, and Snapshot Measurement	LabMax-Pro SSIM
High-Speed Analog Signal on Oscilloscope	J-Power Pro

Legacy meters (such as FieldMax II and LabMax-TOP) do not support high-speed measurement modes, nor the extended wavelength compensation.

Applications

This Sensor extends PowerMax Pro technology into a smaller form factor (15x15 mm active area versus 30x30 mm).

These detectors are designed for volume OEM integration into laser systems that incorporate active feedback control or real-time QC monitoring and in-line control. PowerMax-Pro sensors alleviate issues common to semiconductor and infrared detectors that have smaller active areas and steeper spectral response curves.

The high response speed of the PowerMax-Pro 15mm Sensor is particularly advantageous in applications for laser power monitoring of Continuous Wave (CW) or modulated laser systems.

The PowerMax-Pro 15mm Sensor can provide active feedback control within laser processing systems.

Technology Comparison

The PowerMax-Pro 15mm Sensor utilizes a new version of the thin-film transverse thermoelectric OEM detector introduced in earlier PowerMax-Pro models.

This power-sensing technology offers the broad wavelength sensitivity and large dynamic range of a thermopile with the fast response speed of small infrared detectors. The microsecond response time enables nearly instant power measurement without any overshoot, and can provide pulse energy, peak power, and rise/fall time with modulated sources.

These detectors are designed for integration into laser systems for real-time QC monitoring and in-line control. PowerMax-Pro sensors alleviate issues common to semiconductor and infrared detectors that have smaller active areas and steeper spectral response curves.

PowerMax-Pro Construction

The PowerMax-Pro is constructed and configured differently than a thermopile. The materials used in this sensor are a stack of films that have layer thicknesses on the order of microns.

Incident laser light is absorbed and generates heat which is able to flow very quickly through these thin layers to the Heat Sink below the detector where it is dissipated. The electrical signal from the thin film layers moves laterally to the edges of the device to the sensor electrodes.

The time constant is in the microsecond range, enabling the sensor to provide nearly instant power measurement without any overshoot and also enables pulse analysis of modulated lasers (such as peak power, rise/fall time, pulse width, integrated energy).

These detectors now provide a design alternative to semiconductor photodiodes and other infrared detectors that are limited to small active areas that can sample only a portion of the beam and have steep spectral response curves.

Thermopile Sensors

For many years thermopiles have been the detector of choice for lasers used in commercial applications. These detectors operate on the thermoelectric principle in which thermal energy is converted into electrical energy.

The typical thermopile has a central, light absorbing disk, a series of thermocouples that surround the disk, and an annular Heat Sink around the ring of thermocouples. Figure 1-2 shows a conventional thermopile with radial heat flow (≥ 1 s response time).

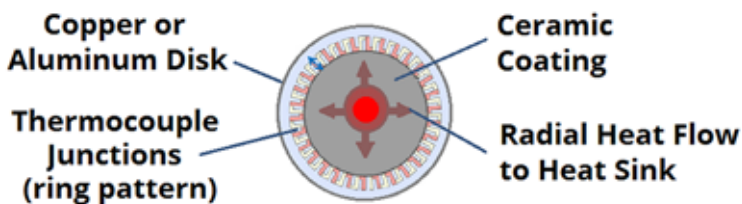


Figure 1-2. Traditional Radial Thermopile Physics

In operation, incident laser energy falls on the absorbing disk in the center of the detector and is converted into heat. This disk is typically coated with a material that absorbs light over a very broad wavelength range to increase sensitivity.

- The heat then flows across the width of the thermopile disk to the Heat Sink, which is held at a near constant ambient temperature by either air or water cooling, as shown in Figure 1-3.
- The temperature difference between the absorber and Heat Sink is converted into an electrical signal by the thermocouples.
- Calibrated electronics in the meter convert the electrical signal into a laser power reading.

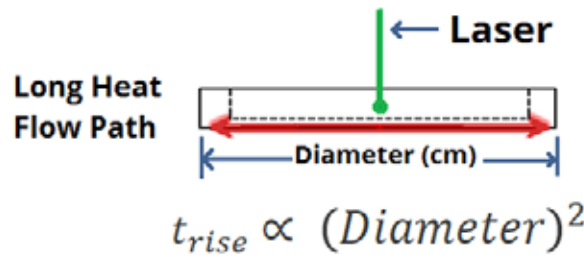


Figure 1-3. Traditional Thermopile – Long Heat Flow Path

Thermopile sensors have several advantages, including a very broad spectral range, an ability to work over a wide range of input powers, high laser damage resistance, and uniform spatial response (meaning insensitivity to changes in beam size, position or uniformity).

The limitation of the technology is that the transfer of heat across the width of the thermopile disk makes this technology inherently slow. It may take up to a minute before the heat flow caused by a kilowatt laser reaches equilibrium and the power measurement becomes stable on the display. Physically larger sensors take even longer to reach this stable state.

This slow response time makes thermopiles best suited for measuring CW laser power. For pulsed lasers, the best they can deliver is average power over a finite time interval, or total integrated energy from a long burst of pulses.

PowerMax-Pro Sensors

Coherent developed PowerMax-Pro technology to meet the growing need for a laser power sensor that offers the benefits of a thermopile, but with a fast response speed approaching that of a semiconductor photodiode.

The PowerMax-Pro sensor does preserve the primary benefits of a traditional thermopile architecture. However, the PowerMax-Pro sensor is constructed and configured differently than a thermopile. In this device, the heat flows vertically through the detector. The electrical field that is generated moves perpendicular to the heat flow, as shown in Figure 1-4.

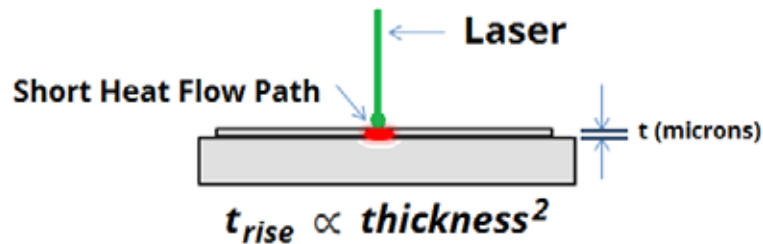


Figure 1-4. Transverse Thermoelectric Physics – Short Heat Path

The materials used in this sensor are a stack of films that have layer thicknesses on the order of microns, illustrated in Figure 1-5.

- Incident laser light is absorbed and generates heat that flows very quickly through these thin layers to the Heat Sink below the detector, where it is dissipated.
- The electrical signal from the thin-film layers moves laterally to the edges of the device, where it is measured by tapping into the sensor electrodes.

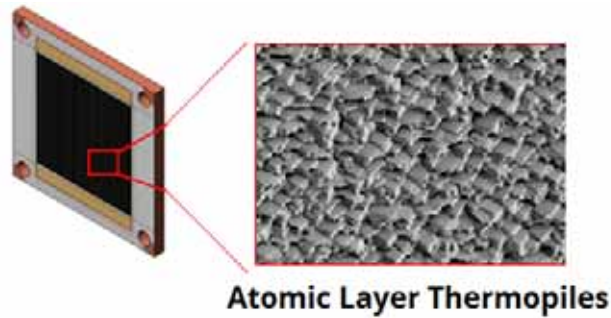


Figure 1-5. Transverse Thermoelectric Physics

Compared with the traditional radial-flow thermopile—which has a sensing time constant value of several seconds to a minute for kilowatt measurements—the time constant for the thin-film configuration is in the microsecond range. The sensor supplies an essentially instant power measurement without any overshoot, as shown in Figure 1-6.

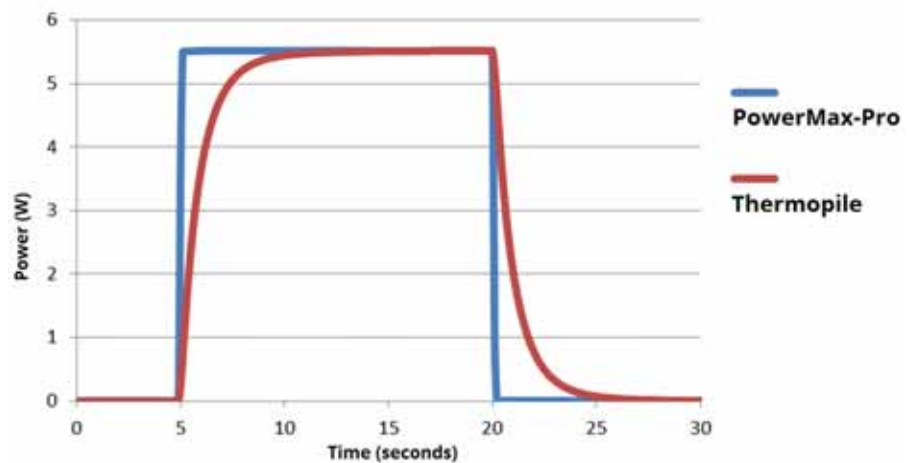


Figure 1-6. Rise Time – Thermopile vs. PowerMax-Pro

The response speed of PowerMax-Pro sensors lets users move beyond just measuring average power and enables visualization of the temporal pulse shape and peak power of modulated lasers with pulse in the 10's of microseconds or longer. These pulses can be integrated to calculate individual pulse energy.

Developer's Kits

The purpose of the PowerMax-Pro 15mm Sensor Developer's Kit is to provide a tool that can be used to quickly verify the current system, then disassemble and reassemble the tool. The sensor can then be used to test integration into user sub-systems and measured performance.

Figure 1-7 shows key components included in a Developer's Kit for the PowerMax-Pro 15mm Sensor:



Figure 1-7. PowerMax-Pro 15mm Sensor Developer's Kit

Table 1-2 lists the Developer's Kits available for the PowerMax-Pro 15mm Sensor:

Table 1-2. Available Developer's Kits

KIT P/N	DESCRIPTION
1342383	Patterned (HD), 300 μm x 100 μm
1342384	Unpatterned (UP). These detectors are recommended for small beams <2 mm diameter in fixed installations with minimal beam movement.
1382766	Broadband (BB)

Figure 1-8 shows the dimensions for the side edge of the housing for the PowerMax-Pro 15mm Sensor. Notice that one edge accommodates a hole to mount an 8-32 optical post:

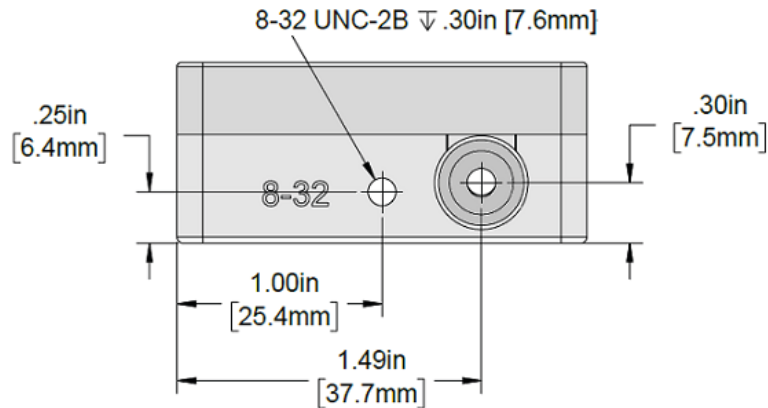


Figure 1-8. 15 mm Sensor – Side Edges for Optical Posts

Figure 1-9 shows the dimensions for the face and side view of the housing for the PowerMax-Pro 15mm Sensor.

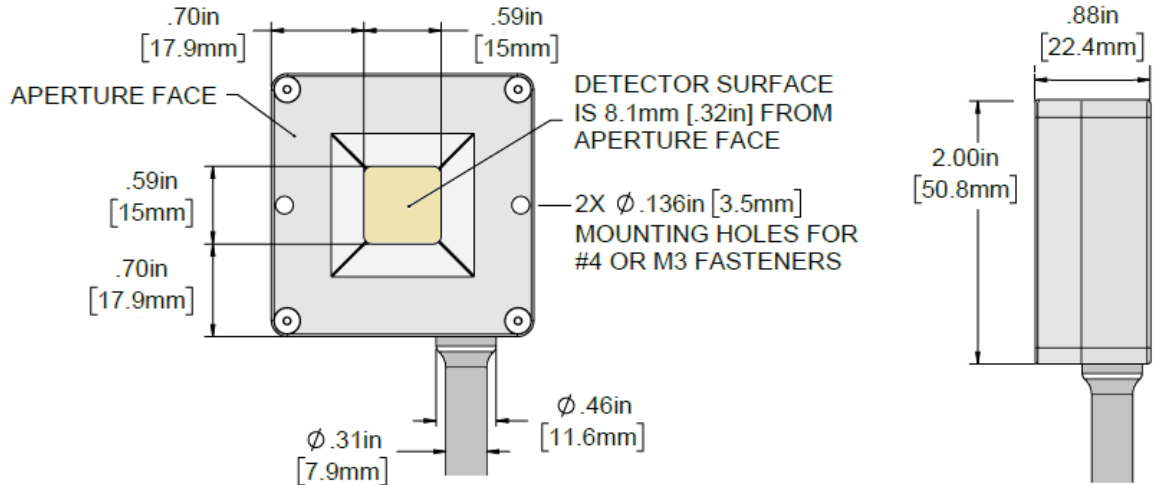


Figure 1-9. Dimensions —15 mm Sensor – Face and Side View

OEM Detectors

In addition to the Developer’s Kits that are available, OEMs can also order individual uncalibrated PowerMax-Pro 15mm OEM detectors, shown in Figure 1-10. These OEM detectors are designed as components to be used by an Original Equipment Manufacturer (OEM) prior to delivery to an end user.



Figure 1-10. Individual OEM Detectors

Table 1-3 lists the part numbers to order for each:

Table 1-3. OEM Detectors to Order

BASE SENSOR P/N	NAME	DESCRIPTION
1385327	Packaged OEM Detector, 15 mm Square	Patterned, 300 μm x 100 μm
1385328		Unpatterned (UP)
1385329		Broadband Coating

These OEM detectors are sold and packaged individually, as shown in Figure 1-11:

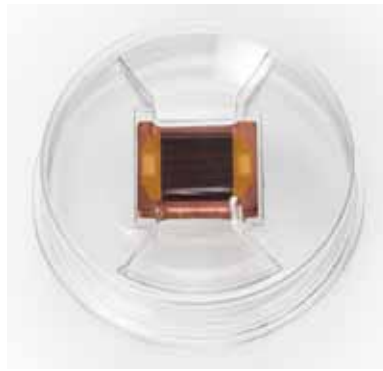


Figure 1-11. Individual Packaged OEM Detector

Figure 1-12 shows the dimensions for the OEM detectors. The notch on the top of the back side identifies the negative end of the element and must be placed in the appropriate position in the sensor (see p. 3-12 for instructions).

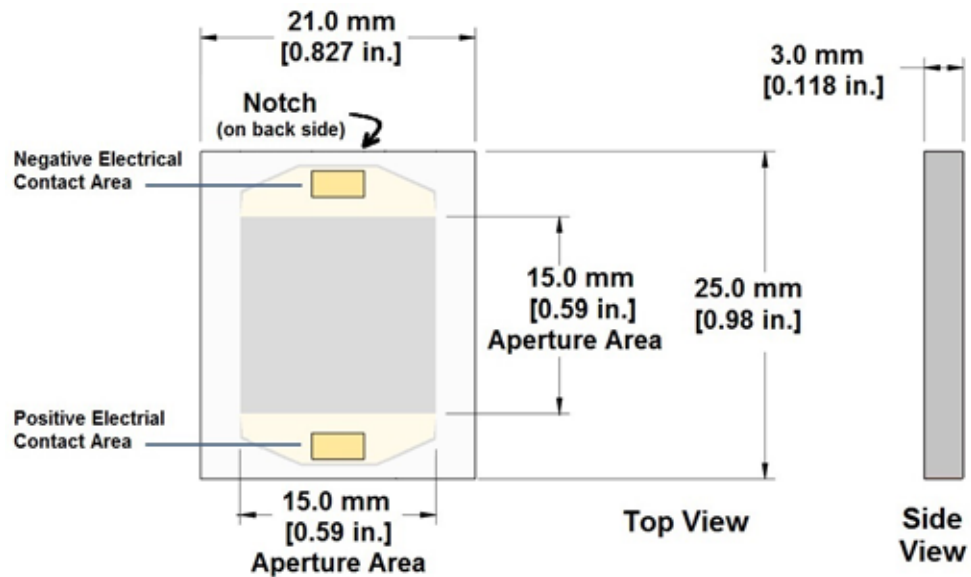


Figure 1-12. Dimensions — OEM Detectors

Standard Accessories

Each of the PowerMax-Pro 15mm Sensor Developer's Kits ship with the following standard accessories:

- Heat Sink
- A post, stand, and base to mount the sensor to an optical table or other flat surface
- Protective Dust Cap
- Pass-Thru Circuit Board (to replace the Amplifier Circuit Board in the sensor)

For set-up and installation instructions, see "Section Two: Set Up the Sensor" (p. 2-1).

Heat Sink for Sensor

The mounting of any laser is important to increase the stability of the beam over time and temperature. A Heat Sink provides correct thermal dissipation and mechanical positioning.



IMPORTANT!

The PowerMax-Pro 15mm Sensor requires a Heat Sink because the base plate of the sensor is cooled by conduction. The sensor must be sufficiently heat sunk or could be damaged.

Figure 1-14 shows the Coherent Heat Sink (P/N 1377945) shipped in each Developer’s Kit. Although OEMs can create their own Heat Sign, this 15 mm square Heat Sink is custom designed for the PowerMax-Pro 15mm Sensor, and is included in the Developer’s Kit.



Figure 1-13. Heat Sink for Sensor

Figure 1-14 shows the dimensions for a Heat Sink from the side that attaches to the sensor Mount. For instructions about how to set up the sensor with a Heat Sink, see “Step 2: Attach the Heat Sink (Optional)” (p. 2-6).

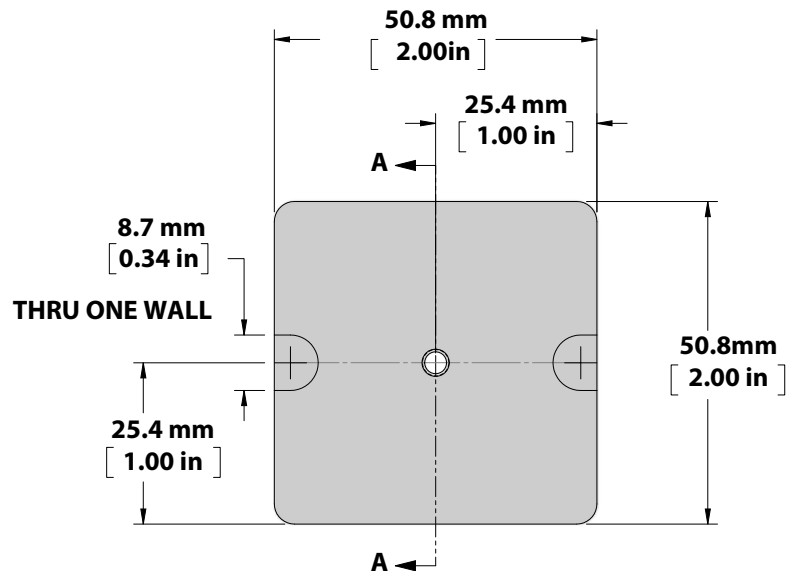
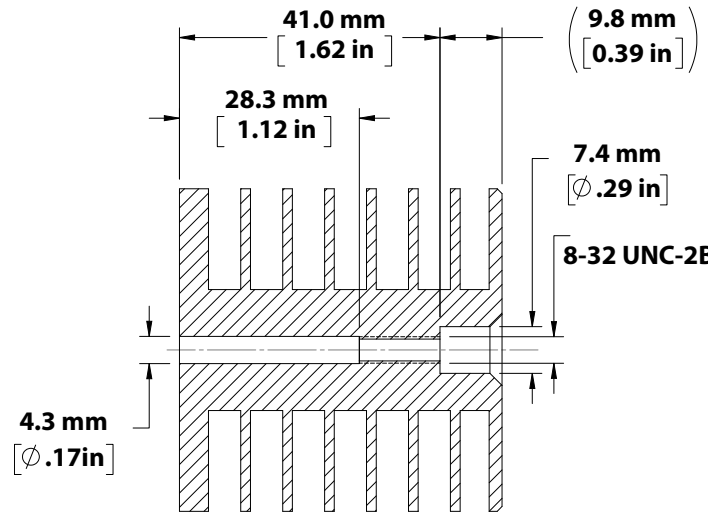


Figure 1-14. Heat Sink for the 15 mm Sensor

Figure 1-15 shows the dimensions for a Heat Sink from the side view of the Heat Sink.



SECTION A-A

Figure 1-15. Heat Sink — Side View

Optical Mounting Base and Post

A Post and Stand Assembly, P/N 1111302) is shipped with the PowerMax-Pro 15mm Sensor, and includes:

- Optical Post
- Optical Post Holder, 3.0" [75 mm]
- Optical Base, 2" X 3" X 3/8"
- Screws for the Base – Socket Head Cap, Hex Socket Drive, 1/4-20 x 0.375"L, Steel, Black Oxide

Figure 1-16 shows the parts for the post and stand assembly (see p. 2-8 for assembly instructions).

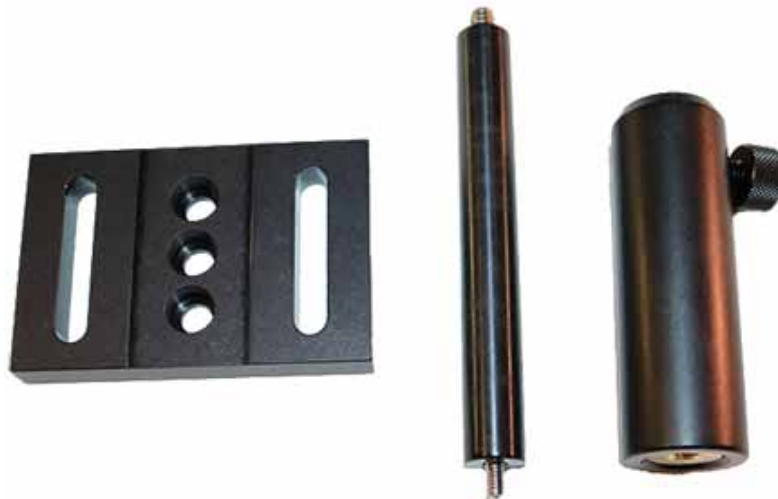


Figure 1-16. Post-and-Stand Base

Figure 1-17 shows the Optical Post that is attached to the sensor—one end is an 8-32 thread and the other is a 1/4-20 thread. Note that the 1/4-20 threaded end of the post does not connect to anything, but simply slides into the Optical Post Holder.



Figure 1-17. Optical Post

The end of the post with the 8-32 thread screws into the sensor housing marked 8-32 (see Figure 1-18). There is no connection from the post to the M4 threaded connector on the sensor housing.



Figure 1-18. Sensor Post Mount Options

Figure 1-19 shows the dimensions for the Optical Base.

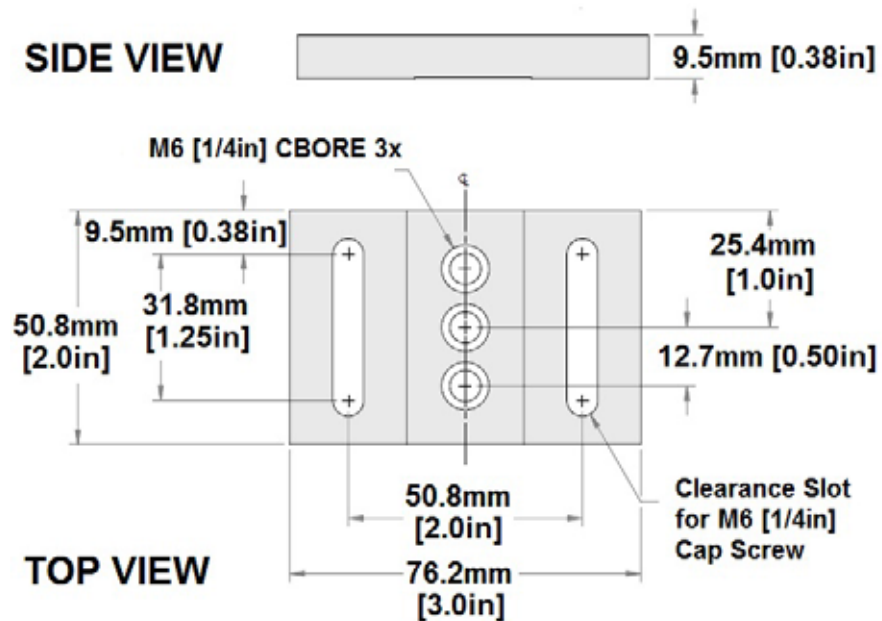


Figure 1-19. Dimensions — Optical Base

The Optical Base is attached to the Optical Post Holder using a socket cap screw that fits within a clearance hole on the bottom of the post holder. The base is compatible with either Imperial or Metric tables, posts, and post holders.

Figure 1-20 shows the dimensions for the Optical Post Holder from the side view.

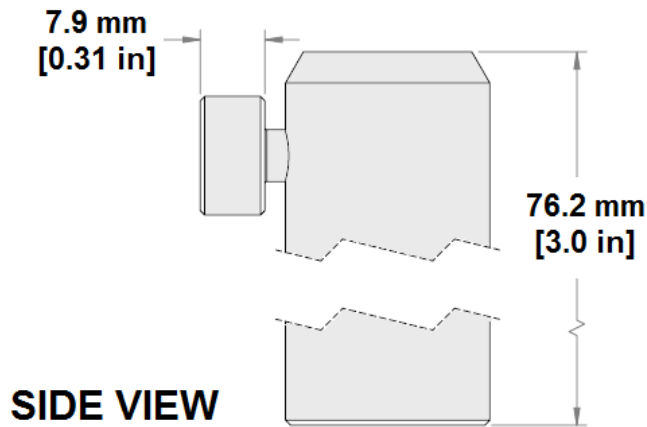


Figure 1-20. Dimensions, Side View — Optical Post Holder

Figure 1-21 shows the dimensions for the Post Holder from the top view.

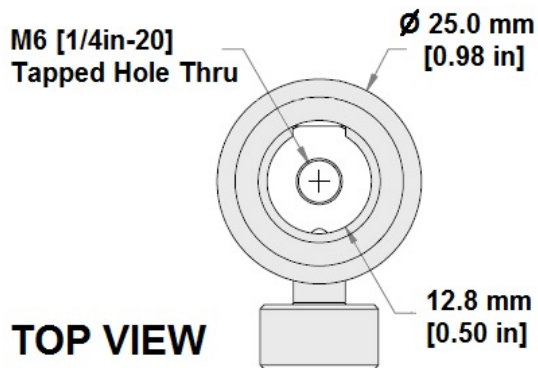


Figure 1-21. Dimensions, Top View — Optical Post Holder

Figure 1-22 shows the dimensions for the Optical Post that screws into the sensor housing mount. See “Attach Sensor to a Post-and-Stand” (p. 2-8) for details about how to set up the post and stand and attach to the sensor.

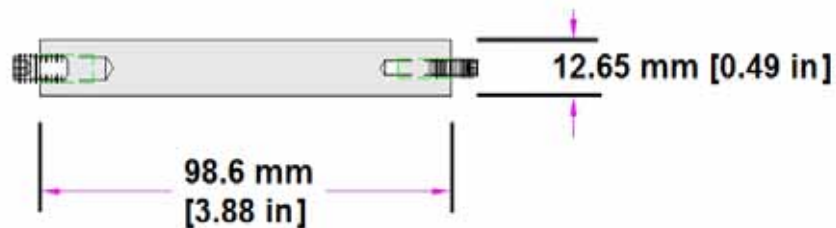


Figure 1-22. Post to Mount Sensor

Protective Dust Cap

The use of a Protective Dust Cap is critical for maintaining the sensitivity of the sensor and accuracy of measurements.

In general, use the Protective Dust Cap when the sensor is being stored and not in use to avoid any debris in the environment from contaminating the detector.

This is **highly recommended** when:

- The sensor is used in processing equipment
- Any environment where dust and debris is produced

The Protective Dust Cap (shown in Figure 1-23) is shipped with the PowerMax-Pro 15mm Sensor. Note the tabbed edges on all four sides that fit the surface like a cap.



Figure 1-23. Protective Dust Cap



CAUTION!

If dust or debris has collected on the sensor, it is recommended that you use an Air Puffer (see p. 3-3) or compressed nitrogen to gently blow particulates off the sensor before using. Failure to do so can cause damage the sensor when particulates are burned onto the detector element when hit by a laser beam.

Figure 1-24 shows the dimensions for the Protective Dust Cover that is shipped with the PowerMax-Pro 15mm Sensor sensor.

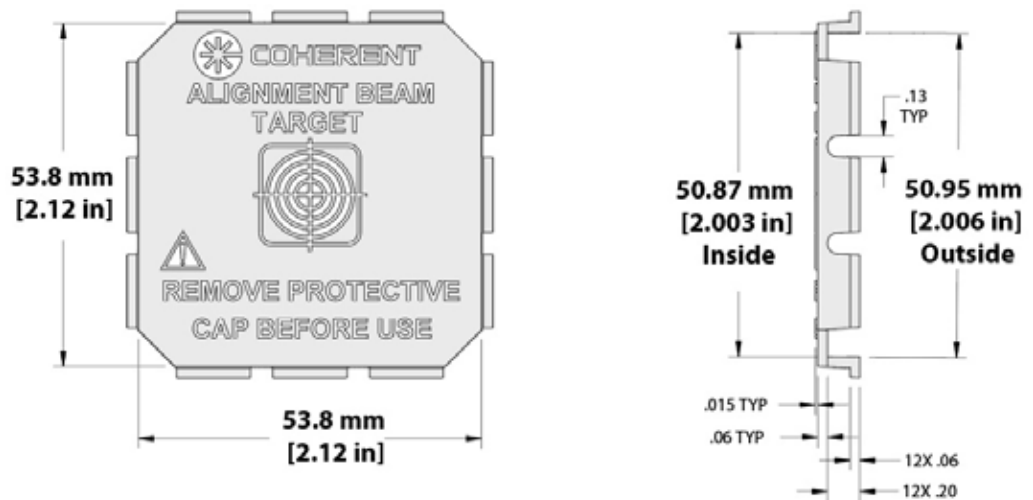


Figure 1-24. Dimensions — Protective Dust Cap

Remember to periodically check the sensor for dust and contaminants; see “Inspect and Clean the Sensor” (p. 3-4).

Circuit Board

Two different circuit boards are part of each Development Kit, one already inside the sensor and another to swap out.

- An **Amplifier Circuit Board** (shown in Figure 1-25), which amplifies the signal and provides a calibrated output. The Amplifier Board is *already installed* in the sensor shipped in the Development Kit. The sensor has been tested and calibrated at the factory.

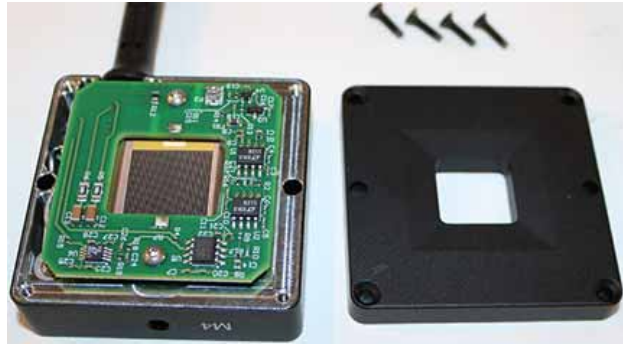


Figure 1-25. Amplifier Circuit Board

- A **Pass-Thru board** (shown in Figure 1-26), an additional Circuit Board with an SMB connector, that is included in the shipping box. This board is used to measure the raw element. This board is NOT calibrated. Developers can use the Pass-Thru Circuit Board to test a raw signal with their system or replace a circuit board in the sensor with an amplifier circuit board of their own design.



Figure 1-26. Pass-Thru Circuit Board (Front and Back)

See “Install a Pass-Thru Circuit Board” (p. 3-9) for instructions about how to remove the Amplifier Circuit Board and replace it with the Pass-Thru Circuit Board.

Specifications

This section lists various specifications for a PowerMax-Pro 15mm Sensor in the Development Kit.

Sensor Specifications

Table 1-4 lists the general specifications for each of the Developer’s Kits. The Unpatterned (UP) detectors are recommended only for use with small beams < 2 mm diameter in fixed installations with minimal beam movement.

Table 1-4. PowerMax-Pro 15mm Sensor Specifications

	POWERMAX-PRO 15 MM HD DEVELOPER'S KIT	POWERMAX-PRO 15 MM BB DEVELOPER'S KIT	POWERMAX-PRO 15 MM UP DEVELOPER'S KIT
PARAMETER	1342383	1382766	1342384
Wavelength Range	400 nm to 1100 nm 9 μ m to 11 μ m	400 nm to 11 μ m	400 nm to 1100 nm 9 μ m to 11 μ m
Sensor Active Area	15 x 15 mm		
Detector Coating	HD	BB	UP
Rise and Fall Time	≤ 10 us	75 us (30 to 70 us typical)	≤ 10 us
Minimum Beam Size	2 mm	2 mm	Damage threshold dependent
Calibration Wavelength	1064 nm		
Calibration Uncertainty	$\pm 2.5\%$ (k=2)		
Spectral Compensation Accuracy	$\pm 3\%$		
Spatial Uniformity (center 70% of aperture; 2.5 mm beam)	$\pm 5\%$ $\pm 3\%$ Typical	$\pm 5\%$ $\pm 3\%$ Typical	$\pm 3\%$ (within 5 mm x 5 mm central area; 2.5 mm beam)
Thermal Drift	+/-1 mW in a typical industrial lab environment		

Power and Energy Specifications

Table 1-5 lists the power specifications for the PowerMax-Pro 15mm Sensor:

Table 1-5. Power Specifications

SPECIFICATION	VALUE
Average Power Range (Continuous)	2.5 mW to 5 W; up to 9W with a Heat Sink
Maximum Modulated Peak Power (use for >1 usec pulses up to CW)	9 W (adjustable by changing amplifier gain)
Maximum Intermittent Average Power (<5 minutes with no Heat Sink)	9 W (adjustable by changing amplifier gain)
Maximum Average Power Density	25 W/cm ² with no Heat Sink
	50 W/cm ² with Heat Sink
	300 W/cm ² with water-cooled Heat Sink (customer supplied)
Maximum Peak Power Density	14 kW/cm ²
Maximum Energy Density	33 mJ/cm ² (10 ns; 1064 nm)
Power Linearity	$\pm 2\%$
Maximum Temperature for OEM Detectors	60°C
Noise Equivalent Power: <ul style="list-style-type: none"> • Standard Mode (10 Hz) • High-Speed Mode (20 kHz) • Snapshot Mode (625 kHz) 	<ul style="list-style-type: none"> • <50 μW • <550 μW • <6 mW

If your laser emits more than the maximum rated power, following are some options:

- Where you want to measure a high-power laser and not to sample the beam, the best option is to buy a sensor rated to handle a higher power level. Coherent currently offers 150 W, 1 kW, and 3 kW models.
- Where you want to continuously sample a low-power pick-off of a much higher power laser, install a beamsplitter so that only a portion of the main beam hits the detector.
- Where you want to use the Developer’s Kit sensor or the OEM detectors at power levels >9 W for some reason (perhaps because of the compact size), then contact Coherent for technical advice and support. In this situation, you must supply a water-cooled Heat Sink assembly and mount it to the back of the assembly (in place of the finned Heat Sink that we provide).

Physical Specifications and Handling

Table 1-6 lists physical specifications for the PowerMax-Pro 15mm Sensor:

Table 1-6. Physical Specifications

SPECIFICATION	VALUE
Cable Type	DB-25
Cable Length	2.5 m (8.2 ft)
Cooling Method	Air (Convective)
Operating Environment	5° to 40°C Non-condensing Humidity

Environmental Storage

Most Coherent sensors are designed to operate from 5° to 40°C during normal operation. These sensors can be stored at normal room temperature.

Relative humidity (dependent on the room temperature, air flow and circulation) is not critical for these sensors. However, you should ensure that humidity is never allowed to condense or allow moisture build or collect on the sensor surfaces. This can degrade the sensor over time.

Mechanical Storage

When the sensor is not in use, it is strongly recommended that you always cover the sensor to keep dust, dirt, and debris from collecting on the sensor.

When the sensor is not in use:

- Add the Protective Dust Cap shipped to the sensor to protect from inadvertent damage to the surface from dust and debris any time the sensor is not in use.
- If the sensor will not be used for an extensive amount of time, or if the environment has a higher amount debris, place the sensor in a bag to keep debris off the sensor.

All cables should have minimum 6” to 8” in coil loops to keep from binding, bending, or otherwise pinching and breaking down the wires. Such actions can cause premature failure. Whenever possible, wrap the cables in their natural coil or roll.

Store items in original boxes to protect them from accidental drops and damage from stacking.

SECTION TWO: SET UP THE SENSOR

This section describes how to unpack and set up the PowerMax-Pro 15mm Sensor Developer's Kit. This lets you perform a quick check of how the sensor works with an OEM system.

The PowerMax-Pro 15mm Sensor Developer's Kit (P/N 1382766) is used as an example in this chapter. The process is the same for other Developer's Kits.

Set-up activities should be done in a clean environment under normal humidity and temperature conditions (see p. 1-16).

This section describes the following steps:

- “Step 1: Unpack the Shipping Box” (p. 2-3)
- “Step 2: Attach the Heat Sink (Optional)” (p. 2-6)
- “Step 3: Mount the Sensor (Optional)” (p. 2-7)
- “Step 4. Connect the Sensor to a Meter” (p. 2-10)
- “Step 5: Take a Test Measurement” (p. 2-12)

In addition, remember to periodically check the sensor for dust and contaminants; see “Inspect and Clean the Sensor” (p. 3-4).

Before You Begin

Before you begin set-up, first gather the necessary tools and equipment, then inspect the shipping box and unpack the contents.

Ensure that the work environment is generally clean and free of dust and particulates as much as possible (see p. 1-16 for specifications).

Safety and Handling Precautions

This section describes the precautions you should take and the ways in which you should work with the sensor.

ESD Precautions

Particularly when handling a bare OEM detector element, use precautions to deal with Electrostatic Discharge (ESD):

- Wear appropriate ESD protective equipment (smocks, heel or wrist straps, and so on as required by your organizations policies and procedures).
- All ESD sensitive electronic components or assemblies must be stored in or transported in HDPE Static Dissipative containers.
- Static-sensitive parts or assemblies must be bagged only in the metal impregnated (shiny gray) bags. NEVER use pink anti-static bags as they are a potential source of contamination that may impact life of the laser.

Laser Safety

Remember to always follow laser safety precautions in a laser environment:

- Refer to “Appendix A: Safety and Compliance” to learn about required safety precautions when working with lasers.
- Refer to “Appendix B: Laser Back Reflection” to prevent damage or noise caused by back reflection.

NO Contact with Sensor

Keep sensors in a clean environment to extend the lifetime and accuracy of the product. Any significant changes in the color of the absorbing disk due to contaminants can lead to changes in the absorption properties of the sensor, thus degrading accuracy.

Use extreme care in working with the OEM detector. These are **no-contact sensors**. Any contact with the surface of the detector can negatively affect the longevity and accuracy of the sensor.

- **Always** wear protective powder-free nitrile or latex gloves or finger cots when working with the OEM detector.
- **Never** touch the active area of the OEM detector, which can deposit natural oils from your fingertips onto the surface.



WARNING!

Do NOT probe the sensor!

Traditional practices when evaluating technology often use a probe to measure resistance; however, doing so will damage the sensor.

The thin-film electrode in the PowerMax-Pro 15mm Sensor easily shorts to the substrate when probed.



Figure 2-1. WARNING: Do NOT Probe the Sensor!

- PowerMax-Pro sensors have special coatings. **Never use any solvent or liquid solution** on the coating of the sensor.
- **Do not use any type of cloth, tissue, swab**, or similar material that could leave lint behind.
- **Do not place sharp items or tooling on or near the sensor surface** as these may puncture the surface layer. That damage results in inaccurate readings.

Avoid Debris

It is important to prevent dust, debris, and other contamination from getting inside the sensor cavity. Contamination can cause changes in sensitivity to the sensor to become burned onto the surface of the element.

- Start any work on the sensor with a **clean work surface**.
- Only use a **clean and dry air supply** or compressed nitrogen for cleaning. Avoid applying excess air pressure to the sensor during cleaning. Instead, use only an air puffer or compressed nitrogen to clean dust or particulates off of the sensor to avoid introducing additional problems by spraying oil or other contaminants along with the air supply.

For instructions about cleaning, see “Inspect and Clean the Sensor” (p. 3-4).

Tools and Equipment for Set-Up

Gather the following items; note the ones that are shipped with the Development Kit for the PowerMax-Pro 15mm Sensor.

- A hex driver, included in the Kit
- A torque screwdriver or holder for the T6 Torx Bit (1/4" Hex Shank, 1" Long), included in the Kit
- Small, flat-tip screwdriver
- An air puffer to clean dust or particulates off of the detector

Step 1: Unpack the Shipping Box

This section provide general instructions about how to receive and unpack the shipping box. The contents of the shipping box vary, depending on the model ordered; see "Developer's Kits" (p. 1-5) for list of available sensor kits and accessories

Receive and Inspect

After you receive your order, immediately inspect the shipping boxes for any indication of damage.

If you see any damage, document these discrepancies on the packing list. Also immediately contact both the shipping carrier and either an authorized Coherent representative or the Coherent Order Administration Department, as follows:

- Inside the USA: 1-(800)-367-7890
- Outside the USA: 1-(408)-764-4557



NOTICE!

After unpacking the sensor and any options or accessories, save the shipping box and all packing materials. These materials are required later for safe transport of the sensor should you need to ship it to another location.

Unpack the Shipping Box

The packing contents in the shipping box may vary by each Kit. All Kits include the following components:

- PowerMax-Pro 15mm Sensor with an attached DB-25 connector
- Protective Dust Cap
- Heat Sink and screw
- Optical post-and-stand base, post, post holder (optional for mounting)
- Tools (Hex wrenches and a T6 bit)

As you unpack components, retain all shipping materials for times when you may need to ship the sensor to another location.

1. Open the shipping box, shown in Figure 2-2.



Figure 2-2. Shipping Box

2. Remove the foam-backed cardboard inset, shown in Figure 2-3.



Figure 2-3. Remove Foam Insets

3. Remove the top foam layer to reveal important paperwork for the sensor, shown in Figure 2-4. Remove the documentation and retain for your records.



Figure 2-4. Certificate of Calibration and other Documents

Documentation includes the following:

- Certificate of Calibration with the serial number, compliance, and calibration information specific to that sensor
- CE Declaration of Conformity
- China RoHS 2 compliance
- Warranty

Figure 2-5 shows how the components are packaged in the shipping box:



Figure 2-5. Shipping Box Contents

4. Unpack the contents of the kit. The Post Holder, Stand, and Base are packed in the slots towards the back of the shipping box. Lift out the pink poly bags that contains the sensor assembly, the Heat Sink, tools, Pass-through Circuit Board, and thermal/gap pads, as shown in Figure 2-6.



Figure 2-6. Unpack and Lay Out All Components

5. Open the pink poly bags, remove all components, and place on a clean, dry surface. Verify that all parts (shown in Figure 2-7) are available for set-up.

The following tools and accessories are also included in the Kit:

- Protective Dust Cap
- Post and Stand
- T6 bit
- Allen wrenches



Figure 2-7. All Components Unpacked

Step 2: Attach the Heat Sink (Optional)

The Heat Sink is required only for certain power levels—identified in “Power and Energy Specifications” (p. 1-15)—so the requirement for a Heat Sink may be optional, depending on your equipment and application.

A Coherent Heat Sink designed for this sensor is shipped in the Developer’s Kit.

To attach the Heat Sink to the Sensor:

1. Place the Heat Sink on the sensor housing mount, with the Coherent brand on the housing facing the flat surface of the Heat Sink,.
2. Align the Heat Sink with the sensor so that the two cut-outs on sides of the flat surface of the Heat Sink align with the holes on the side of the sensor housing, as shown in Figure 2-8:

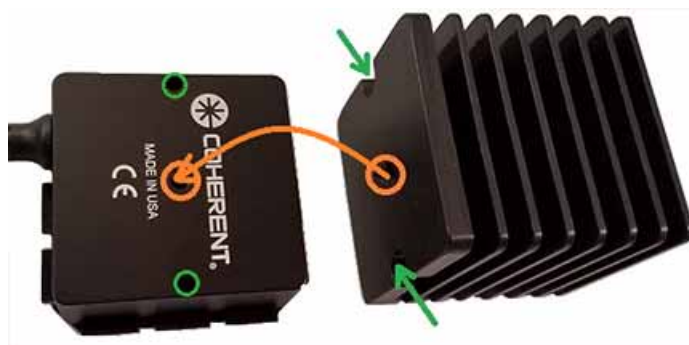


Figure 2-8. Align Heat Sink

3. Note there is a Modular Pyro, Modified Screw (1.75” long) already inserted into the center of the Heat Sink. Hand tighten this center screw, as shown in Figure 2-9:
4. Using the hex wrench, torque the screw to 3 in-lb., 48 in-oz., or 0.34 newton-meter.



Figure 2-9. Attach Heat Sink

Step 3: Mount the Sensor (Optional)

This section describes how to mount the PowerMax-Pro 15mm Sensor, either:

- Directly attach the sensor to a flat surface, such as a bench or optical table.
- Mount the sensor on a post and stand in a vertical orientation.

The sensor can also be mounted into a customized OEM system.

Attach Sensor Directly to a Flat Surface

The PowerMax-Pro 15mm Sensor has been machined to allow a through-mount of the sensor to a flat surface.

Select the appropriate hardware to fixture the sensor in place for your application. The screws that you use are dependent on the flat surface—and includes such factors as the size of the hole, the thread pitch, the frame and/or the clamping mechanism selected.

Figure 2-10 shows the pre-drilled holes in the Sensor Housing mount, viewed from the bottom:



Figure 2-10. Sensor Housing Mount Drill Holes

To attach the Sensor to a flat surface:

1. Place the Mounting Plate on a flat surface that has been pre-drilled with holes that align with the sensor housing mount.

2. Insert screws through the mounting holes in the Sensor housing and into the pre-drilled holes on the flat surface.
3. Tighten to secure to the flat surface.

Attach Sensor to a Post-and-Stand

This section describes how to attach the PowerMax-Pro 15mm Sensor in a vertical orientation to a Post and Stand Assembly (P/N 1111302), shipped in the Developer's Kit for the PowerMax-Pro 15mm Sensor, which includes:

- Optical Post, equipped with two Hexagon socket set screws (one 8-32 x 1/2", one 1/4-20 x 1/2")
- Optical Post Holder, 3.0" [75 mm], Stainless steel
- Optical Base, 2" X 3" X 3/8"
- Screws for the Base – Socket Head Cap, Hex Socket Drive, 1/4-20 x 0.375"L, Steel, Black Oxide

To attach a post to the sensor:

1. Select the post to mount the sensor. Notice that each end has a different Hex socket screw size—select the 8-32 x 1/2" threaded end. This matches the 8-32 threaded hole on the sensor housing shown in Figure 2-11:



Figure 2-11. Sensor Post Attachment Option

Notice the orientation of the Sensor Mount on different ends of the sensor housing. Because of this, the Heat Sink also has a different orientation, depending on how the Sensor is mounted to the post and stand.

2. Insert the post into the selected end of the sensor, as shown in Figure 2-11, and hand tighten, then hand torque to secure.



Figure 2-12. Attach Post Holder to Sensor

3. Set aside the sensor with post attached while you assemble the remaining parts of the post-and-stand assembly. Keep the protective dust cover in place when the sensor is stored or not in use.

The optical base mounting plate (shown in Figure 2-12) is attached to a flat surface.



Figure 2-13. Optical Base Mounting Plate

4. Holding the assembly of the sensor and post firmly, align the post with the threaded hole in the optical base mounting plate.
5. Tighten the set screw on the post holder to secure the inner post and stabilize the sensor.

Attach the stand to a flat surface (optional):

1. Attach the optical base mounting plate to a flat surface (such as an optical table) using hardware designed for your fixture.
2. Tighten to secure.

Figure 2-14 shows two examples of the sensor and assembled post and stand:

- A sensor with no Heat Sink attached
- A sensor with the Heat Sink already attached to the sensor



Figure 2-14. Sensor on Post-and-Stand Assembly

Step 4. Connect the Sensor to a Meter

Coherent recommends using the PowerMax-Pro 15mm Sensor with the LabMax-Pro SSIM meter, shown in Figure 2-15.



Figure 2-15. LabMax-Pro SIMM Meter

This combination provides “instant” power readings on, and allows you to view temporal pulse shapes $> 100 \mu\text{sec}$ pulse width and $> 10 \text{ kHz}$ PRF. For more information, see:

<https://www.coherent.com/measurement-control/measurement/laser-power-and-energy-meters/labmax-pro-ssim>



CAUTION!

Observe all Laser Safety protocols; see “Appendix A: Safety and Compliance”.

The PowerMax-Pro 15mm Sensor is an amplified sensor that requires power, which is sent to the sensor from a meter through the DB-25 connector. The cord for the DB-25 connector is fixed (permanently secured to the PowerMax-Pro 15mm Sensor). This cable and connector cannot be removed or unplugged from the sensor, and has a strain relief section where the cable is attached to the sensor.

To connect the sensor to the meter:

1. Attach the DB-25 connector from the PowerMax-Pro 15mm Sensor to the LabMax-Pro SSIM meter, as shown in Figure 2-16.



Figure 2-16. Connect the Sensor to the Meter

2. Gently tighten the thumb screws to secure the connector to the meter.
The cable for the DB25 connector is attached already to the sensor housing.
Figure 2-17 shows an example of the identification tag showing the item, model, and serial number is attached to the cable. This identification tag may be moved up or down the length of the cable for your convenience as you position the equipment.



Figure 2-17. Identification Tag on Sensor Cable

It is strongly recommended that you do NOT remove the Identification tag from the sensor cable.

3. Connect a cable from the LabMax-Pro SSIM Meter to a personal computer.
4. Go to the section “Step 5: Take a Test Measurement” (p. 2-12) for instructions about taking a measurement.

Optional Mobile App

There is also a Mobile App for the LabMax-Pro SSIM meter that can be used with tablets or mobile phones with the PowerMax-Pro 15mm Sensor. Figure 2-18 shows the sensor connected to an Android-based tablet.



Figure 2-18. LabMax-Pro Mobile App

When used with the Mobile App, you can connect using USB, WiFi, or a corporate WiFi network and view high-resolution snapshot data. In addition, these tools and applications allow you to save, import, and export data. For more information, see:

<https://www.coherent.com/measurement-control/measurement/labmax-pro-mobile-app>

Step 5: Take a Test Measurement

For highest accuracy, the measured beam should be aligned so that it is centered in the front aperture of the sensor and perpendicular to the front aperture plate surface. The alignment target on the protective dust cap and the geometry of the sensor mount can be used to square and center the beam.



CAUTION!

While the Sensor housing cover can be used for preliminary alignment, it is not designed to absorb laser energy.

To take a test measurement:

1. Remove the protective Dust Cap before Turn on the LabMax-Pro SSIM Meter.

When starting up from a cold start, there is some warm-up to electronics to consider:

- For the best accuracy, the magnitude of the error would depend on how much power you are measuring and how long are you measuring it for. If you are looking for an instant measurement of watts, there will be very little effect.
- If you are starting a 30-minute test run in the mW power level, the best practice would be to allow the instrument to be powered on for 15 minutes, then zero the settings, then start your measurement.

To take a test measurement (continued):

2. Direct the laser beam so that it is perpendicular to the PowerMax-Pro 15mm Sensor. That is, the incoming beam should be perpendicular to the front aperture plate surface.
3. Center the beam in the front aperture on the sensor.
4. Remove the Protective Dust Cap before firing the laser beam at the sensor.
5. Take the measurement.
6. Immediately replace the Protective Dust Cap. Remember to keep the Cap intact while checking measurements.
7. Remove the cap before firing the laser again.
8. Review the results of the measurement, and repeat as necessary.

Next Steps

If you want to make changes to the Developer's Kit, such as installing the Pass-Through Circuit Board, go to "Section Three: Disassemble the Sensor" (p. 3-1). If you want to customize a sensor for your system, go to "Section Four: Design Integration" (p. 4-1).

SECTION THREE: DISASSEMBLE THE SENSOR

The PowerMax-Pro 15mm Sensor, shown in Figure 3-1, is designed to be modular for engineering and testing purposes. Developers can take apart the sensor and reconfigure it for use with their system and unique application.



Figure 3-1. Assembled PowerMax-Pro Development Kit 15 mm Sensor

This section describes how to disassemble and reassemble the sensor when a developer chooses to:

- Remove the amplifier circuit board installed in the sensor and replace it with either the Pass-through circuit board (provided in the Developer’s Kit) or with a circuit board of another design.

Replace the OEM detector in the Developer’s Kit with a different type of OEM detector.

It’s important to follow instructions about how to tighten screws, protect from Electrostatic Discharge (ESD), replace the thermal or gap pad, and install the sensor in the correct orientation.



IMPORTANT!

Failure to carefully follow instructions could result in damage to the sensor assembly. This may occur when making contact with the OEM detector or thermal contact pad, installing the OEM detector backwards or not in the correct orientation, incorrectly installing screws, and so on.

Refer to “Appendix A: Safety and Compliance” to learn about required safety precautions when working with lasers.

The PowerMax-Pro 15mm Sensor Developer's Kit (P/N 1382766) is used as an example in this chapter. However, the process to disassemble a sensor is the same for all PowerMax-Pro 15mm Sensor Developer's Kits.



IMPORTANT!

A factory calibration sticker is applied to the side of the sensor. If the sensor is disassembled, the calibration is invalid.

Before You Begin

Before you begin the process to disassemble and/or reassemble the sensor:

- Gather the necessary tools and equipment
- Ensure that the work environment is clean and free of dust and particulates.

Tasks described in this section should be done in a clean environment under normal humidity and temperature conditions (see p. 1-16 for specifications).

Tools and Equipment

Gather the following items, as shown in Figure 3-2:



Figure 3-2. Tools Required to Disassemble the Sensor

Some tools are shipped in the Development Kit for the Sensor.

- Torx T6 Bit, 1/4" Hex Shank, 1" Long, used to remove screws for the cover, circuit board, and frame; provided in the Kit.
- Torque driver (**not** shipped with the Kit) to use with the Torx T6 bit (in the Kit)
- Hex wrenches (included in the Kit) used to remove or replace the Heat Sink
 - 9/64" Hex Key
 - 3/16" Hex Key
- Small, flat-tip screwdriver (**not** shipped with the Kit), used to leverage the OEM detector out of the housing mount.

In addition, you will also need:

- Powder-free nitrile or latex gloves or finger cots – always use gloves or finger cots when working with the OEM detector.
- A source for clean, dry air or compressed nitrogen to clean dust or particulates off of the sensor, such as an Air Puffer, as shown in Figure 3-3. This is a rubberized bulb that creates air pressure based on a squeezing motion. The air flow can gently dislodge debris that may have landed on the surface of the sensor.



Figure 3-3. Air Puffer to Remove Dust Particles

Precautions and Best Practices

This section describes the precautions you should take and the ways in which you should work with the sensor.

ESD Precautions

Precautions to deal with Electrostatic Discharge (ESD) include:

- Wear appropriate ESD protective equipment (smocks, heel or wrist straps, and so on as required by your organizations policies and procedures).
- All ESD sensitive electronic components or assemblies must be stored in or transported in HDPE Static Dissipative containers.
- Static-sensitive parts or assemblies must be bagged only in the metal impregnated (shiny gray) bags. NEVER use pink anti-static bags as they are a potential source of contamination that may impact life of the laser.

Laser Safety

When working with the sensor in a laser environment, always be aware of laser safety precautions:

- Refer to “Appendix A: Safety and Compliance” to learn about required safety precautions when working with lasers.
- Refer to “Appendix B: Laser Back Reflection” to prevent damage or noise caused by back reflection.

Avoid Debris

It is critical to prevent dust, debris, and other contamination from getting inside the sensor cavity and onto the OEM detector. Contamination can cause changes in sensitivity to the sensor or become burned onto the surface of the OEM detector.

- Start any work on the sensor with a **clean work surface**.
- Only use a **clean and dry air supply** or compressed nitrogen. Avoid applying excess air pressure to the sensor during cleaning. Instead, use an air puffer or compressed nitrogen to clean dust or particulates off of the OEM detector to avoid introducing additional problems by spraying oil or other contaminants along with the air supply.

NO Contact with Sensor

Keep sensors in a clean environment to extend the lifetime and accuracy of the product. Any significant changes in the color of the absorbing disk due to contaminants can lead to changes in the absorption properties of the sensor, thus degrading accuracy.

Use extreme care in working with the OEM detector. These are **no-contact sensors**. Any contact with the surface of the sensor can negatively affect the longevity and accuracy of the sensor.

- **Always** wear protective powder-free nitrile or latex gloves or finger cots when working with the OEM detector.
- **Never** touch the active area of the OEM detector, which can deposit natural oils from your fingertips onto the surface.



WARNING!

Do NOT probe the sensor!

Traditional practices when evaluating technology often use a probe to measure resistance; however, doing so will damage the sensor. The thin-film electrode in the PowerMax-Pro 15mm Sensor easily shorts to the substrate when probed.



Figure 3-4. WARNING: Do NOT Probe the Sensor!

- PowerMax-Pro sensors have special coatings. **Never use any solvent or liquid solution** on the coating of the sensor. The coating's porous nature breaks down with solvents, resulting in corrosion or long-term damage.
- **Do not use any type of cloth, tissue, swab,** or similar material that could leave lint behind.
- **Do not place sharp items or tooling on or near the sensor surface** as these may puncture the surface layer. That damage results in inaccurate readings.

Inspect and Clean the Sensor

Dust in the atmosphere can deposit onto the surface of the exposed OEM detector. When irradiated by a high-power beam, dust can burn and cause damage to the sensor surface.

Before you begin, inspect the OEM detector to ensure there is no dust on the OEM detector. Any dust or contaminants can result in damage to the sensor.

This procedure should be periodically repeated to ensure optimal operation.

To inspect the OEM detector:

1. Always turn off any laser sources before you begin the inspection of the optical port and OEM detector. Follow all laser safety practices (see “Appendix A: Safety and Compliance”).
2. Wear protective powder-free nitrile or latex gloves or finger cots to work with the OEM detector.
3. Remove the Protective Dust Cap and store it in a clean resealable bag to avoid contamination of the Dust Cap.
4. If dust or debris has settled on the sensor coating, the safest cleaning method is to use an air puffer or compressed nitrogen.



IMPORTANT!

Do not touch the OEM detector with your finger or any object.

Do not use any dry products to clean the OEM detector, including a tissue, swab, or cleaning fabric.

Do not use any wet products to clean the OEM detector, including alcohol or any wet cleaning solution.

5. Replace the Protective Dust Cap on the sensor as soon as possible.

Disassemble the Sensor

After unit is disassembled and reassembled the Coherent calibration is invalidated.

Figure 3-5 shows a breakout diagram for components in the sensor assembly. It's important to disassemble and reassemble the sensor in the order and orientation described in the following instructions.

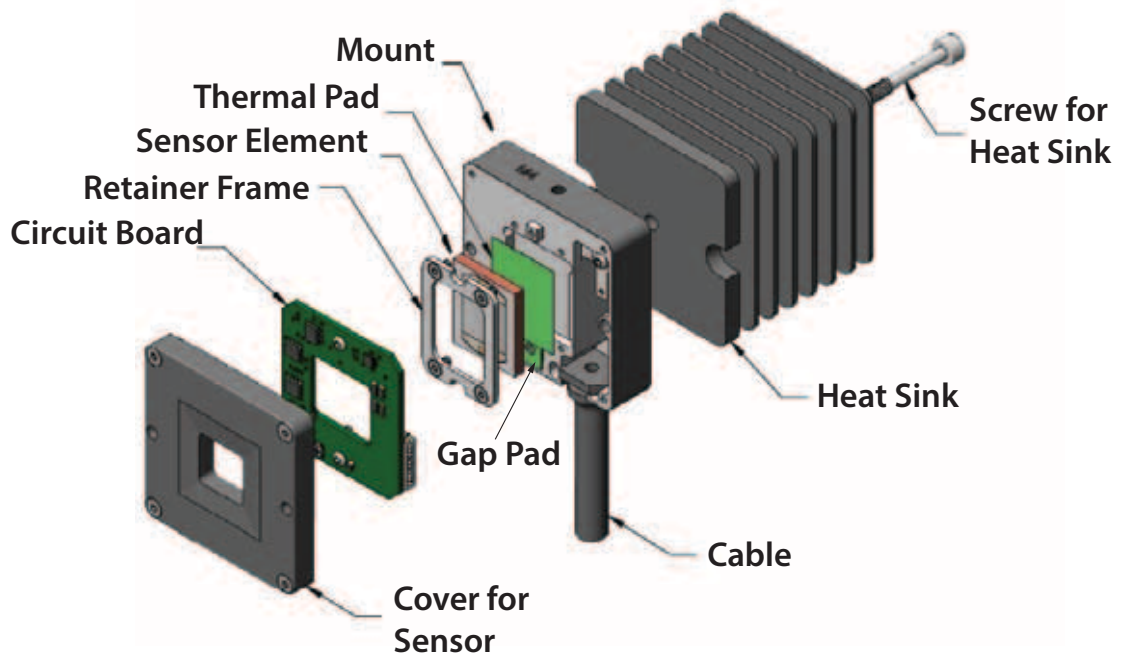


Figure 3-5. Breakout Diagram — PowerMax-Pro 15mm Sensor

To disassemble the sensor:

1. Remove the sensor from the post and stand or any other mounting device.
2. Place sensor on a clean, flat surface.
3. Unscrew the Heat Sink from the Sensor for easier handling and set aside.
4. Remove the Protective Dust Cap on the sensor and set aside.
5. Use a Torx-bit driver to unscrew the four (4) flat-head screws from each corner of the cover of the sensor, as shown in Figure 3-6.

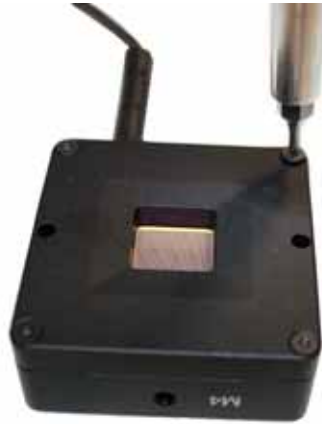


Figure 3-6. Unscrew the Sensor Cover

6. Lift off the cover and set aside. This exposes the Amplifier Circuit Board, installed in the sensor before the Development Kit is shipped.
7. Unscrew two (2) button-head Torx-drive Stainless Steel screws for the circuit board, as shown in Figure 3-7. Set screws aside.



Figure 3-7. Unscrew the Circuit Board

8. Lift the circuit board up and away from sensor. Take care to keep the wire assembly as straight as possible and do not twist, as shown in Figure 3-8:

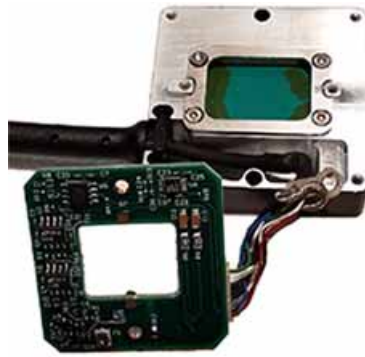


Figure 3-8. Remove the Circuit Board from the Sensor

9. Gently disconnect the connector on the circuit board from the wiring assembly, as shown in Figure 3-9. Set aside the circuit board with its screws.

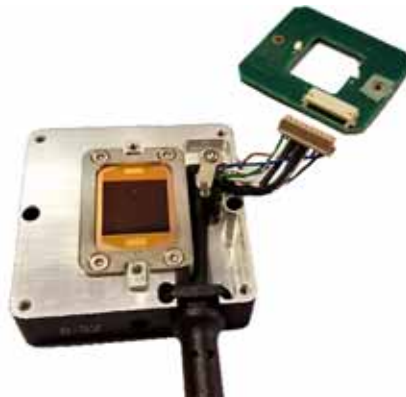


Figure 3-9. Disconnect the Circuit Board

10. Unscrew the Ground Lug as shown in Figure 3-10 and set the screw aside with the other screws. You will need these to attach the Pass-Through circuit board.



Figure 3-10. Unscrew the Ground Lug

11. Lift the wiring assembly out of the channel in the sensor housing, as shown in Figure 3-11. Take care to keep the wire assembly in its current state and do not twist the wires.



Figure 3-11. Remove Wiring Assembly from the Sensor

Now that the sensor is disassembled, an OEM may customize the sensor according to their own design requirements, such as installing the pass-thru circuit board (or a circuit board of their own design) or using a different sensor. See “Section Four: Design Integration” (p. 4-1) for guidelines.

Replace a Gap Pad

Before you replace the circuit board, check to see if the Gap Pad is damaged in any way. If so, you must replace the Gap Pad **before** you replace the circuit board.

If the Gap Pad is damaged:

1. Carefully remove the old Gap Pad from the sensor housing and/or the circuit board (if it is stuck to either or both). Remember to use finger cots or gloves.
2. Locate the spare Gap Pad in the Developer’s Kit.

Alternately, you can cut material to size from the spare Thermal Pad included in the Developer’s Kit, or order additional material. To do so, go to www.bergquistcompany.com and select:

- Gap Pad: Bergquist 2200SF (Thermally Conductive Silicone-Free Gap Filling Material) and/or
 - Thermal Pad: Bergquist Hi-Flow 300P (Electrically Insulating, Thermally Conductive Phase Change Material)
3. Place the Gap Pad sticky side up, aligning the hole on the Gap Pad with the hole on the sensor housing, as shown in Figure 3-12. This aligns the Gap Pad with the thermistor area on the Pass-Thru Circuit Board.



Figure 3-12. Gap Pad

Install a Pass-Thru Circuit Board

The PowerMax-Pro 15mm Sensor ships with an Amplifier Circuit Board already installed; this is a fully-functional, working sensor.

Coherent also provides a Pass-Thru Circuit Board in the Developer's Kit that can replace the installed Amplifier Circuit Board (see Figure 3-13). The Pass-Thru Circuit Board can be used for design validation.



Figure 3-13. Pass-Thru Circuit Board—Ready to Install

Another alternative is to replace the Amplifier Circuit Board with an OEM-designed circuit board.

To replace the circuit board and reassemble the sensor:

1. Check that the contacts on the Circuit Board are not bent or damaged. Figure 3-14 shows the recommended distance between the circuit board and the sensor to successfully make contact. Also see the section, “Working with the OEM Detector” (p. 4-4) for additional information.

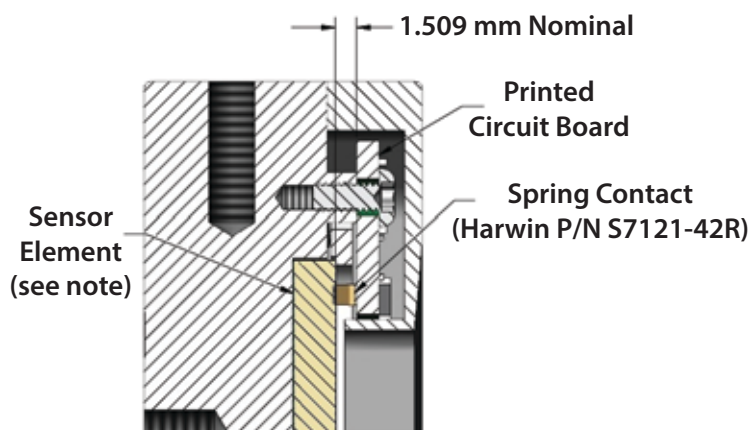


Figure 3-14. OEM Detector Spring Contacts and Spacing

2. Align the Pass-Thru Circuit Board with the channel in the sensor housing.
3. Ensure that the connector for the Pass-Thru Circuit Board is placed outside of the channel in the sensor housing, as shown in Figure 3-15.



Figure 3-15. Align Pass-Thru Board in Sensor Housing

4. After the board is in place, use the two button-head screws to secure the Circuit Board, as shown in Figure 3-16. Torque the screws to 3 in-lb., 48 in-oz., or 0.34 newton-meter.



Figure 3-16. Attach Pass-Thru Circuit Board

5. Place the sensor cover on the sensor, as shown in Figure 3-17. Be sure to align the cover so that the side drill holes are in alignment with the sensor housing.

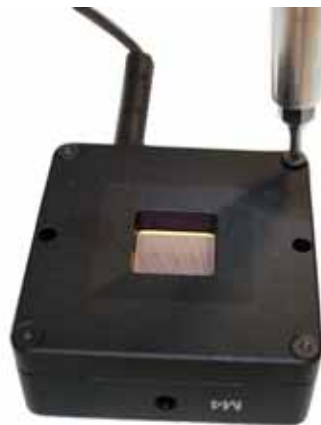


Figure 3-17. Screw On the Sensor Cover

6. Use a Torx driver to screw in the four (4) flat-head into each corner of the sensor cover. Replace the flat-head screws in the following order, initially slightly tightening each:
 - Top right corner
 - Bottom left corner
 - Top left corner
 - Bottom right corner
7. Finish tightening all screws in the same order. Torque the screws to 3 in-lb., 48 in-oz., or 0.34 newton-meter.
8. Attach the Protective Dust Cap.
9. Attach an SMB Cable, as shown in Figure 3-18:



Figure 3-18. Attach SMB Cable

10. Attach a Heat Sink (optional, depending on the power of the laser).

Change the Sensor

In addition to the Developer’s Kits that are available, developers can change the OEM detector.

Table 3-1 lists the individual OEM detectors that are available to order from Coherent for the PowerMax-Pro 15mm Sensor:

Table 3-1. OEM Detectors to Order

P/N	NAME	DESCRIPTION
1385327	Packaged OEM Detector, 15 mm Square	Patterned, 300 μm x 100 μm
1385328		UP
1385329		Broadband Coating

Figure 3-19 shows the OEM detectors available to order:



Figure 3-19. Individual OEM Detectors

These OEM detectors are individually packaged, as shown in Figure 3-20:

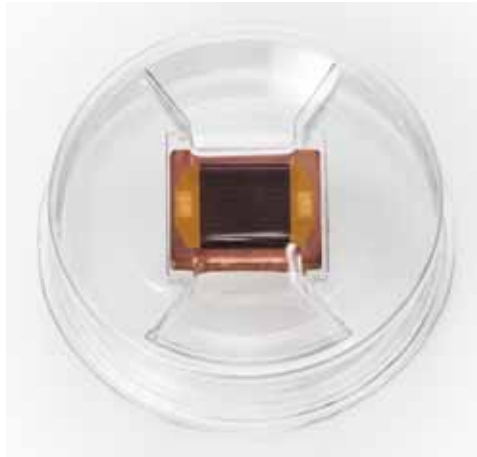


Figure 3-20. Individually Packaged OEM Detector



CAUTION:

Remember to always use protective hand covering, such as gloves or finger cots (powder-free nitrile or latex), when working with OEM detectors.

To change an OEM detector:

1. Follow instructions to disassemble the sensor described in the first part of this section (see p. 3-5).
2. Unscrew the four (4) flat-head countersunk screws for the retainer over the OEM detector, as shown in Figure 3-21. This frame secures the OEM detector in the sensor.



Figure 3-21. Remove Sensor Retainer (Frame)

3. After you set the frame aside, the entire OEM detector is now exposed, as shown in Figure 3-22:



Figure 3-22. Exposed OEM detector

4. Carefully remove the OEM detector from the housing. To do so, use a small-tip, flat-head screwdriver to gently leverage under the sensor in the machined corner relief (“indented” areas) at each corner of the OEM detector, as shown in Figure 3-23:

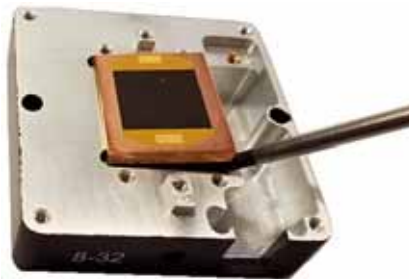


Figure 3-23. Remove OEM Detector from Housing Mount



CAUTION!

Take care to only touch the edges on the OEM detector. NEVER touch inside the edges, which can result in damage to the OEM detector.

5. Set the OEM detector in the protective case, and place the cover on top.
6. Place the Sensor Housing Mount on a clean flat surface with channeled side up, with the cable cut-out facing towards you.
7. If the Thermal Pad currently installed under the OEM detector is damaged, you must replace it as follows. Otherwise, skip to the next step.
 - a.) Use the spare Thermal Pad provided in the Developer’s Kit (Bergquist Hi-Flow 300P).
 - b.) Carefully remove the plastic film from the replacement Thermal Pad.
 - c.) Lay down the new Thermal Pad into the inset in the sensor housing, as shown in Figure 3-24.

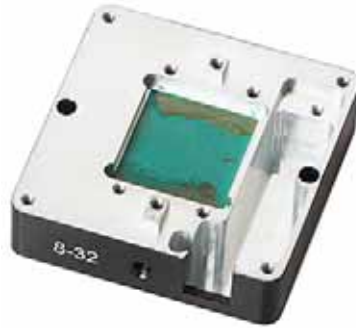


Figure 3-24. Replace Thermal Pad

8. Hold the OEM detector by the edges only, and turn it over. Locate the small notch on the top edge of the back side of the OEM detector, shown in Figure 3-25.

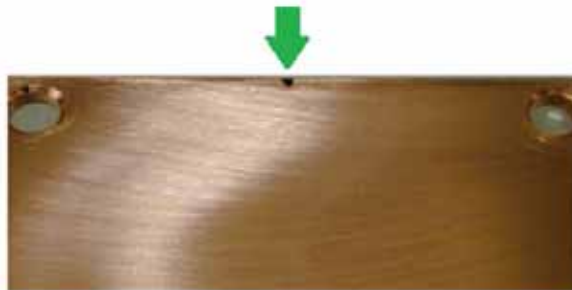


Figure 3-25. Notch on Back of OEM Detector

9. Place the OEM detector on top of the Thermal Pad with the notched edge side down; that is, place the side that is fully copper placed against the Thermal Pad. The orientation of the OEM detector is important. If the OEM detector is placed backwards into the sensor housing, it will not be damaged. However, the signal output will be negative. If this occurs, simply swap the orientation. The notch should be placed towards the top end of sensor housing, away from you. As a point of reference, the channel cutout for the wire assembly is at the bottom of the sensor housing, as shown in Figure 3-26:

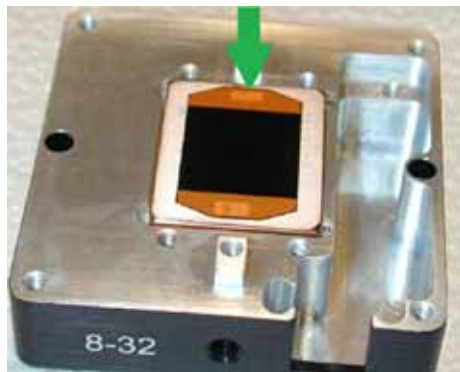


Figure 3-26. Orientation of the OEM Detector in the Housing Mount

10. When the element is in place, lay the retaining bracket on top of it. Place the indented underside of the frame down on the OEM detector and the top, smooth side of the frame face up—see Figure 3-27.

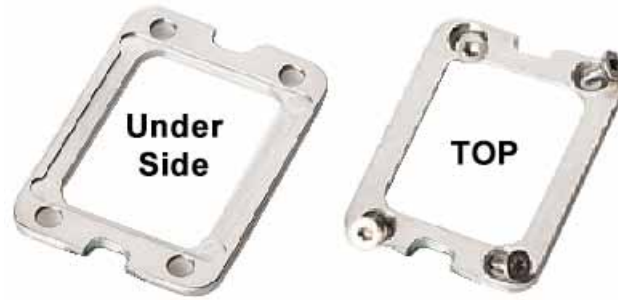


Figure 3-27. Frame Top and Bottom View

11. Secure the bracket by replacing the flat-head screws in the following order, slightly tightening each as you go. Repeat as needed in the same order to tighten.
 - Top right corner
 - Bottom left corner
 - Top left corner
 - Bottom right corner



CAUTION:

Use care to **NEVER touch or drop screws onto the active area of the OEM detector.**

12. Finish tightening all screws in the same order. Torque the screws to 3 in-lb., 48 in-oz., or 0.34 newton-meter.
13. When finished, the retention frame should now be attached, as shown in Figure 3-28:



Figure 3-28. Retention Frame Secured

Replace the Sensor Cover

1. Locate the four (4) flat-head screws (Torx Drive, 2-56 UNC x 0.188" Long, Steel, ASME B18.3, ASTM F835, Black Oxide) screws and the cover for the Sensor Mount.
2. Position the cover so that the screw holes align; particularly ensure that the side drill holes are in alignment.

3. Use a Torx driver to screw in the four (4) flat-head into each corner of the cover of the sensor. Replace the flat-head screws in the following order, only slightly tightening each.
 - Top right corner
 - Bottom left corner
 - Top left corner
 - Bottom right corner
4. Finish tightening all screws in the same order. Torque the screws to 3 in-lb., 48 in-oz., or 0.34 newton-meter.
5. Attach the Protective Dust Cap.
6. Attach the Heat Sink (optional, depending on the laser power).
7. Mount the Sensor either on a flat surface or on the post-and-stand assembly.

SECTION FOUR: DESIGN INTEGRATION

For OEMs who want to integrate the sensor into their system, this section describes design considerations for the following:

- A new Heat Sink (p. 4-1)
- Signal and grounding pins for DB-25 connector (p. 4-2)
- A new amplifier circuit board (p. 4-3)
- An individual OEM detector (p. 4-4)
- Thermal interface (p. 4-5)
- Spectral curve (p. 4-6)



IMPORTANT!

Failure to carefully read these design guidelines could result in damage to the sensor assembly.

Before you begin, read the following precautions about handling and environmental guidelines:

- “Safety and Handling Precautions” (p. 2-1)
- “Inspect and Clean the Sensor” (p. 3-4)

To save time and expedite development, use the Development Kit for the PowerMax-Pro 15mm Sensor. Alternatively, contact Coherent representative for custom development for volume production; see “Contact Product Support” (p. C-3).

Design a Heat Sink

Developers may choose to design their own customized heat dissipation system instead of using the Coherent Heat Sink provided in the Developer’s Kit for the PowerMax-Pro 15mm Sensor.

When designing a new Heat Sink, it must meet the following requirements for roughness and flatness of the mounting surface and maximize the performance of the Heat Sink. An incorrectly Heat Sink design can affect the performance of the sensor or cause damage to the detector if the temperature gets too high.

Extruded Heat Sinks may be warped. The mounting surface should be milled flat to ensure good thermal contact and to prevent damage to the laser head (within < 0.05 mm over the mounting surface).

Pyrolytic graphite pads can be used to improve thermal contact between the baseplate and the Heat Sink. The maximum temperature for the sensor is 60°C.

Also ensure that the drill pattern on the Heat Sink is designed in such way that there is no mechanical stress to any of the components when the sensor is securely attached and the screws are fastened. Mechanical stress can lead to unwanted effects such as malfunction, low performance, damage of the components, and unsafe operation.

Signal and Grounding for DB-25 Connector

The PowerMax-Pro 15mm Sensor includes an attached DB-25 connector.

Figure 4-1 shows the ground and shield pin-outs for the cable. The Cable Shield drains the discharge through the DB-25 shell.

The "SHIELD GND" from the cable is soldered to the DB-25 shell here.

The "SHIELD GND" is attached to the sensor housing on this end.

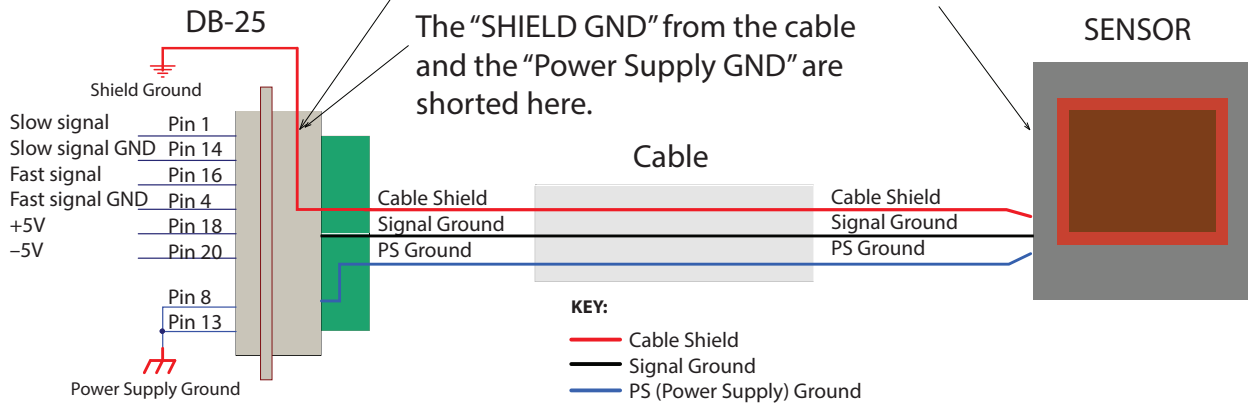


Figure 4-1. DC-25 Connector Ground and Shield Diagram

Table 4-1 also lists the pin-outs:

Table 4-1. DC-25 Connector Pin-Outs

PIN-OUT*	DESCRIPTION
1	Slow signal
14	Slow signal GROUND
16	Fast signal
4	Fast signal GROUND
18	+5V Power
20	-5V Power
8	Power Supply (PS) Ground
13	

Circuit Board Design

Should OEMs choose to design and develop their own circuit board, refer to the following considerations:

- Basic guidelines block diagram
- Current amp
- Voltage amp
- Resistance

Figure 4-2 shows a basic block diagram for a design that works with the sensor.

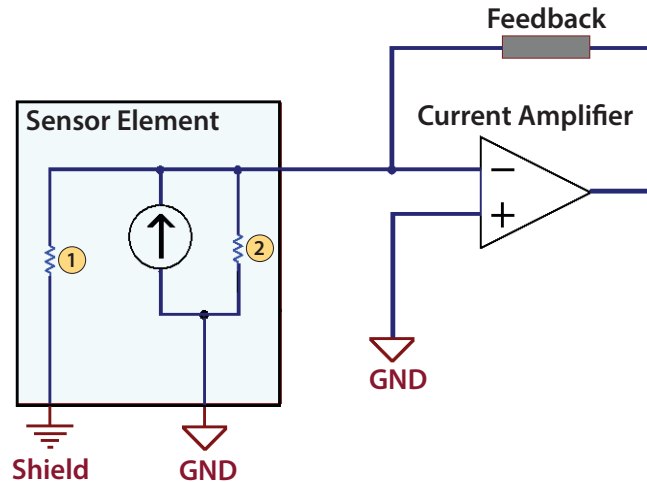


Figure 4-2. Circuit Board Design

KEY:

1. Resistance of the active area to the copper substrate is approximately >1 Meg Ohms.
2. Resistance of the active area (from “+” to “-”) is approximately 20 Ohms.

Coherent recommends using a current amplifier or trans impedance amplifier design.

- Use a high-quality amplifier (low noise, low drift, low offset, and so on) when designing the circuit.
- Amplify the signal as close to the OEM detector as possible.
- Do not use a differential amplifier.
- The Responsivity (current mode) will be ~9 to 15 $\mu\text{Amps/Watt}$
- The Responsivity (voltage mode) will be ~180 to 240 $\mu\text{Volts/Watt}$

Connect the Shield and Ground near the Power Supply or the Analog-to-Digital (A/D) converter to reduce noise.

Avoiding any type of bias voltage is critical with this detector technology. Bias voltages may cause the signal to be inaccurate or drift.

Working with the OEM Detector

This section describes design tips when working with an individual OEM detector.



CAUTION!

NEVER touch the active area of the OEM detector. Touching anywhere inside the edges can cause damage to the OEM detector.

Always use protective gloves or finger cots (powder-free nitrile or latex) when working with the OEM detector.

Figure 4-3 shows the recommended spacing when designing in contacts for the OEM detector.

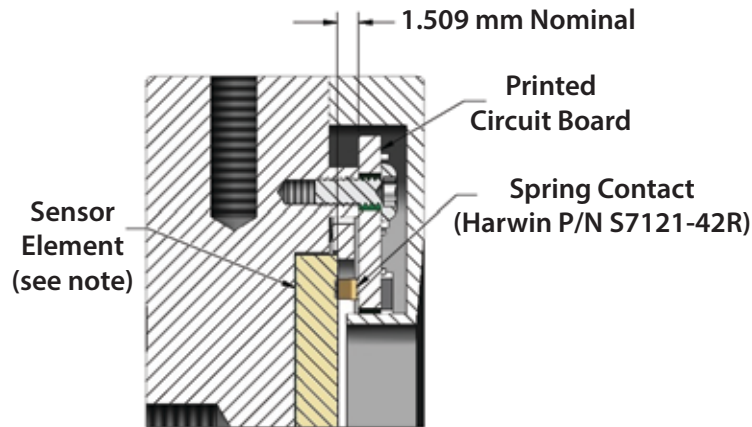


Figure 4-3. OEM Detector Spring Contacts and Spacing

NOTE: Coherent recommends using a metal-on-metal connection with the sensor housing or using thermal conductive pads to maximize thermal contact. For contact with the circuit board, Coherent recommends using only spring contacts (Harwin P/N S7121-42R) to touch the OEM detector.



CAUTION!

Coherent does *not* recommend using Pogo pins or other sharp or “Point” contact methods such as tweezers, probes, or screwdrivers. These may penetrate the thin contact surface and damage the OEM detector.

Each Developer’s Kit includes a replacement Thermal Pad for the OEM detector and a replacement Gap Pad to mount the circuit board in the sensor. Pads can be cut to size.

A Thermal Pad and Gap Pad can tear, wrinkle, go through a phase change, or may melt a bit and stick to the components during handling and use. This often occurs when a higher power is used for testing. Should additional thermal conductive pads be needed, go to www.bergquistcompany.com and select the desired material:

- Gap Pad: Bergquist 2200SF (Thermally Conductive Silicone-Free Gap Filling Material)
- Thermal Pad: Bergquist Hi-Flow 300P (Electrically Insulating, Thermally Conductive Phase Change Material)

See “Section Three: Disassemble the Sensor” (p. 3-1) for instructions about how to remove and replace the pads as you assemble and disassemble the sensor.

Thermal Interface

The PowerMax-Pro 15mm Sensor can drift ± 1 mW in a typical industrial lab environment where air handling is used.

Figure 4-4 shows an example of thermal drift when the PowerMax-Pro 15mm Sensor is used with a LabMax-Pro SSIM Meter in a lab for a duration of 30 minutes.



Figure 4-4. Thermal Drift

When mechanically mounting a OEM detector to an OEM system, there must be good contact and it must be cooled by attaching a thermal mass.

The requirements depend on the power and heating/cooling provided by the OEM system:

- Cap when the OEM detector is used: Up to 5 W of power
- Cap with Heat Sink. Up to 9 W of power
- Beyond that, the sensor requires a custom-designed water cooling

To provide a compression mount to a base and ensure good thermal connectivity, Coherent recommends a picture frame or bracket similar to the one used for the OEM detector in the PowerMax-Pro 15mm Sensor.

Spectral Curve

The chart shown in Figure 4-5 plots the spectral reflectivity of the coatings by wavelength or the PowerMax-Pro 15mm Sensor. (The spectral absorption is the inverse of these plots.)

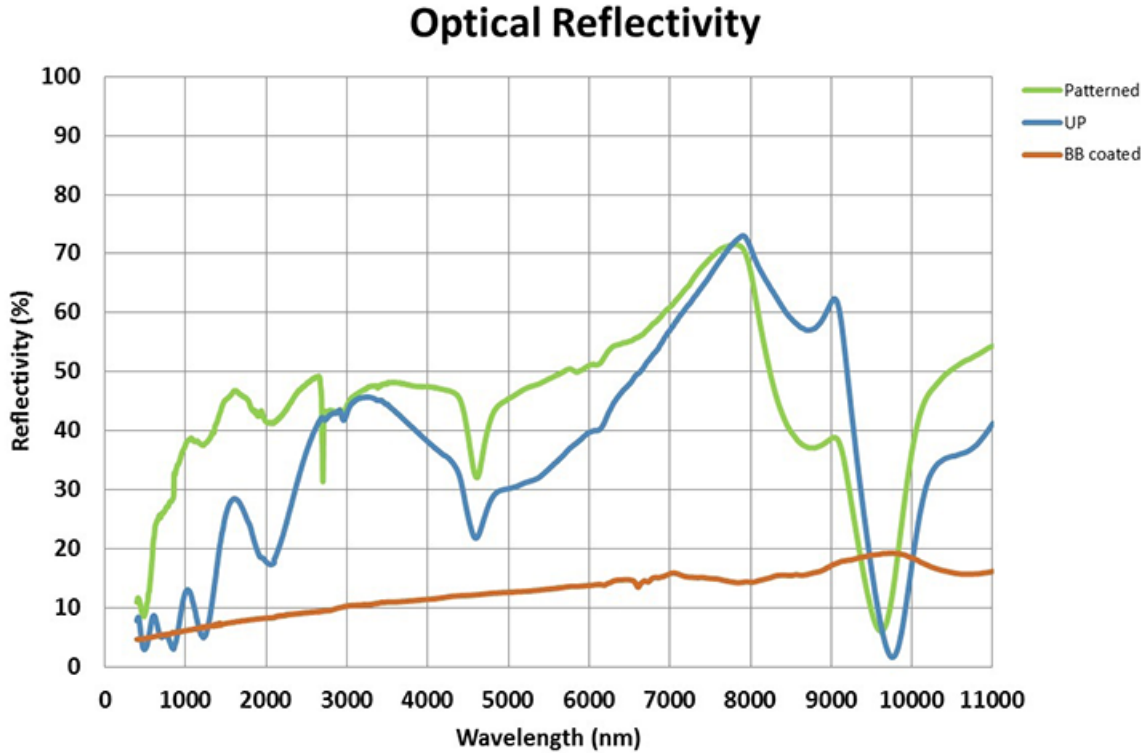


Figure 4-5. Spectral Curve for Optical Reflectivity

The Patterned (HD) and Unpatterned (UP) coatings are not recommended for use between 1100 nm and 9000 nm due to the high level of reflection.

- The reflection from these coatings is more specular than the reflections from a diffuse coating.
- A circular beam reflected off of the HD coating has a diffraction pattern because it is reflecting off of the line pattern structure embedded inside the HD coated detector.

The Broadband (BB) coating is much more absorptive across a broader wavelength range than the HD and UP coatings, and is suitable for use at any wavelength from 400 nm to 11000 nm.

- This coating is diffused, so the reflective light is not collimated.
- The trade-off with this coating is that it adds some thermal resistance to the detector stack, which increases the time constant compared to the HD and UP versions.

APPENDIX A: SAFETY AND COMPLIANCE

This section describes requirements for safety for persons setting up or operating the PowerMax-Pro 15mm Sensor, and includes:

- Laser Safety Hazards (p. A-1)
- Optical Safety (p. A-2)
- Electrical Safety (p. A-3)

You must review these laser safety sections thoroughly BEFORE operating the PowerMax-Pro 15mm Sensor. Carefully follow all safety instructions presented throughout this manual.

- Compliance with standards and regulations (p. A-3)
 - Laser compliance (p. A-3)
 - Environmental compliance (p. A-4)

Also see “Appendix B: Laser Back Reflection” for details about practices to avoid hazards and injury from laser back reflection.



This user information reported in this manual is in compliance with the following standards for Light-Emitting Products EN/IEC 60825-1 “Safety of laser products – Part 1: Equipment classification and requirements” 21 CFR Title 21 Chapter 1, Subchapter J, Part 1040 “Performance standards for light-emitting products”.

Laser Safety Hazards

Hazards associated with lasers generally fall into the following categories:

- Biological hazards from exposure to laser radiation that may damage the eyes or skin
- Electrical hazards generated in the laser power supply or associated circuits
- Chemical hazards resulting from contact of the laser beam with volatile or flammable substances, or released as a result of laser material processing

The above list is not intended to be exhaustive. Anyone operating a laser must consider the interaction with its specific working environment to identify potential hazards.

For the PowerMax-Pro 15mm Sensor, hazards vary with the input angle and the laser beam.



WARNING—LASER RADIATION!
Always avoid eye or skin exposure to both DIRECT and SCATTERED radiation.

Optical Safety

Laser light, because of its optical qualities, poses safety hazards not associated with light from conventional light sources. The safe use of lasers requires all operators, and everyone near a laser, to be aware of the dangers involved. Users must be familiar with the instrument and the properties of coherent, intense beams of light.

The safety precautions listed below are to be read and observed by anyone working with or near the laser. At all times, ensure that all personnel who operate, maintain or service the laser are protected from accidental or unnecessary exposure to laser radiation exceeding the accessible emission limits defined in the laser safety standards.



WARNING!

Direct eye contact with the output beam from the laser may cause serious eye injury and possible blindness.

The greatest concern when using a laser is eye safety. In addition to the main beam, there are often many smaller beams present at various angles near a laser. These beams are formed by specular reflections of the main beam at polished surfaces such as lenses or beamsplitters. While weaker than the main beam, such beams may still be sufficiently intense to cause eye damage.

Laser beams are powerful enough to burn skin, clothing, or combustible materials, even at some distance. They can ignite volatile substances such as alcohol, gasoline, ether, and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers, and photodiodes.

Laser Safety Eyewear

Always wear appropriate laser safety eyewear for protection against the specific wavelengths and laser energy being generated.

The appropriate eye protection can be calculated as defined in the “EN 207 Personal eye protection equipment—Filters and eye-protectors against laser radiation (laser eye-protectors)”, in other national or international standards (such as ANSI, ACGIH, or OSHA) or as defined in national safety requirements.



CAUTION!

Laser safety eyewear protects the user from accidental exposure to laser radiation by blocking light at the laser wavelengths. Always wear the appropriate laser safety glasses matched to the lasers used in your environment.

Because laser safety eyewear may also prevent the operator from seeing the beam or the beam spot, exercise caution even while wearing safety glasses.

Viewing Distance

A laser produces optical power levels that are dangerous to the eyes and skin if exposed directly or indirectly. Operate all laser products only with proper eye and skin protection at all times. Never view directly emitted or scattered radiation with unprotected eyes.

When viewing the laser during operation, the operator must maintain the Nominal Ocular Hazard Distance (NOHD) between the laser or scatter radiation and the operator's eyes. Check the Operator's Manual for the laser you are using for details.

Maximum Accessible Radiation Level

A laser produces visible radiation over the various wavelengths. See the Product Label on your laser for details about maximum emission levels.

Electrical Safety

The PowerMax-Pro sensor does not have dangerous voltages.

Electrostatic charges easily collect on the human body, equipment, and facilities, and can discharge without detection. Dry air and carpet create a higher potential for Electrostatic Discharge (ESD).



WARNING!

Electrostatic charges easily collect on the human body and equipment and can discharge without detection.

Take necessary precautions or shielding to protect the system from ESD to prevent performance degradation or damage to the system.

The most common damage occurs when handling a device during installation or use.

When mobile equipment (a cart or table) is used as an ESD-protected workstation, connect it to ESD ground that meets ANSI/ESD S4.2 required limits for an ESD-protected workstation ($<1 \times 10^9$ ohms).

Compliance

This section describes compliance with various government requirements for safety, environmental regulations, and control law.

Laser Safety Standards

Following are sources for information about laser safety standards, as well as safety equipment and training.

Within the United States:

The applicable United States Government laser safety requirements are contained in 21 CFR Title 21 Chapter 1, Subchapter J, Part 1040 ("*Performance standards for light-emitting products*"). The text of this federal standard is available from:

U.S. Food and Drug Administration
Center for Devices and Radiological Health (CDRH)
Document Mail Center – WO66-G609
Sliver Spring, MD 20993-0002
Website: www.fda.gov

Outside of the United States:

For jurisdictions outside of the United States:

Safety of laser products - Part 1: Equipment classification and requirements
IEC 60825-1 / EN 60825-1

Safety of laser products - Part 14: A user's guide
IEC 60825-1 / EN 60825-1

Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use
IEC 61010-1 / EN 61010-1

Publications and Guidelines

International Electrotechnical Commission (IEC)
www.iec.ch

American National Standard for Safe Use of Lasers
ANSI Z136 Series
American National Standards Institute (ANSI)
www.ansi.org

A Guide for Control of Laser Hazards
American Conference of Governmental
and Industrial Hygienists (ACGIH)
www.acgih.org

Laser Safety Guide
Laser Institute of America
www.lia.org

CE Marking

The European Community requirements for product safety are specified in the Low-Voltage Directive (LVD) (published in 2014/35/EU).

This Directive requires that lasers comply with the standard EN 61010-1/IEC 61010-1 “Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use” and EN 60825-1/IEC 60825-1 “Safety of Laser Products”. Compliance with the European requirements is certified by CE Marking.

Electromagnetic Compatibility

The primary issue for electromagnetic compatibility is to design covers, shielding, grounding, routing of electrical cable assemblies, and control elements with the proper safety features for a complete system.

The PowerMax-Pro sensor has been tested and shown to be compliant with the relevant requirements of the following directives for Electromagnetic Compatibility EN 61326-1_Ed2:2013 (IEC 61326-1_Ed2:2012) and EN 61000-3-2:2006.

Environmental Compliance

This section describes compliance with various environmental regulatory directives to identify hazardous substances.

Battery Directive

There is no battery in the PowerMax-Pro sensor.

EU REACH

Coherent products are classified as “articles” according to EU REACH definition, as follows:

Article means an object which, during production, is given a special shape, surface or design that determines its function to a greater degree than its chemical composition. (REACH, Article 3(3))

Articles as defined by REACH regulations are exempt from registration as long as they are not intended to release a chemical substance.

To the best of our knowledge, all Coherent product meet the definition of “article” according to REACH.

In addition, to the best of our knowledge, Coherent products do not contain any Substances of Very High Concern (SVHC) above the legally mandated thresholds included in the REACH SVHC list, which is updated every six months. The current SVHC list is available on-line at <https://echa.europa.eu/candidate-list-table>.

RoHS Compliance

The European Union RoHS Directive EN 50581:2012 restricts the use of certain hazardous substances in electrical and electronic equipment. Coherent is in compliance with this Directive and can provide RoHS certification upon request. Compliance of this laser with the EMC requirements is certified by the CE mark.

China RoHS Compliance

This section details compliance with the China RoHS (Restriction of Hazardous Substances) Regulation SJ/T 11364-2014.

This Regulation restricts the use of certain hazardous substances in electrical and electronic equipment. The China RoHS Regulation applies to the production, sale, and import of products into the Peoples Republic of China.

Any hazardous substances in the PowerMax-Pro sensor are listed on the label, shown the example in Figure A-1.

部件名称 Part Name	产品中有害物质的名称及含量 有害物质 Hazardous Substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷电路板组装 Printed Circuit Board Assembly	X	○	○	○	○	○

本表格依据 SJ/T 11364 的规定编制
 ○: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。
 X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。


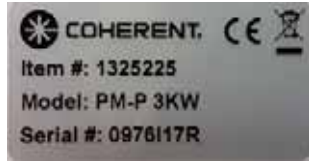


Figure A-1. China RoHS Label

The table shows that Lead (Pb) may be found in components of the PowerMax-Pro sensor. The environmental-friendly use period is 20 years, indicated by the number 20 inside the circle.

The China RoHS Regulation also requires that the date of manufacture be identified. This is provided on the Certificate of Calibration shipped with each product.

Examples of product labels are shown in Figure A-2.



Label on the Sensor



Label on the Box

Figure A-2. Examples of Product Labels

**Waste
Electrical and
Electronic
Equipment
(WEEE, 2002)**

The European Union Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU) is represented by a crossed-out garbage container label. The WEEE Directive applies to your product and any peripherals marked with this symbol.

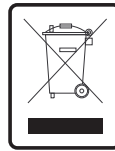


Figure A-3. WEEE Label

The purpose of this directive is to minimize the disposal of WEEE as unsorted municipal waste and to facilitate its separate collection.



Do not dispose of these products as unsorted municipal waste. Contract your local distributor for procedures for recycling this equipment.

APPENDIX B: LASER BACK REFLECTION

The PowerMax-Pro 15mm Sensor is used in environments where lasers may be active.

This section describes back reflection and tells how to prevent damage or noise caused by back reflection.

The lasers shown in examples in this section are for purposes of illustration only. The same principles apply to any lasers in the work environment.



WARNING—LASER RADIATION!

Always wear correct laser safety eyewear and follow laser safety precautions when using these procedures. Avoid eye and skin exposure to both DIRECT and SCATTERED radiation.

What is Back Reflection?

Back reflection (also referred to as retroreflection) occurs when a part of the laser beam is sent back into the laser's exit aperture. Back reflection can be caused by any object in front of the laser (such as other equipment or even a wristwatch) and can result in instability, noise, or damage to the laser.

In a normal application, the laser beam exits the beam aperture and none of the light from the laser is reflected back. Ideally, 100% of the output power from the laser is used in the application and none of the light is scattered or sent back into the laser exit aperture.

Figure B-1 shows the location of the laser exit aperture on a few lasers manufactured by Coherent.

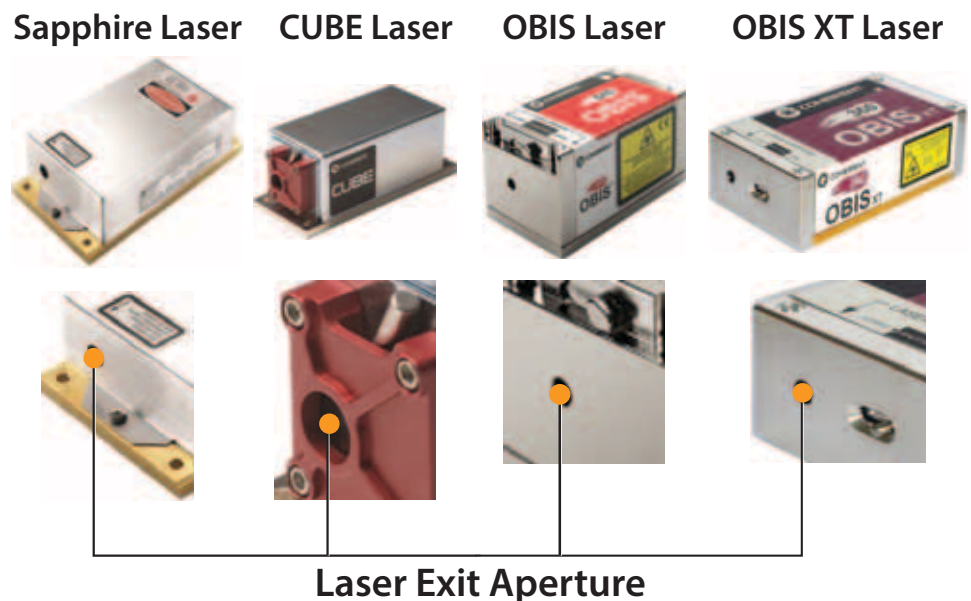


Figure B-1. Location of Exit Apertures

The amount of back reflection that can damage a laser diode changes from device-to-device. Sometimes a back reflection as low as 4% of the total beam power is sufficient to cause damage.

Damage from back reflection can be immediate, or it can be subtle and slowly decrease the service life of the laser.

Indications that there are back reflections to the laser that may cause permanent damage include:

- No output power
- Low output power
- Over-current of the laser diode

Back reflection can also cause the output power noise (RMS noise and Peak-to-Peak noise) to increase if the reflection interferes with the laser cavity or light-loop.

Figure B-2 shows a laser beam hitting an object and reflecting part of the beam back into the laser exit aperture.

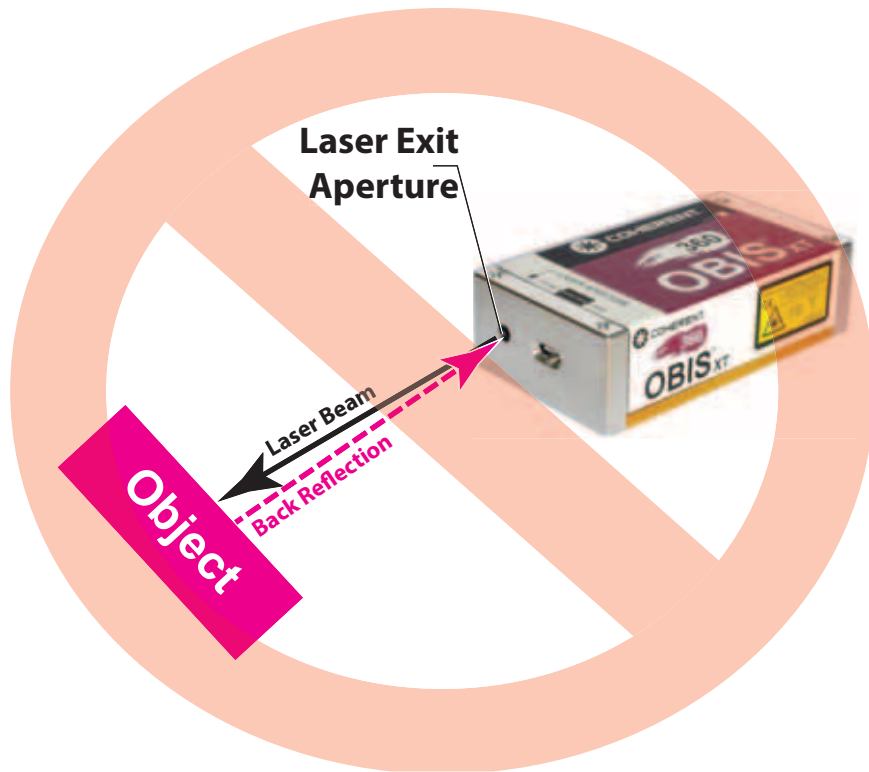


Figure B-2. Laser Back Reflection



CAUTION!

Avoid any condition where the laser beam—or any part of the laser beam—reflects back into the laser exit aperture. As little as a 5% back reflection can damage the diode.

Coherent recommends that the laser light be reflected away from the laser exit aperture to a safe beam dump (absorber), as shown in Figure B-3.

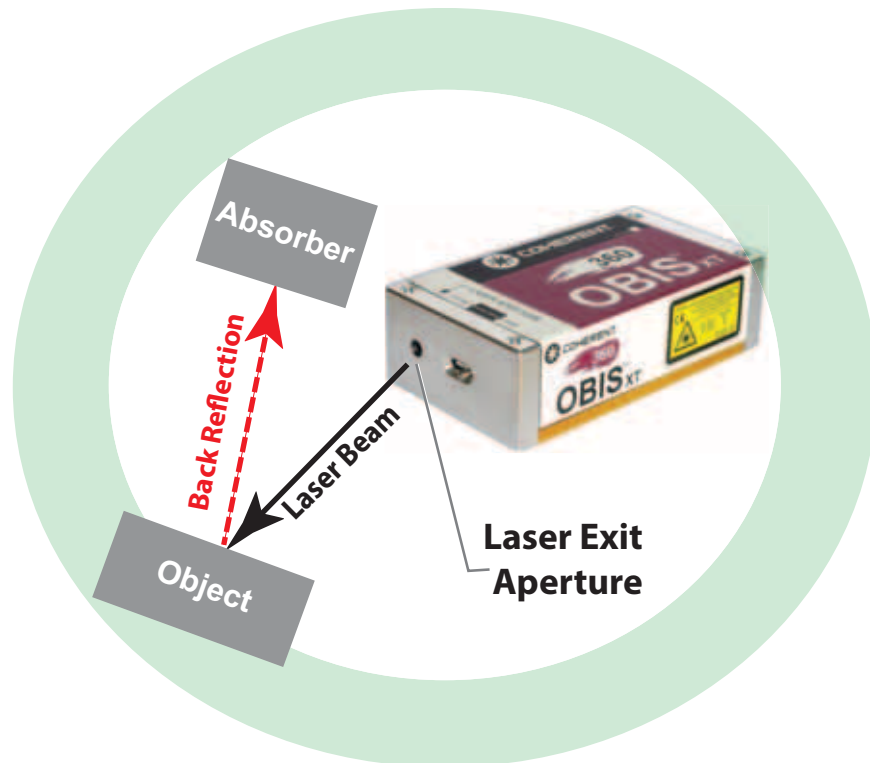


Figure B-3. Reflect Laser Light Away from Laser Exit Aperture

How to Prevent Back Reflection

The following procedure describes how to prevent a strong back reflection and possible damage to the laser:

1. Use the USB or RS-232 controls to set the power at 10% of the rated output power before opening the laser aperture.
2. Do optical or laser alignment at this low output power to confirm there are no back reflections.

Sources of back reflections include:

- Fiber, Fiber Ferrule, or Fiber Connector
- Optical Filters that are not angled but are perpendicular to the beam
- Neutral Density Glass or Beam Attenuators that have a front surface reflection that can create a back reflection.
- Beam Block at normal incidence that reflects power back into the laser
- Plano-concave or Plano-convex lenses where the flat surface reflects back part of the beam
- Power measurement probes that use a reflective attenuator or have a surface that reflects the laser light.
- Mirrors or other shiny surfaces from mounts or other optical components in the beam path.

When measuring laser power with a power meter, always angle the power sensor so that the laser beam does not reflect back into the laser exit aperture.

To properly measure laser power:

1. Take the measurement near the laser.
2. Move the power sensor to maximize the reading of the output power.



CAUTION!

DO NOT let this movement and alignment create a back reflection.

In many cases an object is positioned in front of the laser as a beam block. Make sure the object is not reflective and does not create a back reflection to the laser.

If you cannot adjust your application to decrease the back reflection of the laser light into the laser's exit aperture, add an optical isolator to protect the laser. Although the optical isolator adds cost and requires additional space, it can be an appropriate safety factor to increase the life of the laser.

Be aware of every optical surface in front of the laser. All objects have the opportunity to create a back reflection. In many cases the front surface and the back surface of the optic are a source of back reflection. Figure B-4 shows a set-up that might cause back reflection damage.

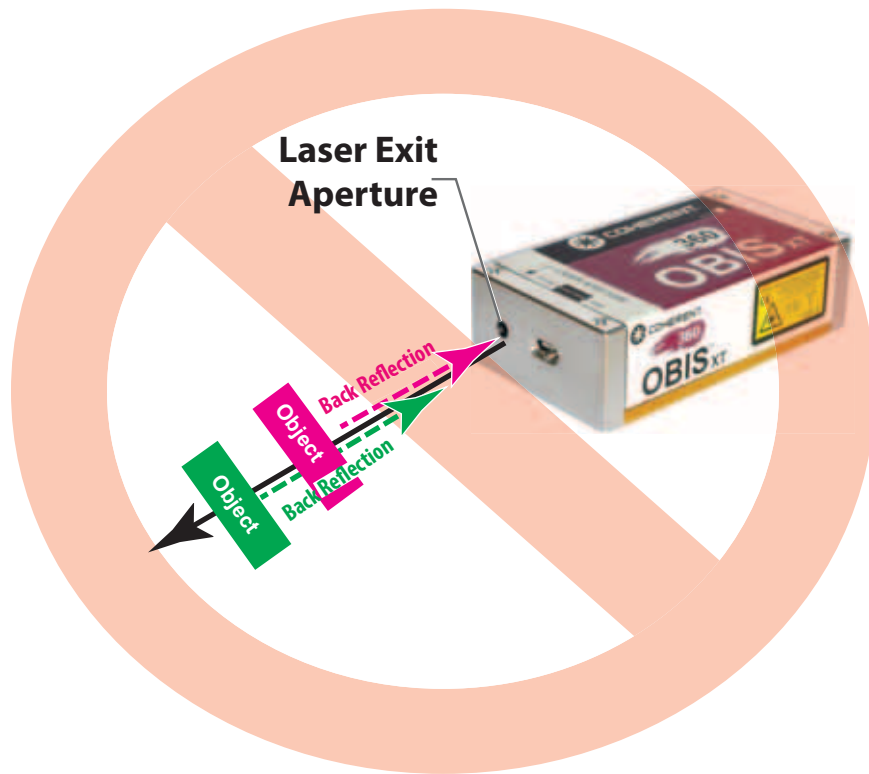


Figure B-4. Incorrect Set-Up Causes Laser Back Reflection Damage

With any optic or object, the angle of incident can impact the optics performance or function. Review the specifications for each optical element to understand how much angle is acceptable.

- The closer the object is to the laser, the more angle is needed to direct the back reflection away from the laser exit aperture.
- The farther the object is away from the laser, the less angle is needed to direct the back reflection away from the laser exit aperture.

The set-up shown in Figure B-5 is safer than the set-up in the previous illustration because both objects are set at a slight angle to the laser. This change of angle sends the back reflection away from the laser exit aperture.

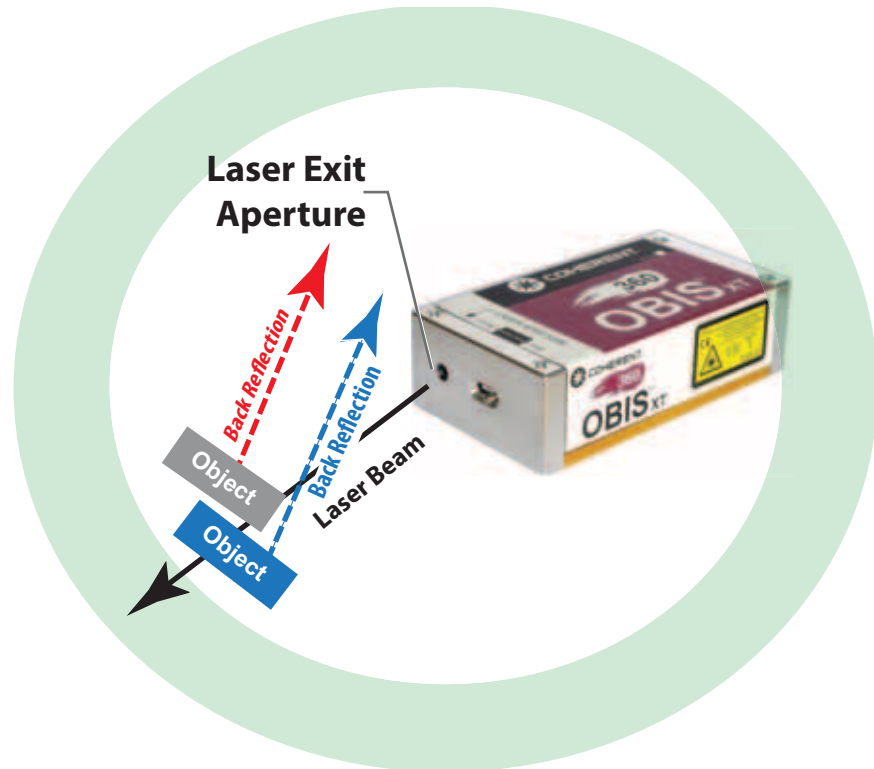


Figure B-5. Safer Laser Set-Up



IMPORTANT!

The Coherent product Warranty does not cover damages to the laser caused by customer usage. Take precautions with initial set-up to avoid damage to the laser. Avoid any condition where any part of the laser beam reflects back into the laser exit aperture.

Summary of Precautions

- Review the objects in front of the laser and note which surfaces are a possible hazard for back reflections. Change the objects to be less reflective whenever possible. Adding Anti-Reflective (AR) coatings to optics and more diffuse surfaces to mounts or beam shutters can help.
- If possible, add an angle to the object so that the reflection does not enter the laser exit aperture.
- Take precautions when moving objects that can create a back reflection in front of the laser.
- Decrease the power from any possible back reflections by starting the laser at lower output power—for example 10% output power—before opening the laser shutter.
- ***Using correct safety precautions***, watch where the reflections from objects are returning to make sure the reflections are not at or near the laser exit aperture.
- Take extra precautions when using a laser power meter— consider how close the measurement is being taken to the laser and the angle at which the beam can reflect off the sensor so that it doesn't reflect back into the laser.
- A laser that shows low output power, no output power, over-current, or high noise, indicates a possibility that there is a back reflection to the laser.
- Add an optical isolator to those applications that have laser exit aperture back reflections that cannot be corrected by angling the optics.

APPENDIX C: SERVICE AND SUPPORT

This section provides information about:

- Calibration
- Obtaining service
- Product shipping instructions
- How to contact Product Support

Calibration

Coherent laser power and energy meters are precision instruments, capable of delivering very accurate measurements, as well as providing many years of useful service. To maintain this high level of performance, Coherent recommends that meters and sensors are serviced and re-calibrated once a year.

Any required service must be performed at Coherent's facility in Wilsonville, Oregon.

To arrange for warranty service or annual recalibration, contact your regional Coherent service center to obtain a Return Material Authorization (RMA) number.

Use the shipping box and packaging materials you retained to safely transport the sensor back to the factory for its annual calibration. See "Product Shipping Instructions" for details.

Should you experience any difficulties with the PowerMax-Pro 15mm Sensor sensor and need more assistance or technical information, contact LMC as described in the next sections.

Coherent Calibration Facilities

As the largest laser manufacturer in the world, Coherent has been able to build state-of-the-art calibration facilities containing the widest possible range of laser types and technologies. This enables us to perform instrument and sensor calibration under virtually any combination of wavelength, power, and operating characteristics.

Coherent is a registered ISO 9001:2000 company, our products are NIST traceable, and our calibration labs are fully ANSI Z540 compliant.

In addition to the technological advantage, we also strive to deliver the best service in the industry, with a knowledgeable and responsive staff, and rapid turnaround.

NIST Calibrated Standards

Sensors are calibrated against NIST-traceable working standard sensors which are, in turn, calibrated against NIST-calibrated golden standard sensors. These working and golden standards are maintained with the utmost care, recalibrated annually, and verified even more regularly. Coherent maintains multiple NIST-calibrated standards at many laser wavelengths to support growing calibration requirements.

Optical Calibration

Optical calibration is a core competency at Coherent, and we strive to continually improve our methods, precision, and repeatability.

Additionally, most of the calibrations are performed with highly automated systems, thus reducing the possibility of human error to nearly zero.

Strict quality inspections during many stages of calibration and testing assure a precise and accurate instrument that is NIST traceable and CE marked. The benefit is that instruments calibrated by Coherent consistently perform as expected under their actual use conditions.

Obtaining Service

To obtain service under warranty, Customer must notify the Company of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. The Company shall, in its sole discretion, determine whether to perform warranty service at the Customer's facility, at the Company's facility, or at an authorized repair station.

If Customer is directed by the Company to ship the product to the Company or a repair station, Customer shall:

- Package the product (to protect from damage during shipping) as instructed in “Product Shipping Instructions”.
- Ship it to the address specified by the Company, shipping prepaid. The customer shall pay the cost of shipping the Product back to the Customer in conjunction with recalibration and recertification; the Company shall pay the cost of shipping the Product back to the Customer in conjunction with product failures within the first twelve (12) months of time of sale or during an extended 12-month warranty period.

You must include a Returned Material Authorization number (RMA) assigned by the Company on the outside of all shipping packages and containers. Items returned without an RMA number are subject to return to the sender. Detailed instructions to prepare a product for shipping are provided in the next section.

Product Shipping Instructions

To prepare a product for shipping to Coherent:

1. Contact Coherent Customer Service (see “Contact Product Support” in the next section) for a Return Material Authorization number.
2. Attach a tag to the product that includes the name and address of the owner, the person to contact, the serial number, and the RMA number you received from Coherent Customer Service. This tag should be packed inside the box.
3. Wrap the product with polyethylene sheeting or equivalent material.

4. Using the original shipping and packaging materials, pack the product. If the original carton and packing materials are not available:
 - Obtain a corrugated cardboard shipping carton with inside dimensions that are at least 6 in. (15 cm) taller, wider, and deeper than the product. The shipping carton must be constructed of cardboard with a minimum of 375 lb. (170 kg) test strength.
 - Cushion the instrument in the shipping carton with packing material or urethane foam on all sides between the carton and the product. Allow 3 in. (7.5 cm) on all sides, as well as the top and bottom.
5. Seal the shipping carton with shipping tape or an industrial stapler.
6. Add the RMA number you received from Coherent Customer Service to the shipping label for the box.
7. Ship the sensor to the following address:

Coherent, Inc.
Laser Measurement and Control, Attn: RMA #
27650 SW 95th Ave.
Wilsonville, OR 97070
USA

Contact Product Support

Coherent provides telephone and web-based technical assistance as a service to its customers and assumes no liability thereby for any injury or damage that may occur contemporaneous with such services.

Under no circumstances do these support services affect the terms of any warranty agreement between Coherent and the buyer. Operation of any Coherent laser with any of its interlocks (or safety features) defeated is always at the operator's own risk.

Please be prepared to provide the following information to the Support Engineer who responds to your request:

- Model or part number of your unit
- Serial number of your unit
- A description of the problem
- Any corrective steps you may have attempted

For the latest Customer Service information, refer to the company website:

www.Coherent.com

In the USA and North America

If you are shipping products from within the United States or North America, contact Coherent LMC Technical Support directly, either:

- By phone in North America: (800) 343-4912 or (408) 767-4042
- By e-mail: LMC.sales@coherent.com

Telephone coverage is available Monday through Friday (except during U.S. holidays). Inquiries received outside normal office hours are tracked by our automatic answering system and promptly returned the next business day.

International

If you are located in Europe, contact LMC Technical Support directly, as follows:

- Germany: +49-6071-968-0
- Japan: +813-5635-8680

For Coherent general Technical Support, contact your local Coherent Service Representative, or contact us as follows:

- By phone: 1-(408)-764-4557 or 1-(800)-367-7890
- By email: customer.support@coherent.com
- To view a list of contact names, telephone numbers, and addresses worldwide, visit our website:

<https://www.coherent.com/support/>

APPENDIX D: WARRANTY

This section provides information about:

- Limited warranty
- Extended warranty
- Warranty limitations

A PowerMax-Pro 15mm Sensor ships with a standard one-year warranty, described in this section.



NOTE:

The warranty is maintained throughout the lifetime of the sensor if it has never been disassembled and is returned annually for service and recalibration.

If the PowerMax-Pro 15mm Sensor is disassembled and reassembled, the Coherent warranty and calibration is no longer valid.

Limited Warranty

Coherent, Inc. (the “Company”) warrants its laser power and energy meters and sensors products (“Products”) to the original purchaser (the “Customer”) that the product is free from defects in materials and workmanship and complies with all specifications, active at the time of purchase, for a period of twelve (12) months.

Coherent, Inc. will, at its option, repair or replace any product or component found to be defective during the warranty period. This warranty applies only to the original purchaser and is not transferable.

Extended Warranty

Coherent, Inc. (the “Company”) offers original purchasers (the “Customer”) purchasing laser power and energy meters and sensors products (“Products”) an extended twelve (12)-month warranty program, which includes all parts and labor.

To qualify for this warranty, a Customer must return the Product to the Company for recalibration and recertification. The Company will re-certify the Product, provide software upgrades, perform any needed repairs, and recalibrate the Product for a fixed service fee (as established by the Company from time to time and in effect at the time of service).

If the product cannot be re-certified due to damage beyond repair, parts obsolescence, or other reasons, the Customer may be informed that an Extended Warranty program is not available for the Product.

If the Product fails and is returned to the Company within one year following the date of recalibration and recertification service, the Company will, at its option, repair or replace the Product or any component found to be defective.

If the Product must be replaced and the Product is no longer available for sale, Coherent reserves the right to replace with an equivalent or better Product. This warranty applies only to the original purchaser and is not transferable.

Warranty Limitations

The foregoing warranties shall not apply, and Coherent reserves the right to refuse warranty service, should malfunction or failure result from:

- Damage caused by improper installation, handling or use.
- Laser damage (including OEM detectors damaged beyond repair).
- Failure to follow recommended maintenance procedures.
- Unauthorized product modification or repair.
- Operation outside the environmental specifications of the product.

Coherent assumes no liability for Customer-supplied material returned with Products for warranty service or recalibration.

THIS WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES WHETHER WRITTEN, ORAL, OR IMPLIED. COHERENT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL THE COMPANY BE LIABLE FOR ANY INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH ITS PRODUCTS.

