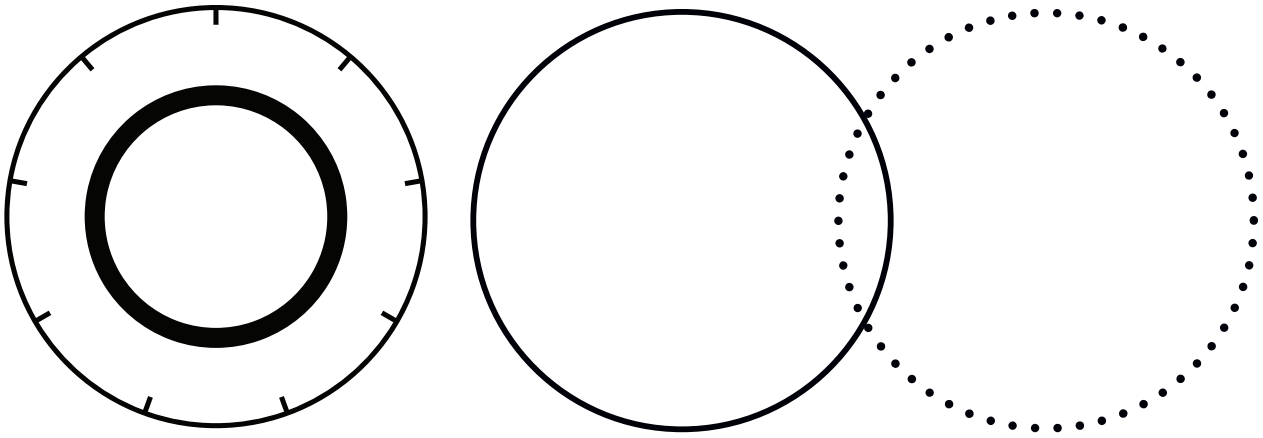
PM10K+/PM15K+ Sensor System

Operator's Manual



INNOVATIONS THAT RESONATE

COHERENT

PM10K+/PM15K+ Sensor Systems

Operator's Manual

COHERENT

Technical Support

In the U.S.:

Should you experience any difficulties with your product or need any technical information, please go to our website www.Coherent.com. Should you need further assistance, please contact Coherent LSM Service by e-mail LSMservice@coherent.com or telephone, (800) 343-4912. Please be prepared to supply the model and serial number of your product, the description of the problem, and any attempted corrective steps to the Product Support Engineer responding to your request.

Telephone coverage is available Monday through Friday (except U.S. holidays and company shutdowns). Inquiries received outside of normal office hours will be captured by our automatic answering system and will be quickly returned the next business day.

Outside the U.S.:

If you are located outside the U.S., please visit www.Coherent.com for technical assistance, or contact your local Service Representative. Service Representative telephone numbers and addresses can be found on the Coherent website.

Coherent provides telephone and web-based technical assistance as a service to its customers and assumes no liability for any injury or damage that can occur at the same time with such services. Under no conditions 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 defeated is always at the operator's own risk.

Corporate Addresses:

Coherent Corp	**Coherent Europe B.V. as EU Representative**
5100 Patrick Henry Dr.	Huis Ter Heideweg 14, Zeist,
Santa Clara, CA 95054	3705 LZ, Utrecht, The Netherlands

Product Made in Wilsonville, Oregon U.S.A.

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Signal Words and Symbols in this Manual

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.

1.1.1 Signal Words

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

The signal words **DANGER**, **WARNING** and **CAUTION** designate the degree or level of hazard when there is the risk of injury:

DANGER!
Indicates a hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING!
Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION!
Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

The signal word "***NOTICE***" is used when there is the risk of property damage:

NOTICE
Indicates information considered important, but not hazard- related.

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

1.1.2 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:

This symbol is intended to alert the operator to the presence of additional information.

This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.

This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.

This symbol is intended to alert the operator to the presence of dangerous voltages within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock.

This symbol is intended to alert the operator to the danger of Electro-Static Discharge (ESD) susceptibility.

This symbol is intended to alert the operator to the danger of crushing injury.

This symbol is intended to alert the operator to the danger of a lifting hazard.

1.2 Preface

This manual contains user information for the PowerMax 10kW/15kW Sensor System.

NOTICE
Read this manual carefully before operating the power sensor for the first time. Failure to follow the instructions and safety precautions in this manual can result in serious injury or death. Special attention must be given to the material in 'Safety Summary' (p. 7), that describes the safety features built into the laser. Keep this manual with the product and in a safe location for future reference.

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

1.3 Export Control Laws Compliance

It is the policy of Coherent to comply strictly with U.S. export control laws.

Export and re-export of laser products 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.

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 U.S. law, clarification must be obtained from Coherent or an appropriate U.S. Government agency.

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.

1.4 The Operator's Manual

This Operator Manual is designed to familiarize the user with the PM10K+/PM15K+ system and its designated use. It contains important information on how to install, operate, and troubleshoot the sensor system safely, properly, and most efficiently. Observing these instructions helps to avoid danger, reduce repair costs and downtimes, and increase the reliability and lifetime of the sensor system.

This Manual:

- describes the physical hazards related to the sensor system, the means of protection against these hazards, and the safety features incorporated in the design of the sensor system
- briefly describes the purpose and operation as well as the primary features, system elements, subsystems, and fundamental laser control routines of the sensor system
- describes the fundamental operation of the sensor system
- describes the maintenance procedures for the sensor system which can be performed by the end user. This includes a time schedule for all periodic routine replacement procedures and a basic trouble-shooting section.

The screenshots in this manual are only examples and may show configurations or parameter settings which do not apply to this power sensor system. Changing parameter settings to correspond with screenshots may reduce laser performance or even damage the sensor system!

1.4.1 Intended Audience

The Operator's Manual is intended for all persons that are to work on or with the sensor system. It assumes that the reader has received guidance from their company's laser safety officer on the safe operation of the sensor system.

None of the procedures described in this manual requires the defeating of safety interlocks. Where specific training is required to perform procedures, this is clearly indicated at the beginning of the corresponding section.

1.4.2 Availability and Use

This Operator's Manual must always be available wherever the sensor system is in use. Keep this manual in a safe location for future reference. It must be read and applied by any person in charge of carrying out work with and on the sensor system, such as

- operation (including setting up, troubleshooting in the course of work, removal of production waste, care and disposal of consumables,
- service (maintenance, inspection, repair) and/or
- transport.

1.4.3 Numbering of Sections, Pages and Instructions

The sections are numbered continuously. The name of the section appears in the upper outside corner of every odd page. Each section ends with an even page number. Consequently, certain even pages at the ends of sections will be intentionally left blank.

The pages of this manual are numbered continuously by section. The page number appears in the bottom center of every page.

Each step within a procedure is sequentially numbered. Each procedure starts with the step number one.

2 Safety Summary

Carefully review the safety information to prevent personal injury or damage to this product or any equipment connected to it. There are no user-serviceable parts. For service information, refer to 'Obtain Service' (p. 138).

WARNING!
Do not operate the system if its panels are removed or any of the interior circuitry is exposed.

WARNING!
Do not operate the system in wet or damp conditions, or in an explosive atmosphere.

NOTICE
Do not operate the system if there are suspected failures. Refer damaged units to qualified Coherent service personnel.

2.1 Safety Information Summary

This section gives summary electrical and laser safety information specifically for the PM10K+/PM15K+ Sensor Systems.

Devices must be IEC/EN 62368 or IEC 60950 tested and approved before they are connected to the USB or RS-232 ports.

For complete safety information refer to 'Safety' (p. 145).

The table below describes standard safety measures necessary when the sensor is used with a laser.

Table 2-1. Laser Safety

Scope	This user information is in compliance with the following standards for Light-Emitting Products IEC 60825-1 "Safety of laser products - Part 1: Equipment classification and requirements" and CDRH 21 CFR Title 21 Chapter 1, Subchapter J, Part 1040 "Performance standards for light-emitting products" except for conformance with IEC 60825-1 Ed. 3 and IEC 60601-2-22 Ed. 3.1, as described in Laser Notice No. 56, dated May 8, 2019.
Hazards	
- Biological/Optical	Exposure to laser radiation may damage the eyes or skin. Wear appropriate laser safety eyewear for protection against the specific wavelengths and laser energy being generated. See '' (p. 145) for additional information/guidelines.
- Electrical	The rules for electrical safety must be strictly followed. See'Electrical Safety' (p. 146) for additional information/guidelines.
- Chemical	Contact of the laser beam with volatile or flammable substances, or released as a result of laser material processing.
Control Measures	Laser incorporates protective housing, safety interlocks, remote interlock connector, key switch, laser emission indicators, beam attenuator, operator's controls, display, and manual reset mechanism in accordance with CFR 1040.10 (f)(6)/IEC 60825-1. See 'Safety' (p. 145) for additional information.
Warning Labels	Refer to Figure I.4 on page 148 for the location of all safety labels.

3 Description and Specifications

3.1 Introduction

The PM10K+/PM15K+ water-cooled high-power laser power sensor systems are used to measure the power output of CO2, fiber, diode, and continuous wave lasers. The series includes the standard PM10K+, the PM10K+ with Backscatter Shield, and the PM15K+.

The PM10K+ features a 65 mm x 65 mm sensor with BB+ coating, handling power densities from 6 kW/cm² (at 1 kW) to 2.6 kW/cm² (at 10 kW). The PM10K+ with Backscatter Shield integrates a specialized water-cooled light trap with 65 mm diameter input port that captures 99% of backscattered laser energy, minimizing reflections.

The PM15K+ expands power handling up to 15 kW continuously at up to 2.0 kW/cm² and 20 kW intermittently, with a larger 100 x 100 mm active area, making it ideal for higher-power and larger-sized laser beams.

Figure 3-1. Power Sensors (PM15K+ USB Model)

All models support USB + DB25 or RS232 communication and deliver fast, 3- to 5-second measurement speed. DB25 + USB sensor models are compatible with stand-alone Coherent power meters, available for order separately

Figure 3-2. Power Sensors (USB Model)

A software application (Coherent Meter Connection) supplies a virtual instrument interface for sensors that enable the operator to take laser power readings, log data, and compute measurement statistics. 5

Users can also write their own software with host interface commands that control all aspects of power meter operation.

For a brief product overview video, go to:

https://www.youtube.com/watch?v=86zNO-yxzCw

3.1.1 Technical Description

3.1.1.1 Technology and Theory of Operation

The PM10K+/PM15K+ power sensors are a great all-purpose technology suitable for many lasers. They are a type of calorimeter sensor.

The Coherent PM10K+/PM15K+ laser power sensors overcome the limitations of previous sensors by employing Coherent's own novel technology. This speeds up the measurement process by 5X. Power measurements that previously required 15 seconds can be completed in under 3 seconds.

Applications

The high-power handling capability of the new PM10K+/PM15K+ models are particularly useful with high-power fiber lasers, CO2 lasers, or solid state lasers for welding, cutting, drilling, and engraving.

- Laser power monitoring of CW or modulated lasers
- Manufacturing, QA, and Engineering Applications
- Commercial OEM integration
- Laser Welding, Cutting, Brazing processes

3.2 Product Overview

3.2.1 Key Product Features

The PM10K+/PM15K+ sensor systems, within the PowerMax product line, now provide the ability to capture and measure ultra high power laser output.

Key features of the PM10K+/PM15K+ Sensor systems are:

- Fast 2-second measurement speed
- BB+ broadband absorber coating, from 190 nm to 11 microns, with a high-power density threshold
- Large active area: 65 x 65 mm (PM10K+), 100 x 100 mm (PM15K+)
- DB25 with USB and RS-232 configurations
- Water-cooled sensor system
- Safety interlock monitors temperature and water flow conditions
- Flexible dovetail rail mounts on three sides, as well as post-mount fixtures for flexible mounting
- Multi-mode Status LED

3.2.2 Additional Technical Product Features

3.2.2.1 Fast Response Time

The PM10K+/PM15K+ provide 4 to 5 times faster response time than competitive products. The 99% response time for the power meter is as quick as two seconds depending on water flow rate.

The graphs in Figure 3-3 and Figure 3-4 in show response time comparisons with and without speedup.

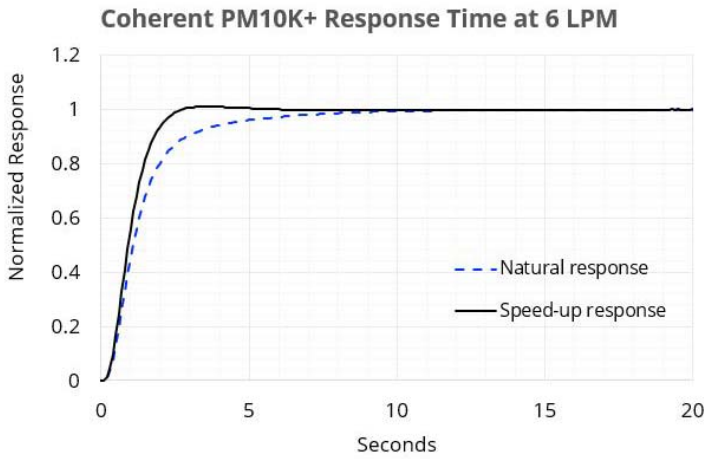


Figure 3-3. Speedup and Natural Response Time Comparisons (PM10K+)

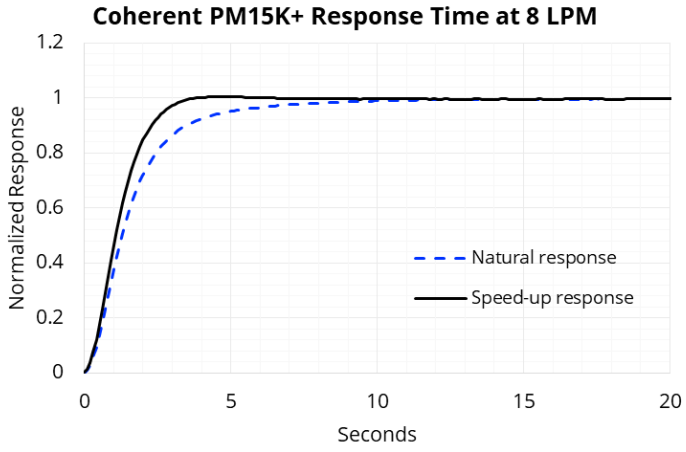


Figure 3-4. Speedup and Natural Response Time Comparisons (PM15K+)

3.2.3 Software Features

The Coherent Meter Connection software offers an easy-to use Windows-based interface to perform a wide range of analysis functions for instrument control and measurement. This includes:

- Trending with Time and Power cursors
- Energy integration
- Tuning
- Data logging
- Statistics
- Histogram

For more details refer to the Coherent Meter Connection User Manual (PN 1343658) available at www.coherent.com/resources.

3.2.4 Understand Product Configurations

The current product configurations for the PM10K+/PM15K+ Sensor systems is shown in Table 3-1.

Table 3-1. Model Configurations

Part Number	Description
2293937	PM10K+, 65mm Aperture, USB with DB25
2293938	PM10K+, 65mm Aperture, RS-232
2293940	PM10K+, 65mm Aperture, DB25/USB, Backscatter shield
2293941	PM10K+, 65mm Aperture, RS-232, Backscatter shield
2311240	PM15K+, 100mm Aperture, USB with DB-25
2311244	PM15K+, 100mm Aperture, RS232

3.2.5 PM10K+ Description

The PM10K+/PM15K+ models have a 65mm x 65mm square active absorber capture area. Refer to Figure 3-5.

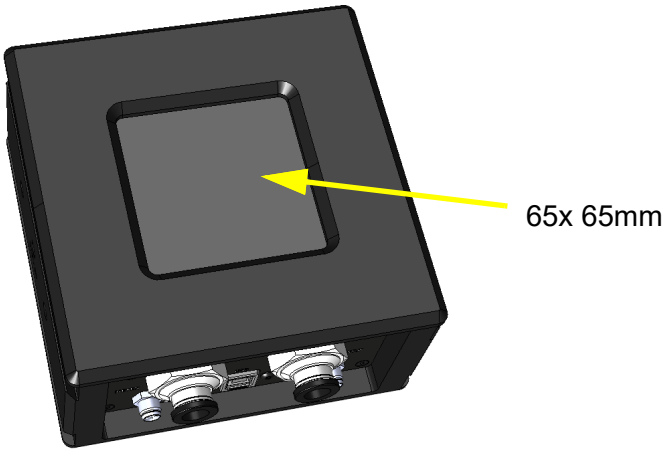


Figure 3-5. Active Sensor Absorber Area (PM10K+ model)

It has multiple inputs and outputs for water, communications and power.

The RS-232-enabled model (PN 2293938) also has a separate 5VDC power connector. Refer to Figure 3-6.

Figure 3-6. Connections - PM10K+ RS-232 Model

The USB + DB25-enabled model (PN 22939737) supports direct metered connection through the DB25 cable. Device power is supplied through the USB connection or DB25 cable via the connected meter. If both USB and DB25 meter are connected, power is supplied by the USB connection. Refer to Figure 3-7.

Figure 3-7. Connections - PM10K+/PM15K+ USB + DB 25 Model

The body has multiple mount features described in ’Mount Features’ (p. 18).

3.2.5.1 PM15K+ Description

The PM15k+ sensor has a 100 x 100mm square active absorber area.

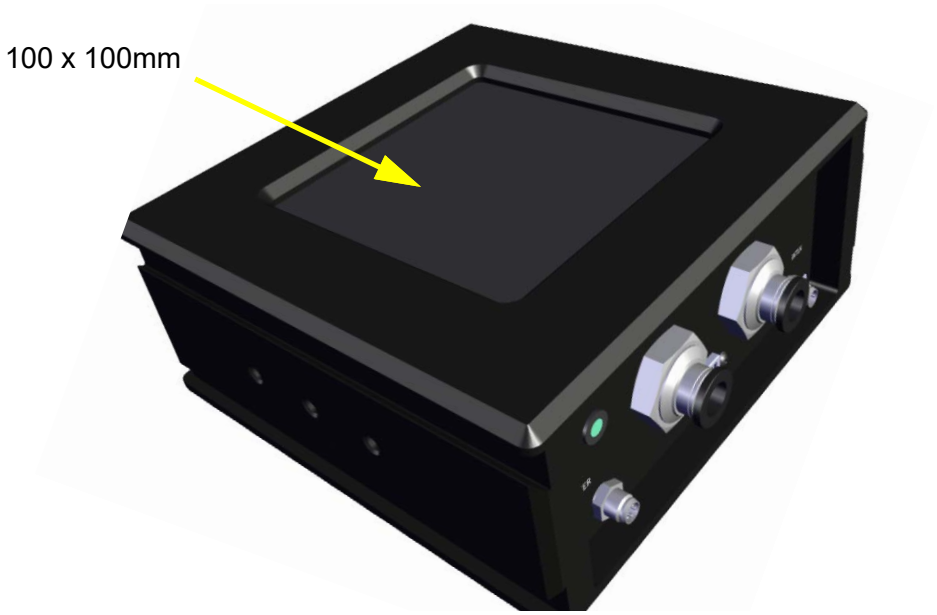


Figure 3-8. Sensor Active Sensor Absorber Area (PM15K+)

The PM15k+ configurations have the same, similarly located inputs and outputs as the respective PM10k+ models.

Figure 3-9. PM15K+ Interface Panel (USB + DB25 Model)

3.2.5.2 PM10K+ with Backscatter Shield Description

It can be important to strongly suppress any reflected and back-scattered light. For example, even a minimum fraction of scattered light from a kilowatt laser beam could be problematic in terms of laser safety. Usually 10% of the laser light is reflected back from the absorber surface.

A PM10K+ Backscatter shield model has an integrated, water-cooled backscatter shield over the absorber surface.

Figure 3-10. PM10K+/PM15K+ Sensor with Backscatter Shield Configuration

The input beam is aimed through the aperture at the front of the backscatter shield and then onto the beam absorber surface of the power sensor located on the inside. 99% of the total incident laser power is contained by the device.

Figure 3-11. Sensor Absorber Surface - Backscatter Shield Configuration

3.3 Mount Features

NOTICE

Unless otherwise noted, illustrations in this section show the base configuration of the PM10K+ that does not have the backscatter shield.

3.3.1 Dovetail Mount Rails

Three outer sides of the sensor have dovetail rail features that can be used to move/adjust the location of the sensor on optional mount hardware and posts. Refer to the example with the mount in Figure 3-12. through Figure 3-16

Figure 3-12. Dove-tail Rails on Sensor (Backscatter Shield Model)

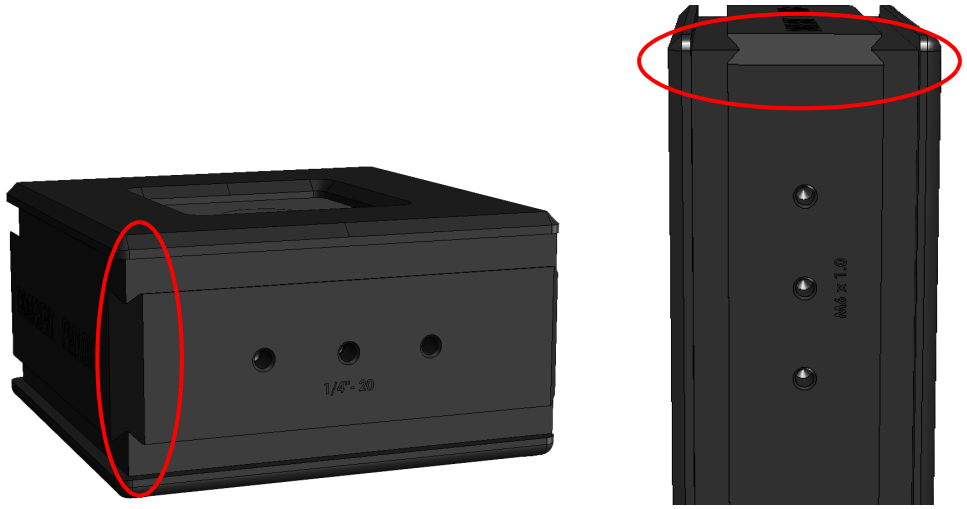


Figure 3-13. Dove-tail Rails on Sensors

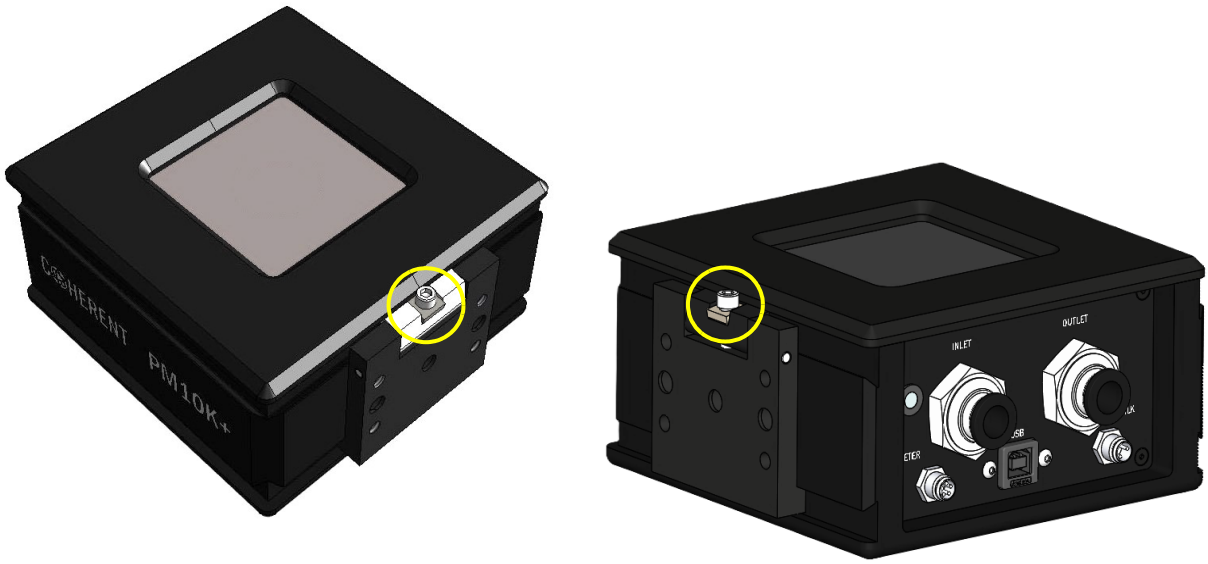


Figure 3-14. Dove-tail Rail Mount with Lock Screw (Circled) Installed on Sensor

Figure 3-15. Dove-tail Rail Mount with Lock Screw (Circled) Installed (Backscatter Shield model)

A mount base on posts (not supplied) can be loosened and tightened, and can be moved along a dove-tail 'rail', for adjustment.

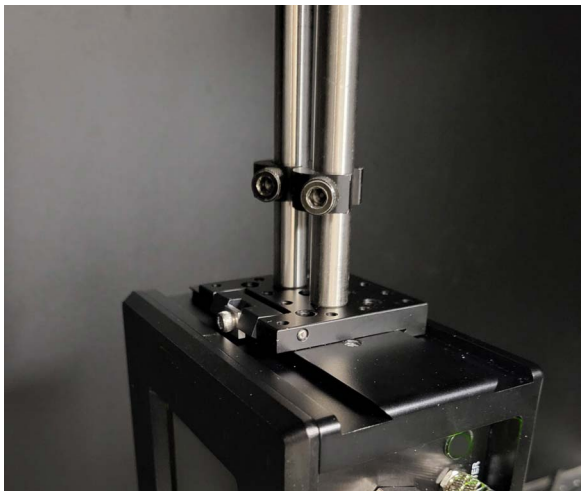


Figure 3-16. Post-mounted on Dove-tail Mount

The laser beam can be easily put in the center of the aperture by sliding sensor along with an optional rail mount.

3.3.2 Post/Stand Mount Features

Two opposite sides of the sensor also each have three direct threaded mount locations for direct installation of customer-supplied mount posts. One side has M6 x 1.0 threaded holes. Refer to the examples in Figure 3-17 for a PM10K+ model without the backscatter shield.

Figure 3-17. Threaded M6 x 1.0 Mount Holes

The other side of the sensor has 1/4-inch - 20 mount holes. Refer to Figure 3-18

Figure 3-18. Side of Sensor with Threaded 1/4-in - 20 Mount Holes

Coherent recommends that when posts are used, that at least two are set up, to keep the unit from having unintentional rotation.

Figure 3-19. Install Two Threaded Mount Posts

3.4 Standard Accessories

3.4.1 Cables and Interfaces

Depending on the model, different input/output accessories are used.

Figure 3-20. USB + DB25 and RS-232 Models (PM10K+)

- For the USB + DB25 model sensors, a specific DB25 analog interface cable (PN 2311500) is supplied for connection directly to an external standalone meter. It has a DB25 connector on one end for meter connection and the other has a push connector to attach to the sensor at the connector labeled 'METER'. Refer to Figure 3-7.

Figure 3-21. DB 25 Analog Cable

NOTICE

The DB25 cables are made with electronics that are programmed specific to the individual units that they are shipped with. Cables are not interchangeable between sensor heads. There is an identifying label with serial information that must match that of the sensor used.

- A supplied USB cable interface provides power and meterless communications through a host PC for the sensors with a USB + DB25 configuration. (PNs 2293937, 2293940 and 2311240)

Figure 3-22. Standard USB Cable

- For RS-232 model (PNs 22939738, 2293941 and 2311244) power sensors, a supplied standard RS-232 cable interface (PN 2237377) provides meterless communications through a host PC.

  It is also possible to set pin 1 through the DB9 connector to provide power to the sensor instead of through the external power supply. For support with such a configuration, contact Coherent Support for additional information.

Figure 3-23. RS-232 Cable

- For RS-232 models, a 5V, 12W power supply (PN 1105557) is provided. This power supply is needed when power is not configured to be provided through the RS-232 cable Pin 1. The power supply cables provided will match the configuration for the final country of use.

Figure 3-24. 5V, 12W Power Supply

3.4.2 Mount Accessories

An included side-locked rail mount accessory (PN 2320728) for the system attaches to the dovetail rails on the sensor. Refer to Figure 3-25.

- For more details and specifications, refer to Table III-1, 'Accessories Included with PM10K+/PM15K+,' on page 153.

Figure 3-25. Rail Mount Accessory and Installation Example

3.4.3 3/8-in Hose Adapter Fittings

A pair of 3/8-inch outer-diameter inlet adapter fittings (PN 2282786) are supplied by Coherent. The fittings can be used with 3/8-in hoses to step down from metric 10mm outer-diameter This allows users to adapt their 3/8-inch tubes to the 10mm push-to-connect interfaces for the sensor inlet/outlet. Refer to Figure 3-26.

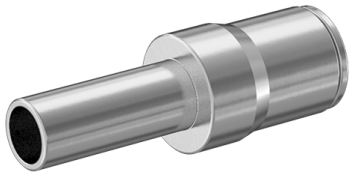


Figure 3-26. 3/8-inch Hose Adapter

3.5 Interlock Connection and Functionality

Each sensor system has a 2-pin, M8 barrel connector for interlock connection.

Figure 3-27. M8, 2-pin Barrel Connector for Interlock

The customer-supplied cable must match to this specification to connect to the user's interlock chain. An example of available cable can be found from suppliers such as Digikey, part number SD-PME02B-FFTBL-C7A. Refer to:

https://www.digikey.com/en/products/detail/ad-am-tech/SD-MME02B-MMTPH-S70-000/9830223

See the example in Figure 3-28.

Figure 3-28. Example M8, 2-pin Barrel Male Connector With 2-wire Pigtail

The sensor provides connection into a laser's interlock system when the sensor detects a dangerous condition.The sensor interlock will be in an open state and will set laser emission to OFF if connected to the laser interlock system. The primary purpose of the interlock is to protect the **sensor** from damage. Other safety precautions must be taken to protect operators when work is done with high power lasers. Refer to the laser documentation for laser safety requirements.

The interlock relay is normally open, which indicates a condition that can damager the sensors. The sensor only closes the interlock relay when the water flow is correct.

Refer to the example interlock diagram in Figure 3-29.

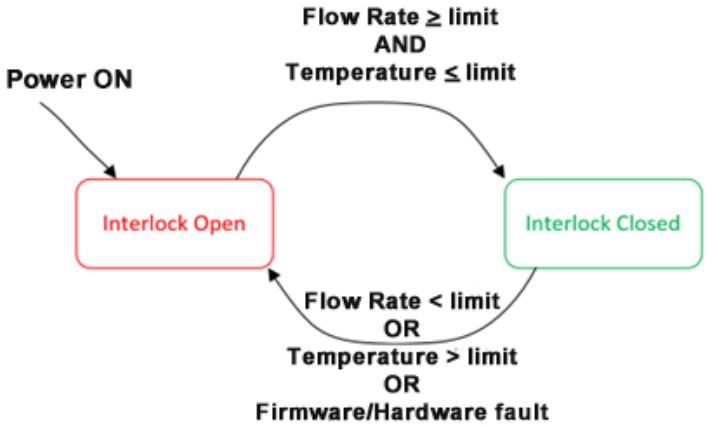


Figure 3-29. Interlock Relay Behavior

3.6 Plug-and-Play Software Interface

The Coherent Meter Connection plug-and-play application software has a graphical user interface used to perform various laser measurement tasks.

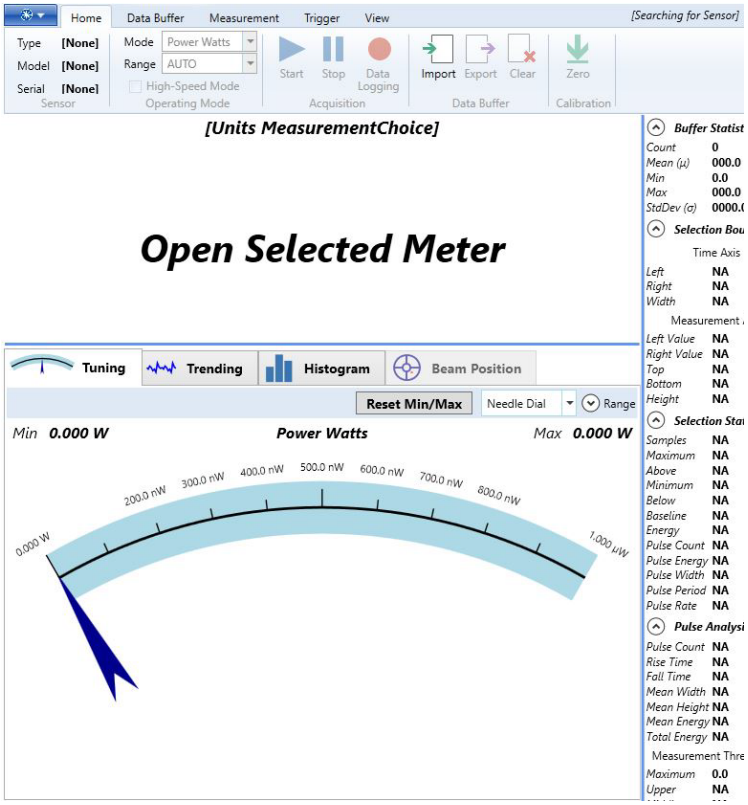


Figure 3-30. Software Interface

The standard application software is supplied standard includes these features:

- Trend analysis with time and power cursors
- Statistics (mean, minimum, maximum, and standard deviation) and log batch to file
- Tuning analysis
- Histogram analysis
- Simultaneously operate several sensors
- Diagnostics for water flow rate and temperature

NOTICE

For access to diagnostic functionality specific to the PM10K+/PM15K+, version 1.3 or higher of the software must be used.

3.7 External Control Remote Interface

For system integrators and for implementations that include customer-written software, the sensors include a complete command set that is easy to access:

- Utilizes a Windows USB driver and supports simple ASCII host commands for remote interfacing.
- Use of customer-written software, the remote interfacing host command set permits sensors to be remotely controlled.

For more information refer to 'Host Interface' (p. 106).

3.8 Specifications

For the latest specification values, also refer to the product datasheet available at www.coherent.com/resources.

3.8.1 Electrical/Power Specifications

A 5-24 VDC power supply can be used with the RS-232 model. Refer to Figure 3-24.

3.8.2 Laser Power Specifications

Table 3-2 shows the laser power specifications for the PM10K+/PM15K+:

Table 3-2. Laser Power Specifications

Parameter	PM10K+	PM10K+ with Backscatter Shield	PM15K+
Average Power Range (continuous) (W);refer to power handling curve for beam size requirements, Figure 3-31, Figure 3-32	100 to 10,000		100 to 15,000
Noise Equivalent Power (W) (at 6 lpm) USB and RS-232 DB-25 with meter	<0.2 (USB and RS-232), <1.0 (DB-25 with meter)		
Maximum Intermittent Power (kW)	12, beam size dependent		20
Maximum Power Density (kW/cm^2) (Gaussian beams)	6.0 at 1 kW 2.6 at 5 kW 2.6 at 10 kW 2.5 at 12 kW		3.2 at 5 kW 2.3 at 10 kW 2.0 at 15 kW 1.9 at 20 kW
ISO 17025 Calibration Uncertainty (%)	±3		
Power Linearity (%)	±1.5		
Spectral Compensation Accuracy (%)	±1.5		

* Applies to USB/RS only and can vary based on the chiller system used.

The graphs in Figure 3-31 and Figure 3-32 show the effect on beam (Gaussian) diameter as power is increased.

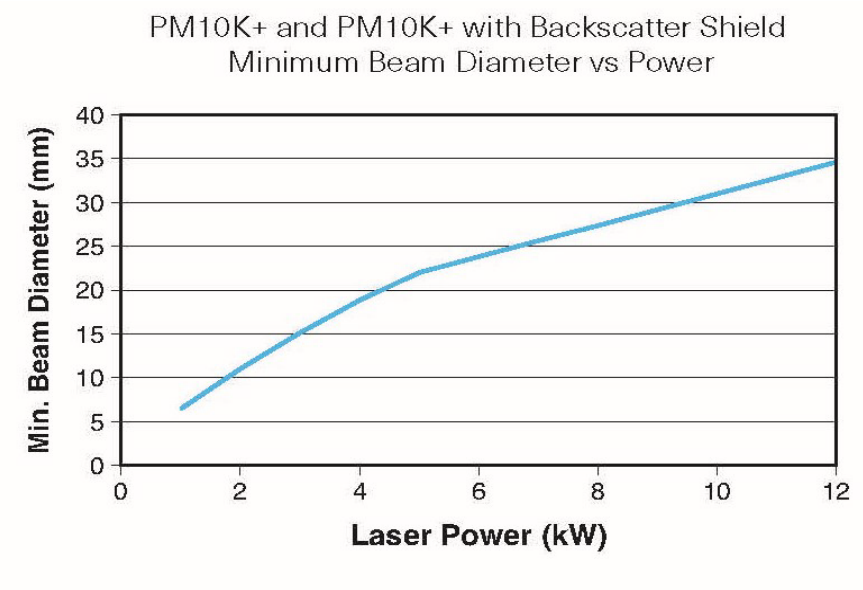


Figure 3-31. Minimum Beam Diameter vs Power (PM10K+)

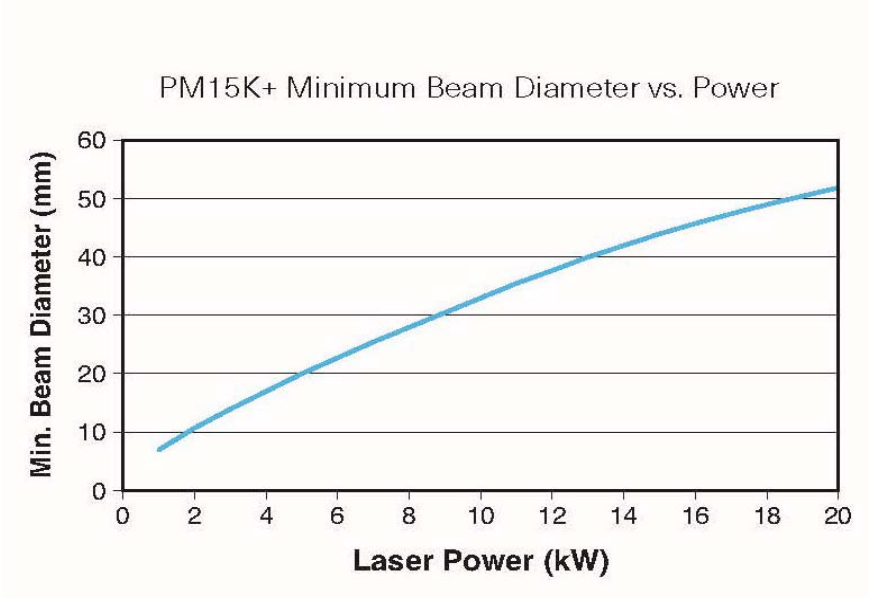


Figure 3-32. Minimum Beam Diameter vs Power (PM15K+)

CAUTION!
Users must keep the laser power and beam size within the specifications below the line in the graph. This allows the laser to operate safely so that the sensor surface is not damaged.

3.8.3 General Specifications

Table 3-3 shows general specifications for each sensor system. For complete specifications refer to the PM10k+ and PM15K+ Laser Power Sensors datasheet at www.coherent.com/resources.

Table 3-3. General Specifications

Specification	PM10K+	PM10K+ with Backscatter Shield	PM15K+
Active Area Detector Dimension	65 x 65mm		100 x 100mm
Detector Coating	BB+		
Recommended Minimum Beam Size (mm) (Gaussian beams)	6.5 at 1 kW 22 at 5 kW 31 at 10 kW 35 at 12 kW		20 at 5 kW 33 at 10 kW 44 at 15 kW 52 at 20 kW
Wavelength Range	0.19 to 11 µm		
Calibration Wavelength	1080 nm		
Calibration Uncertainty (k=2)	± 2 %		
Cooling Method	Water		
Minimum Water Flow Rate (LPM) [1]	6 (~10PSI)		8 (~10PSI)
Response Time (0 to 99%) (at 6 LPM) [2] Speed-up On (seconds) Speed-up Off (seconds)	<3 10		4.5 14
Analog Cable Type	DB25		
Analog Cable Length	2 m		
USB Cable	standard Type A-B		

Table 3-3. General Specifications (continued)

Specification	PM10K+	PM10K+ with Backscatter Shield	PM15K+
RS-232 Cable	standard		
Temperature for usage and storage	5°C to 40°C		
Operating environment	Non-condensing humidity		

[1] Water temp. should be stable to <3 °C change per min. and <1 LPM variation in flow rate for best measurement stability.

[2] Refer to Figure 3-3 (p. 12)

3.8.4 Additional Technical Specifications

3.8.4.1 Spectral Absorption Curve & Spectral Compensation

Each Coherent PowerMax sensor provides spectral compensation to account for the sensor's spectral response at different wavelengths. Selecting the measurement wavelength applies a compensation factor to account for this response.

The graph Figure 3-33 shows the rate of absorption as it relates to the laser wavelength being absorbed.

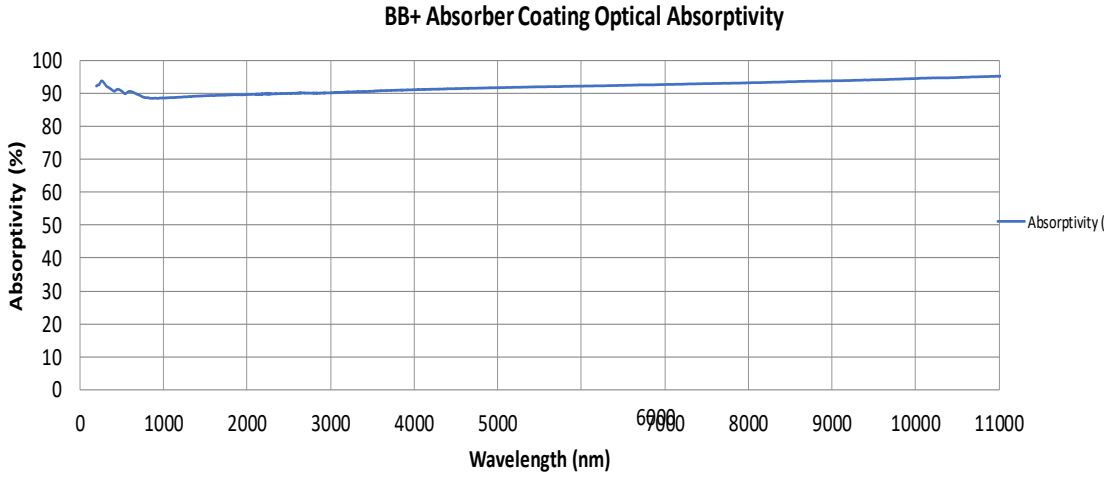


Figure 3-33. Absorber Optical Absorptivity Curve

3.8.4.2 Absorber Damage Resistance

The surface coating on the beam absorber is highly resistant to damage from laser radiation. However if exposed in certain conditions to high-power laser light, the surface can be damaged.

The graphs in Figure 3-31 and Figure 3-32 show the relationship between beam diameter and power levels.

CAUTION!

It is critical that the laser beam diameter and power levels are managed so that the beam intensity does not cause damage to the equipment.

The maximum power density at different kilowatt levels is shown in the specifications in Table 3-2, ’Laser Power Specifications,’ on page 31.

3.8.5 Water Supply Specifications

Water flow is required to keep the device at a correct temperature range and to perform measurement.

3.8.5.1 General Coolant Water Requirements

Following are requirements for coolant for the PM10K+/PM15K+:

- If fluid other than tap or distilled water is used, this can change the cooling/heating capacity and can affect measurement outcomes and accuracy.

The exact temperature of the water is not critical as long as the temperature is relatively stable. The water can be supplied from a chiller or local tap.Allow sufficient time for the water flow and sensor head to reach equilibrium. The water flow should run through the sensor for about two minutes before zeroing the meter and beginning the measurement.

Table 3-4. Water Supply Specifications (all models)

Parameter	Value
Cooling fluid	Water
Temperature	10°C to 25°C
Water temperature stability	<3 °C change per min
Flow rate stability	<1 LPM variation

3.8.5.2 Coolant Water Flow Rates

The specifications for the water system require:

- Nominal flow rate of 8 LPM (liters per minute)
- Minimum flow rate of 6 LPM
- The flow rates are minimums for correct heat transfer from these sensors. Higher flow rates result in slower temperature increases. Flow rates should be stable.

Specifications for fittings for water-cooled PM10K+/PM15K+ sensors are:

- Water port size: 10mm outer-diameter (OD) push-to-connect
- Minimum water flow rate: 1.5 GPM (gallons per minute) or 6 LPM (liters per minute)

3.9 Dimensions and Drawings

This section gives graphical information about the PM10K+/PM15K+ sensor systems with size and spacing dimensions.

3.9.1 PM10K+ Dimensions

A top view of the PM10K+/PM15K+ dimensions is shown in Figure 3-34.

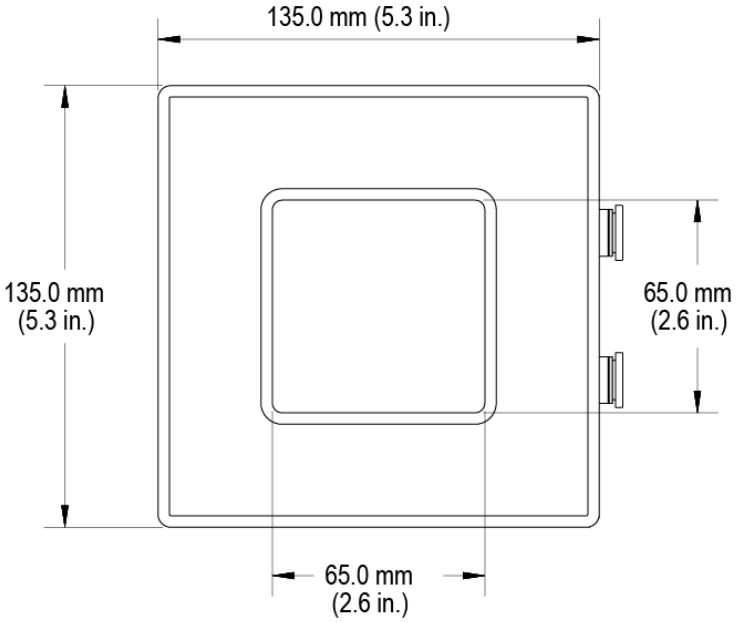


Figure 3-34. PM10K+/PM15K+ Base Unit Dimensions, Top View (in mm)

A view of one side (1/4" - 20 holes) of the PM10K+/PM15K+ is shown in Figure 3-35. Space measurements for the mount holes are shown also.

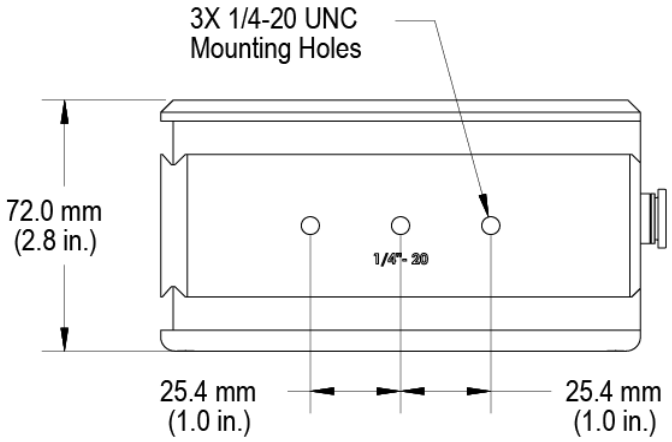


Figure 3-35. PM10K+ Base Unit Height Dimensions and 1/4-20 Mount Hole Locations

Figure 3-36 shows the M6 mount hole locations and spacing on the other side of the PM10K+ model.

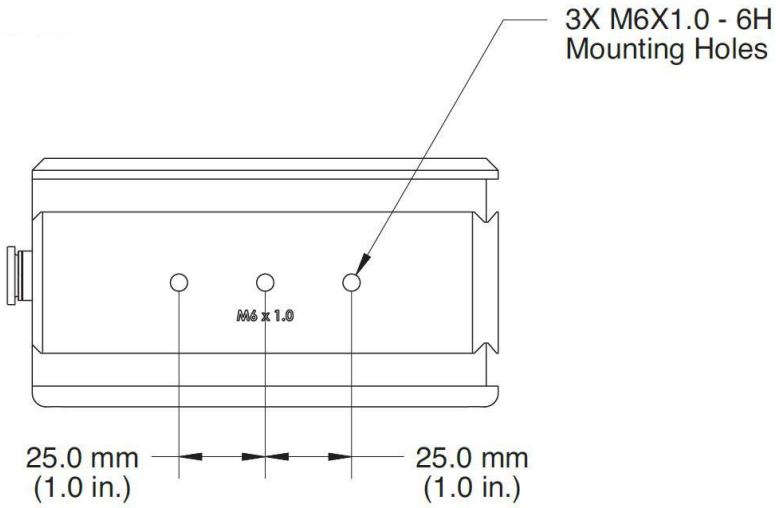


Figure 3-36. PM10K+ Base Unit M6 Mount Hole Locations

3.9.2 PM10K+ with Backscatter Shield Dimensions

A view of the top of the PM10K+/PM15K+ with Backscatter Shield, with dimensions, is shown in Figure 3-36.

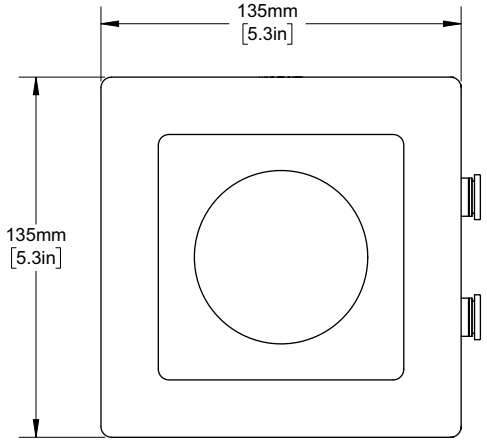


Figure 3-37. PM10K+ with Scatter Shield Unit M6 Mount Hole Locations

Figure 3-39 shows the 1/4” - 20 mount hole locations and spacing on the one side of the PM10K+ with Backscatter Shield model

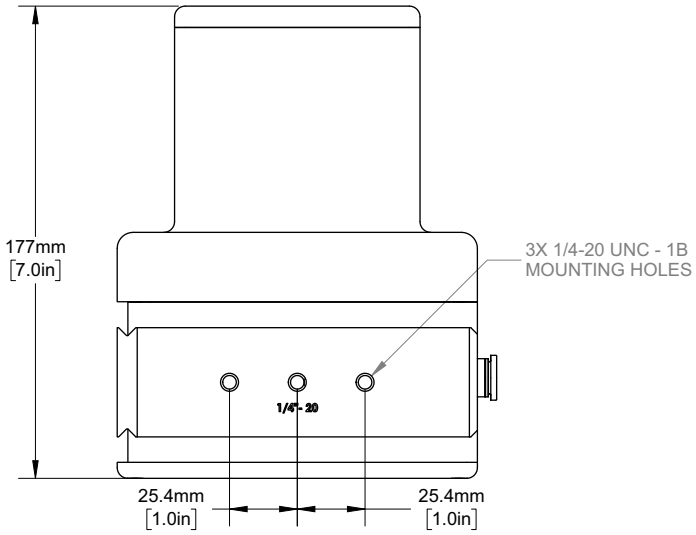


Figure 3-38. PM10K+ with Backscatter Shield 1/4” - 20 Mount Hole Locations

Figure 3-39 shows the M6 mount hole locations and spacing on the other side of the PM10K+ with Backscatter Shield model

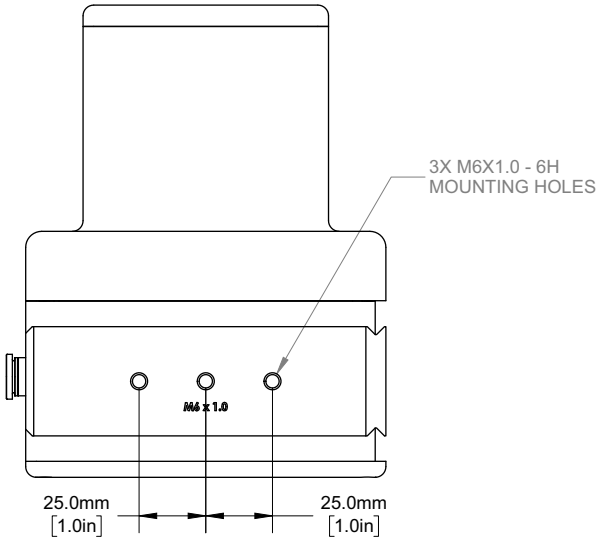


Figure 3-39. PM10K+ with Backscatter Shield M6 Mount Hole Locations

3.9.3 PM15K+ Dimensions

A top view of the PM15K+ dimensions is shown in Figure 3-34.

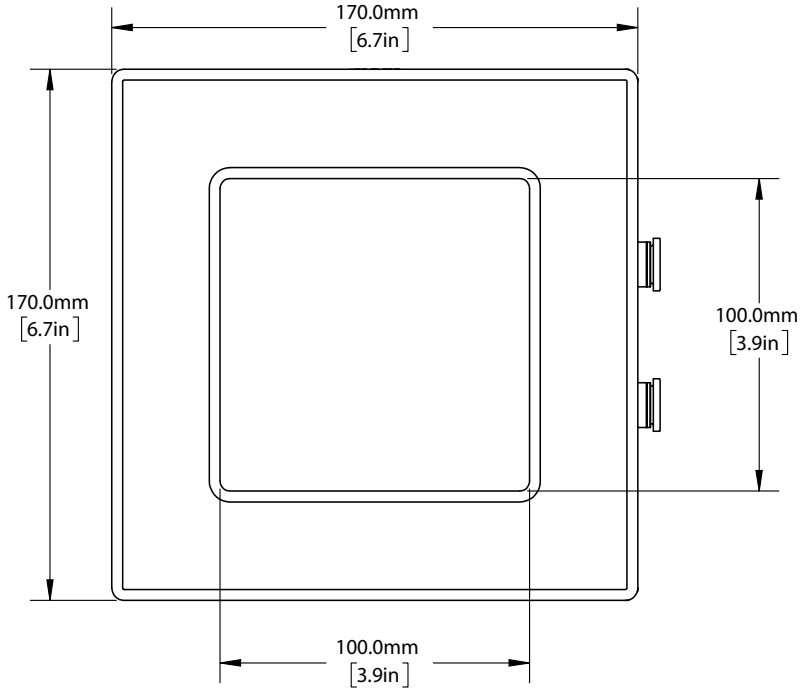


Figure 3-40. PM15K+ Base Unit Dimensions, Top View

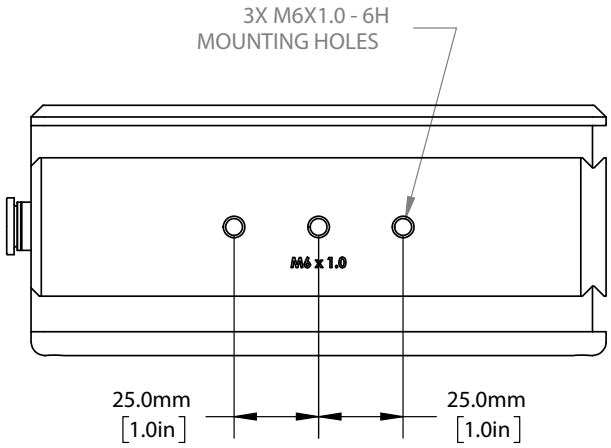


Figure 3-41. PM15K+ Unit M6 Mount Hole Locations

A view of one side (1/4" - 20 holes) of the PM15K+ is shown in Figure 3-35. Space measurements for the mount holes are shown also.

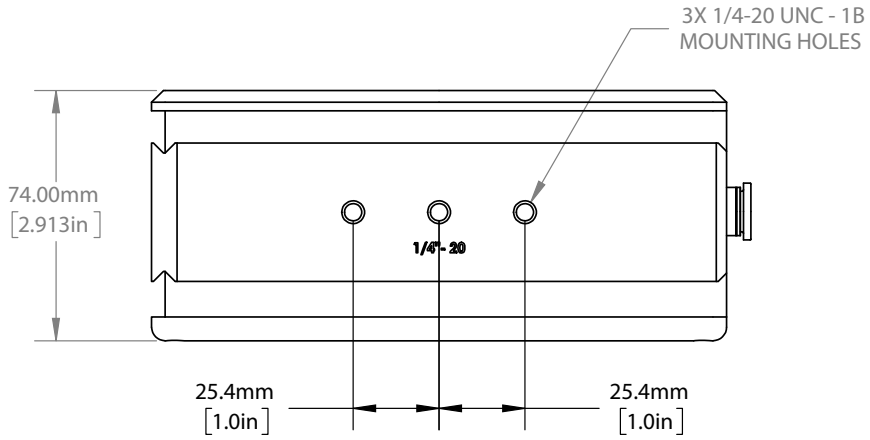


Figure 3-42. PM15K+ Unit Height Dimensions and 1/4"-20 Mount Hole Locations

Figure 3-36 shows the dimensions and M6 mount hole locations on the other side.

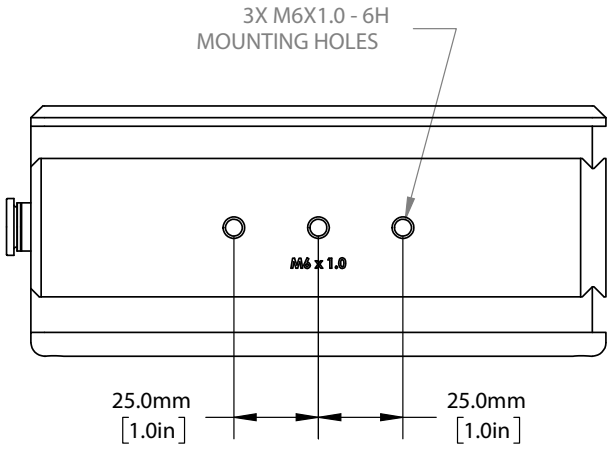


Figure 3-43. PM15K+ Unit M6 x 1.0 Mount Hole Locations

4 Installation and Setup

Unless otherwise noted, illustrations in this chapter reflect the base configuration of the PM10K+/PM15K+ that does not have the backscatter shield.

In addition to the detailed instructions, part one of a two-part training video series, on setup, is available at:

https://youtu.be/K3QIDxOGFVI

4.1 Prepare For Installation

CAUTION!
It is critical to prevent dust, debris, and other contamination from getting onto the sensor element. NEVER touch the sensor element. This can deposit natural oils from fingertips onto the absorber surface.

Such contamination can cause changes in sensitivity to the sensor or become burned onto the absorber surface of the sensor.

4.1.1 Receive, Unpack and Inspect Measurement System

4.1.1.1 Unpack and Inspect the Sensorfd

When the product is received, the shipping container and its contents must be inspected for any damage caused during shipment and for complete contents. If damage has occurred, contact Coherent immediately.

NOTICE
Keep the shipping containers and packing. In the case of a service event, the sensor system will need to be returned to Coherent in the original packaging. See ’Product Shipment Instructions’ (p. 139) for repack instructions.

NOTICE

Unpack the components carefully. The components can be damaged if they fall, get clamped, or are exposed to other environmental conditions that can cause the unit to operate out of specification.

This section supplies general instructions about how to unpack the shipping box.

To unpack the shipping box:

1. Open the shipping box and remove the documentation put in the top layer, Documentation includes the following important information that must be kept for your records. Make note of the Calibration Interval and Due Date.
   - Certificate of Calibration, with the date of it was made and a China RoHS2 compliance sticker
   - Coherent Calibration Interval & Due Date Policy document
   - Installation and Quick Start Guide

Figure 4-1. Packaging With Inner Foam Tray (PM10K+ example)

2. Look at all packaging for contents of the shipping box. The way different models are packed can be different.
   As components are unpacked, keep all shipping materials in the event that the unit must be shipped to a different location or returned to Coherent for annual calibration.

3. Remove the components including cables and power supply from the top inner foam layer.

Figure 4-2. Packaging With Inner Foam Tray

4. Remove the inner foam layer.

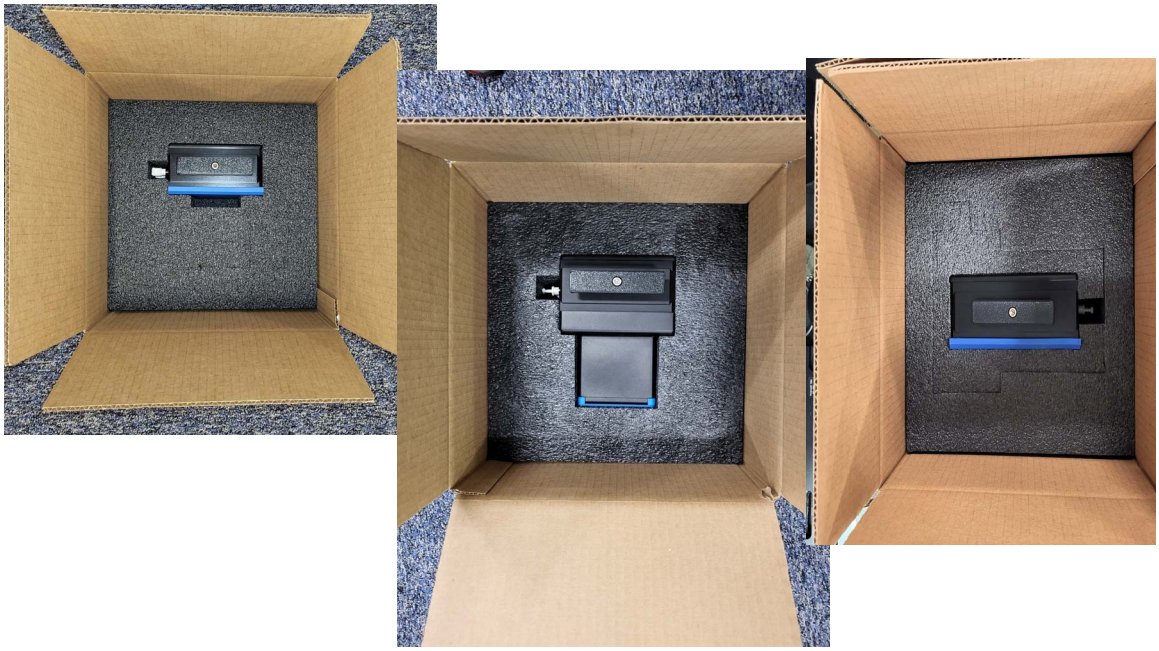


Figure 4-3. Inner Foam Layer Removed

5. Remove the sensor by holding the attached handle and lifting it out of the box. The sensor is heavy and has a handle used to hold and move the sensor. Set the sensor on a clean surface with the handle up.

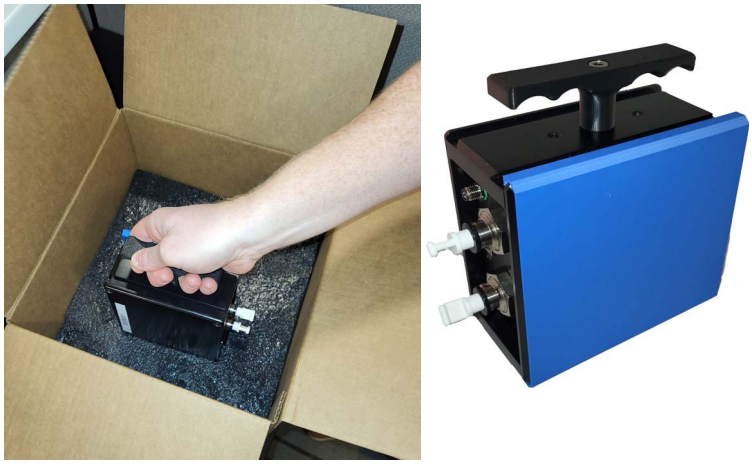


Figure 4-4. Sensor Unit with Handle

6. Put the components on a clean surface.The contents of the shipping box can be different for different models ordered. All orders include the following:
   - PM10K+/PM15K+ sensor with water caps and stow handle
   - DB-25 cable (for USB + DB25 model)
   - Power Supply (for RS232 model)
   - USB Cable (for USB + DB25 model)
   - Documentation

   Do not remove the cover plate from the top of the sensor until the unit is ready to be set up and installed.

CAUTION!
Do NOT touch the sensor surface when the unit is handled. Contamination can cause incorrect measurements.

4.2 Install Directly to a Work Surface

The PM10K+/PM15K+ can be installed and set up directly on an optical table or other works surface. Refer to the example in Figure 4-5. Clamps can be used with the groove on the sides of the sensor, as shown, to

make the sensor secure to the surface of the table. However, this type of setup can limit options to direct and aim the laser beam onto the sensor surface.

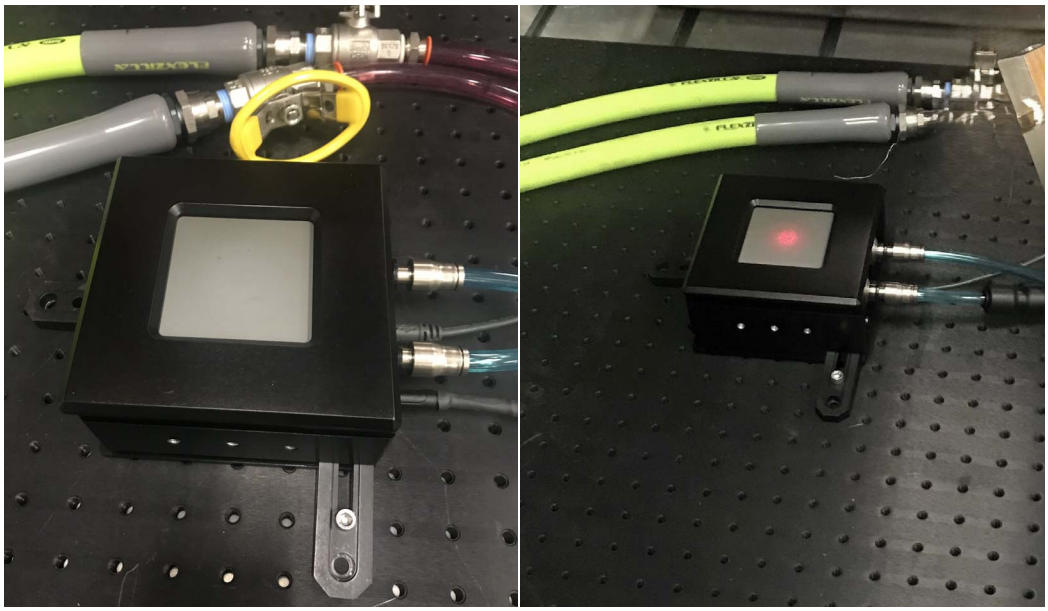


Figure 4-5. Example Install Directly to Work Surface

The procedures that follow show examples of setup with mount features, rail, and posts that allow the sensor to be set in position for laser beam aim and capture.

4.3 Put the Sensor on a Mount

Each sensor has unique mount features, including dovetail rails and threaded mount holes for easy setup and alignment in the beam path. Refer to ’Mount Features’ (p. 18).

4.3.1 Prepare Sensor to Mount

The handle and protective cover can be removed to prepare for mount and operation.

1. Set the sensor in position with access to the handle (PN 2319333).

Figure 4-6. Shipment and Stow Handle Installed

Figure 4-7. Stow Handle

2. If necessary, remove the handle. Use a 3/16-in. hex wrench to loosen the screw on the handle, and then remove the handle. Keep the handle and screw with the shipping materials.

Figure 4-8. Loosen Hex Screw and Remove Handle

CAUTION!
Do NOT touch the sensor surface when the unit is handled. Contamination can cause damage and incorrect measurements.

3. Remove the plastic protective cover from the sensor.

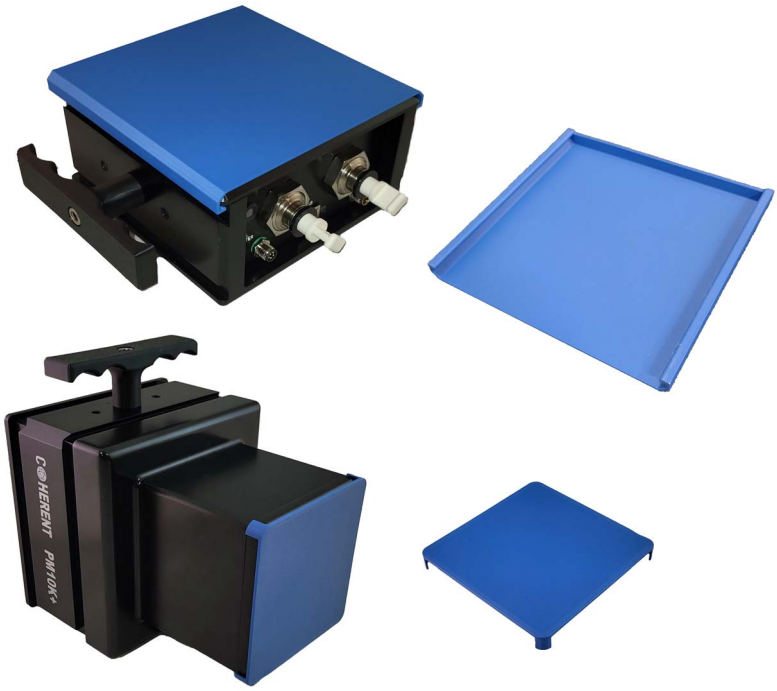


Figure 4-9. PM10K+ models with Protective Cover Plate

4. Keep the protective cover plate and stow it with the shipping materials. It can be necessary when the unit is moved or shipped, to prevent damage to the absorber surface.

4.3.2 Set Up With Dovetail Mount

Coherent recommends that users use the supplied dovetail mount because it is easier to move the sensor in one axis to help get the beam in the center, versus a fixed-mount using posts attached directly to the sensor.

To install the sensor to a mount with the dovetail rail, do the following:

1. Locate the supplied mount plate accessory (PN 2320728). Refer to 'Mount Accessories' (p. 26).

Figure 4-10. Rail Mount Accessory with Lock Screw

2. Put the mount plate onto the dovetail rail on the unit. Refer to Figure 4-11. The figure shows a PM10K+ model for example only.

Figure 4-11. Move Mount Plate onto Dove-tail Rail

User-supplied posts can now be attached to the dovetail. It can be loosened to slide the sensor in either direction during beam alignment, and then made tight by tightening the screw when in the right location.

3. If necessary, install mount posts to the dovetail rail.

Coherent recommends that when posts are used, that minimum two are set up, to prevent unwanted turn when a single post is used. Because the difference in post sizes and lengths needed for various setups, Coherent does not supply mounting posts with the sensors.

Figure 4-12. Dovetail Rail Mount Installed with Posts

Refer to the examples of the dovetail mount attached to posts in Figure 4-12 and Figure 4-13.

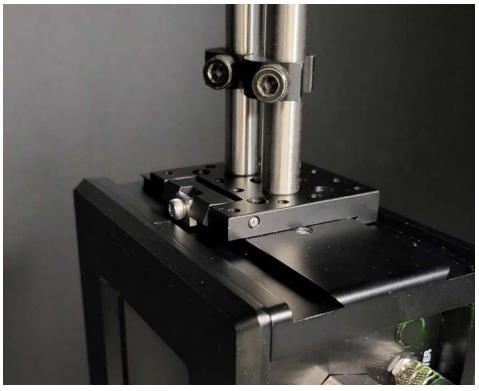


Figure 4-13. Example Dove-tail Mount with Post Setup

NOTICE

The images are for example only. The mount plate may not appear exactly as the plate that is shipped with the unit.

4. Tighten the lock screw on the mount base. Refer to Figure 4-14.

Figure 4-14. Rail Mount Plate Installed on Side Rail

4.3.3 Set Up with Mount Holes on Side of Sensor (Optional)

Note the location of threaded mount holes on either side of the power sensor. One side has M6 x 1.0 threaded mount holes. The other side has 1/4-in. x20 holes Refer to Figure 4-15 and Figure 4-16

Figure 4-15. Threaded 1/4" - 20 Mount Holes

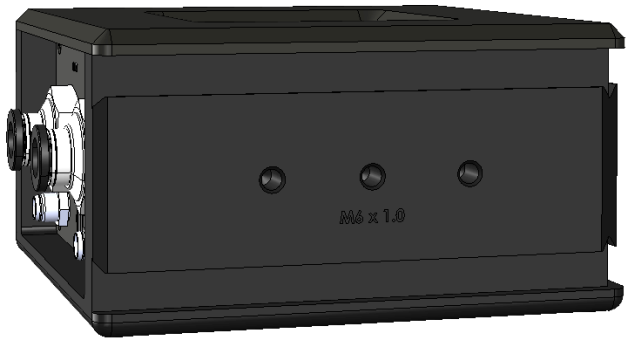


Figure 4-16. Threaded M6 x1.0 Mount Holes

Coherent recommends that when posts are turned into the threads directly in the mount holes, that at least two posts are set up. This prevents the sensor from rotating when a single post is used.

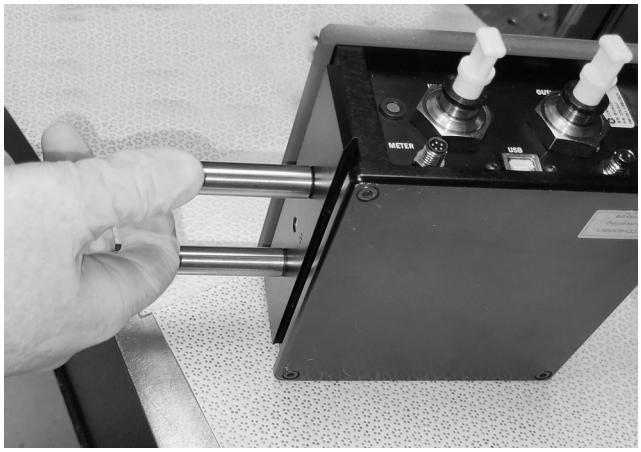


Figure 4-17. Install Two Threaded Mount Posts

Due to the variety of post sizes and lengths needed for various setups, Coherent does not supply mounting posts with the PM10K+.

See the examples in Figure 4-18 for recommended post mount setups.

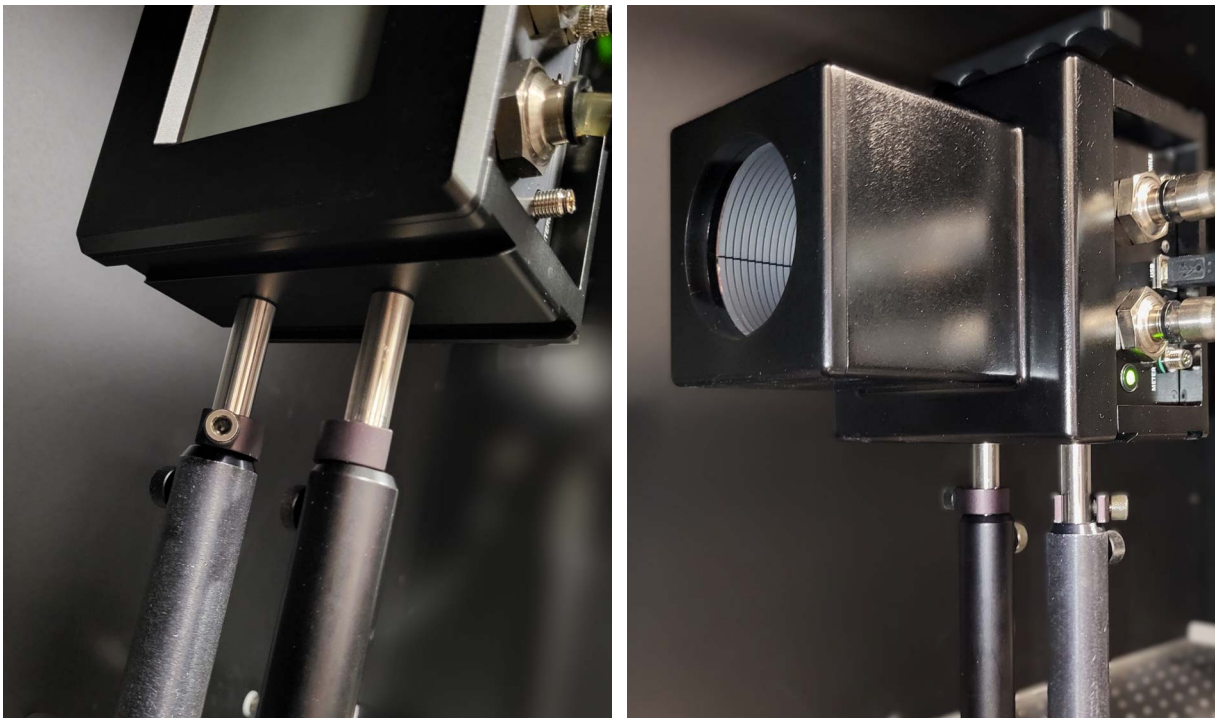


Figure 4-18. Bottom 1/4-in. Direct Post Mount Examples

4.4 Set Up Water Supply System

NOTICE

The example images in this section show the USB model of the PM10K+. The setup for the RS-232 models appears similar.

Before the sensor can be activated to take any measurements, water cooling must first be set up for the internal heat sink. Water must be supplied with hoses to the power sensor to the Water In and Water Out fittings.

WARNING!
Failure to provide water cooling can cause immediate damage to the sensor.

Without water cooling, the laser beam can burn the sensor housing (given the right amount of power over even a short period of time).

WARNING!
If water inlet and outlet water supply is reversed from specification, this will cause incorrect measurements.

This section provides the following information and describes how to set up water cooling:

- 'Precautions When Work is Done with Water' (p. 59)
- 'Water Supply and Hardware Requirements' (p. 60)
- 'Coolant Water Flow and Temperature Requirements' (p. 60)
- 'Install Water Lines' (p. 61)

4.4.1 Precautions When Work is Done with Water

CAUTION!
Correct water flow must be given to the sensor. Water flow must always be within flow rate, stability and temperature specifications. Otherwise, damage to the sensor and incorrect measurements can occur.

Make sure that there is water cooling to the PM10K+ sensor before any measurements are taken.

When work is done with water connection and flow through the sensor, avoid getting water on the absorber surface of the sensor element. Water can have an impact on the absorption rate and affect measurement. It can also lead to a reduced damage threshold.

If water does come in contact with the sensor surface, the best way to quickly remove the water is to use clean dry air to evaporate the water to keep it from soaking into the coating.

Contaminants that can be left after water evaporates could be deposited on the absorber surface and cannot be blown off. These contaminants can often be more difficult to remove than dust particles and can cause damage to equipment.

Any contaminants on the sensor element can change the sensitivity of the detector and impact accurate measurements.

4.4.2 Water Supply and Hardware Requirements

The coolant must meet required specifications in order for the Power Sensor System to function correctly. Refer to 'Water Supply Specifications' (p. 35).

Customer-supplied tubes with size that can attach to the push-to-connect fittings on the sensor system or to the supplied hose adapter fittings must be used. Tubes must be customer-supplied.Tube material must not be so soft that they will not pop out of the fittings. They must be rated for at least a firm durometer 95 Shore A.

The water inlet and outlet are 10mm outer diameter.

Figure 4-19. Example Water Tubes

4.4.3 Coolant Water Flow and Temperature Requirements

The water must flow in the direction from the inlet to the outlet in the sensor system. If the water flow is reversed, this can cause measurement errors. The flow and temperature must be carefully observed, controlled and stable. Refer to 'Coolant Water Flow Rates' (p. 36).

The Diagnostics tab in the Coherent Meter Connection software provides key information about flow and temperature. Refer to 'Diagnostic Functions with PM10K+' (p. 99).

4.4.4 Install Water Lines

CAUTION
Make sure that the correct hose size is installed to the fitting. If a 3/8-in. hose is put directly into the push-to-connect fitting on the sensor, it will not create a seal and can leak water. Adapter fittings must be used with 3/8-in. water hoses to make a correct seal.

4.4.4.1 Install Water Lines with Metric Hoses

This procedure shows how to install 10mm standard hoses directly to the sensor system. If 3/8-in adapter fittings are to be used with 3/8-in hoses, go to 'Install Water Lines With Non-Metric Hoses Hose Adapter Fittings' (p. 64).

CAUTION!
It is critical to prevent contamination on the sensor element. Never touch the absorber surface. It can deposit natural oils from your fingertips onto the absorber surface.

Such contamination can cause changes in sensitivity to the sensor or become burned onto the absorber surface of the sensor.

Water hoses are customer-supplied and not included with the PM10K+/PM15K+ sensor. Hoses can be attached directly to the push-to-connect fittings on the sensor.

It is recommended that water hoses are given labels at each end to identify 'hot' or 'cold'. This helps assure that connections are made to the correct inlets and outlets.

To set up water system for the PM10K+/PM15K+ with 10mm hoses:

1. Gather the necessary tools and parts, including water hoses of sufficient length to reach the cooling system or chiller. Use water hoses that support the specifications shown in Table 3-4 (p. 36). The hoses also must not be softer than a durometer firmness rating of Shore 95 A.
2. If installed, remove the protective caps to the water inlet and outlets. Push the outer ring of the inlet in to release each cap, and then remove the cap. Refer to Figure 4-20.

.

Figure 4-20. Remove Protective Caps

WARNING

Care must be taken to attach the water hoses from the chiller to the sensor water inlet and outlet fittings correctly. If water inlet and outlet water supply is reversed, this can cause incorrect measurements.

3. Push in and attach the water hoses to the correct INLET and OUTLET push-to-connect fittings on the sensor, shown in Figure 4-21.

Figure 4-21. Attach 10mm Water Hoses Directly to Sensor Fittings

The end of the hose (or step-down fitting, if used) for water coming from the chiller, goes into the sensor fitting labeled *INLET*. The water fitting for the line to return water to the chiller is labeled *OUTLET*. Refer to Figure 4-22

Figure 4-22. Water Inlet and Outlet Fitting Labels

4.4.4.2 Install Water Lines With Non-Metric Hoses Hose Adapter Fittings

The sensors have metric 10-mm outer-diameter fittings (push-to-connect) for the water lines. Users can install non-metric 3/8-in hose adapter fittings when 3/8-in hoses are used. The Inlet and outlet fitting locations for water cooling are indicated on the sensor housing.

Figure 4-23. 3/8-inch Hose Adapters

NOTICE

The 3/8 adapters are designed to be semi-permanently attached to the 3/8-in hoses to convert to a 10mm connection. They are NOT meant to be installed on the unit first.

To set up water system with 3/8-in. hoses and adapter fittings, do the following:

1. If installed, remove existing 10-mm water supply and return hoses or protective caps attached directly to the sensor water fittings. Push the outer ring of the inlet in to release each hose or cap. Refer to Figure 4-20
2. Install the two 3/8-in. hose adapters to the ends of each of the 3/8-in. return and supply hoses from the chiller. The hoses, with adapter fittings, are now ready to be installed onto 10mm fittings on the sensor. Refer to Figure 4-24.

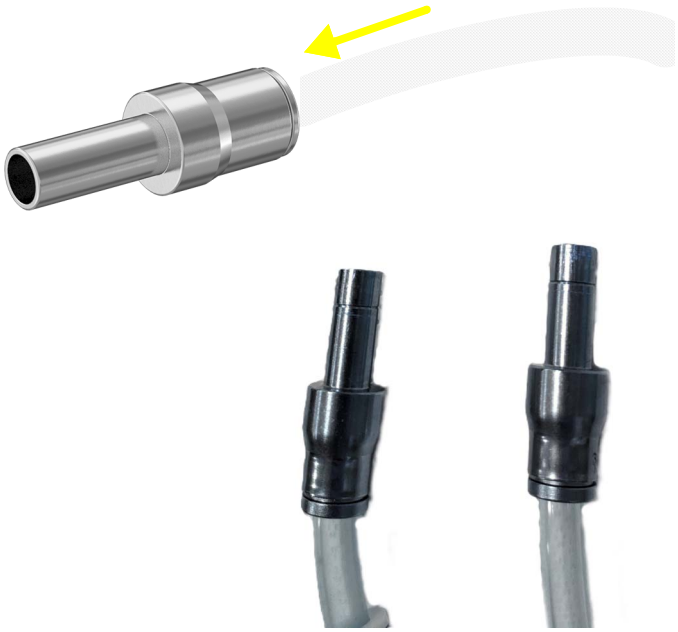


Figure 4-24. Install Water Hoses onto 3/8-in Adapters

3. Take the end of the hose, with adapter, and push the narrow end of the 3/8-in hose adapter into to the correct INLET and OUTLET push-to-connect fitting. Push in until it reaches the end. The fitting on the sensor holds the adapter in place and creates a seal. Refer to Figure 4-25

Figure 4-25. Insert Hose, with Adapter, into Fitting on Sensor

4. Give a small pull on the fitting to make sure that it is secure.
5. Repeat these steps for the other fitting. Refer to Figure 4-26.

CAUTION!
Use care when fittings and adapters are installed. If not installed correctly this can cause water leaks and damage to the sensor.

Figure 4-26. 3/8-in Hoses with Adapters Installed

If hose/adapter must be removed, push the black plastic ring on the sensor fitting inward, to release, and then pull the hose adapter fitting out.

4.5 Connect Communications Interfaces

4.5.1 Connect Sensor to a PC - Use with Coherent Meter Connection

Depending on the model of the PM10K+/PM15K+, different input/output accessories are used.

Figure 4-27. USB + DB-25 and RS-232 Models (Base PM10K+ examples)

4.5.1.1 USB Connection

A supplied standard USB cable is used to connect a USB + DB-25 sensor system and PC.

1. Attach the Type B end of the USB cable to the port labeled ‘USB’ on the sensor system.

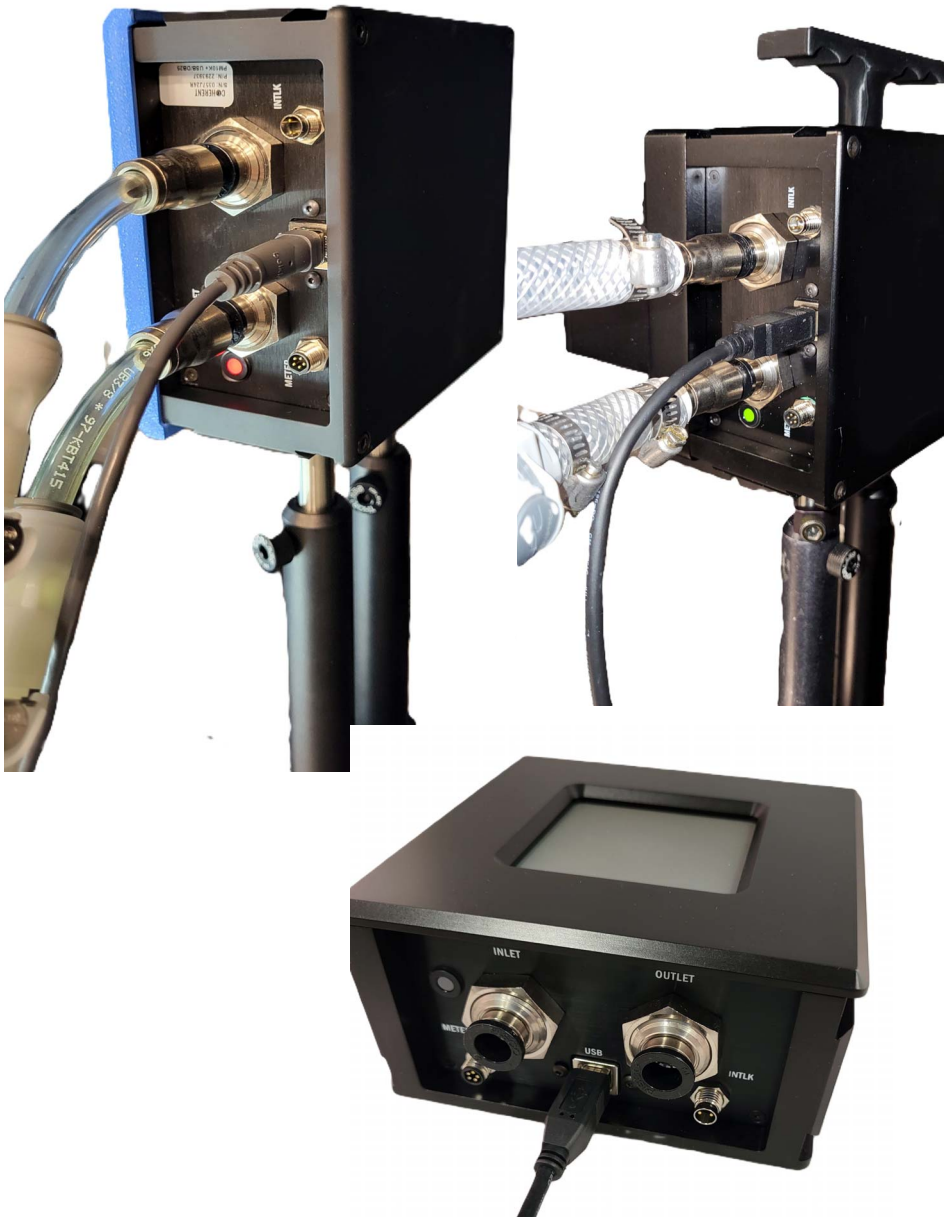


Figure 4-28. Attach USB Cable (PM10K+ Examples)

2. Attach the other end of the USB cable to a USB port on the PC.

4.5.1.2 RS-232 Connection

A standard RS-232 cable is used to attach an RS-232 model sensor to a workstation computer.

Figure 4-29. Sensor System RS-232 Cable

1. Attach the cable to the sensor at the port labeled RS-232.

Figure 4-30. Sensor System RS-232 Port

2. Attach the other end of the cable to the correct RS-232 port on the workstation computer.

4.5.2 Select and Set Up Standalone Meter

The sensor system can be set up to capture and analyze power data with a standalone external meter.

4.5.2.1 Install and Connect Sensor to Compatible Meters

The DB25 cable provided with the USB + DB-25 version of the sensors is used to connect the sensor to a dedicated meter. Coherent recommends one of the following:

- LabMax-Pro SSIM Laser Power and Energy Meter
- LabMax Touch/Touch Meter Pro Laser Power and Energy Meters
- FieldMax Touch/Touch Pro

Figure 4-31. LabMax-Pro SSIM and LabMax Touch Pro Meters

Table 4-1 shows the different measurement modes supported by the PM10K+/PM15K+ sensors and the compatible Coherent meters:

Table 4-1. Coherent Meter Compatibility Matrix

Mode	Compatible With
Basic Measurement	LabMax Touch and Touch Pro, LabMax-Pro SSIM, Legacy Meters

Legacy Coherent meters include the FieldMaxII. For product ordering information refer to ’Shop.Coherent (US Customers Only)’ (p. 154).

Note that Coherent recommends use of the PM10K+/PM15K+ Sensor Systems with the LabMax-Pro SSIM, LabMax Touch or Touch Pro meter. Legacy meters cannot access newer features now available in the software.

4.5.2.2 Connect DB25 for Operation with Meters (USB+DB25 Model)

For USB + DB25 or RS-232 setups that use a PC workstation, a USB or RS-232 cable is used to connect to a PC with measurement software, depending on the configuration. However, a specially calibrated cable with a DB25 connector on one end attaches to a meter for a metered setup (USB + DB25 models).

Figure 4-32. DB25 Cable for with USB+DB25 PM10K+ Configuration

For USB + DB25 configured systems with a metered setup, do the following:

1. Locate the 2m DB25 analog cable (PN 2311500). Refer to Figure 4-33.

Figure 4-33. DB25 Cable for Meter Connection with Example Label

2. Make sure that the serial number on the cable is matched to the serial number on the USB + DB25 model of the sensor. Each cable is calibrated to the sensor it is shipped with.
3. Attach the small barrel-end of the DB25 cable to the METER input on the sensor. Refer to Figure 4-34

Figure 4-34. Meter Cable Connector (USB + DB25 Model)

4. Attach the DB25 connector from the USB + DB25 model of the sensor to a meter, as shown in the example in Figure 4-35.

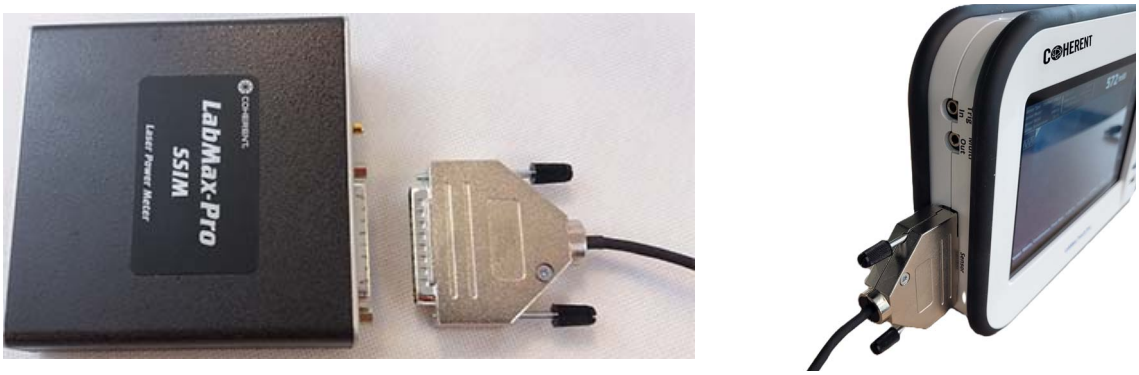


Figure 4-35. Connect Sensor to Meter

5. Gently tighten the thumb screws to secure the connector to the meter. See the examples in Figure 4-36.

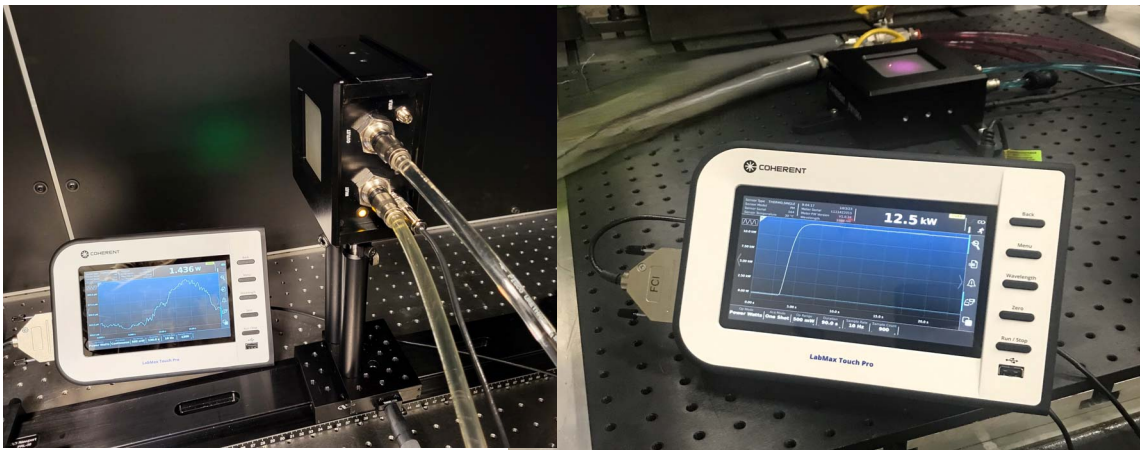


Figure 4-36. Examples - PM10K+ Setups with LabMax Touch Pro Meter

4.6 Supply Power

Power can be provided to the sensor in multiple ways.

For the USB + DB25 models, power can be supplied through the USB cable, or through the DB25 cable with a standalone meter. The cables deliver power to the sensor, and return measurement data from the sensor. Note that the sensors are powered from USB when both USB and DB25 are plugged in.

For for the RS-232 models , power is provided through a dedicated 5V power supply.

CAUTION!

When power is supplied to the power sensor, make sure that no spilled water is present at the connection. When hoses are removed and installed, it is possible that some drip or water splash. Make sure that any visible water is removed from the interface.

4.6.1 Provide Power for USB + DB25 Sensor Systems

The USB interface provides the highest performance in comparison with data sent via DB25 to a standalone meter due to signal type and dynamic range variances. It also allows for improved speed-up function.

For the systems configured with USB, there is NO need for additional power setup other than to assure that the supplied USB cable or the DB25 meter cable is installed correctly.

Figure 4-37. USB Connector (PM10K+ USB Model)

The sensors power on immediately after power is supplied by USB.

4.6.2 Provide Power for RS-232 Sensor Systems

The meterless RS-232 sensor systems typically use an external power supply. However, for custom installations, RS-232 can be configured by the customer to supply power through pin 1 of the 9-pin connector.

To connect the power supply:

1. Attach the connector from the 5V power supply to the 5-24V input on the interface panel on the PM10K+/PM15K+ sensor. Refer to Figure 4-38 (p. 76).

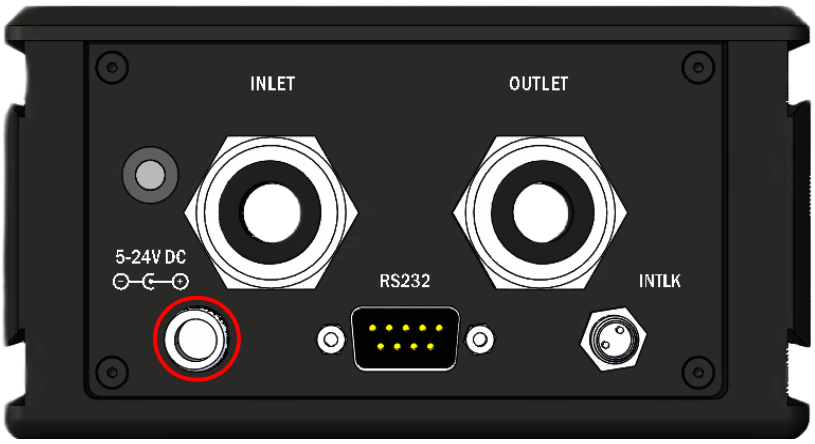


Figure 4-38. Power Connector (PM10K+ RS-232 Model)

2. Connect the power supply plug to a wall outlet. The sensor immediately is powered on.
3. If software is not installed, LED indicator shows a special pulse - go to device manager look for attached devices. Refer to the troubleshooting in 'Troubleshooting and Error Messages' (p. 125).

4.7 Set up Protective Interlock

For interlock function description and specifications about supported cable interface for the interlock, refer to 'Interlock Connection and Functionality' (p. 27).

To set up the safety interlock with the sensor:

1. Locate the customer-supplied interlock cable and attach it to the connector labeled INTLK on the sensor. Refer to Figure 4-39.

Figure 4-39. PM10K+/PM15K+ Interlock Connector (RS-232 Model)

2. Attach the other end of the interlock cable to the interlock connector on the customer-supplied laser or monitoring system or device.

4.8 Clean Absorber Surface

CAUTION!

It is critical to prevent dust, debris, and other contamination from getting inside the sensor cavity and onto the sensor element. In all instructions, when the power sensor is set up, NEVER touch the sensor element. This can deposit natural oils from fingertips onto the absorber surface. Also, do NOT use solvents to clean the surface.

Such contamination can cause changes in sensitivity to the sensor or become burned onto the absorber surface of the sensor.

When the sensor is correctly mounted and installed, use clean dry air to make sure that there is no dust and debris on the absorber surface. Do NOT use solvents to clean the surface.

The cover for the absorber surface, provided, should be installed on the unit during transportation and storage to prevent excessive contamination.

4.9 Install Software

Download the latest version of Coherent Meter Connection (1.3.x.x or newer) from: http://www.coherent.com/resources

For installation requirements and detailed software installation instructions, refer to the *Coherent Meter Connection User Manual* (PN 1343658) available at www.coherent.com.

NOTICE

It is recommended to have Administrator privileges to install and run software.

1. Search for these installation files and then click **Download**. The file will be named something like this:

   `Coherent-Meter-Connection-v1.x.x.x-Release-Setup.exe`

2. Save the installation files to the computer.

NOTICE

To prevent instability of the software, it is strongly recommended to first disable computer hibernation or suspend mode before installing the software.

3. Install the software. Refer to *Coherent Meter Connection User Manual* (PN 1343658) available at: https://www.coherent.com/resources

Figure 4-40. Example Coherent Meter Connection Splash Screen

For instructions about communication with the sensor directly with host commands, see 'Host Interface' (p. 106) of this manual.

5 Controls and Indicators

5.1 Front Panel Indicator

The PM10K+ sensors have a status indicator that is a bi-color, multi-mode modulated LED. It is located next to the water INLET connector. Refer to Figure 5-1.

Figure 5-1. LED Indicator Light Location (PM10K+ example)

Table 5-1 and Table 5-2 show the states and status for the LED indicator light, depending on the model and configuration.

Table 5-1. LED Status Indicator States - Temporal Modulated

Duration	USB Connection	DB25 Connection	RS-232 Connection
Off	No power		
Slow 0.5 Hz on/off blink	USB Communication not established (hub not working/connected, host computer asleep) No host communication (no driver, etc.)	N/A – LED remains solid	NA

Table 5-1. LED Status Indicator States - Temporal Modulated (continued)

Duration	USB Connection	DB25 Connection	RS-232 Connection
Sinusoidal 'breathing'	USB connection is established, host is communicating, but measurement data are not streaming	N/A – LED remains solid	Device is powered ON but not yet streaming
Fast 10 Hz on/off blink	Measurement data are streaming	N/A – LED remains solid	Measurement data are streaming

Table 5-2. LED Status Indicator Sates - Color

LED color state	Status	Interlock
Red	Fault condition alarm (e.g. flow rate below critical threshold). Danger exists for damage to the sensor surface.	Open
Yellow	Warning condition (e.g. flow rate is unstable, flow is > 0 but below spec, etc.)	Closed
Green	All monitored conditions are within spec.	Closed

See the example in Figure 5-2 (p. 80) for a red fault condition alarm.

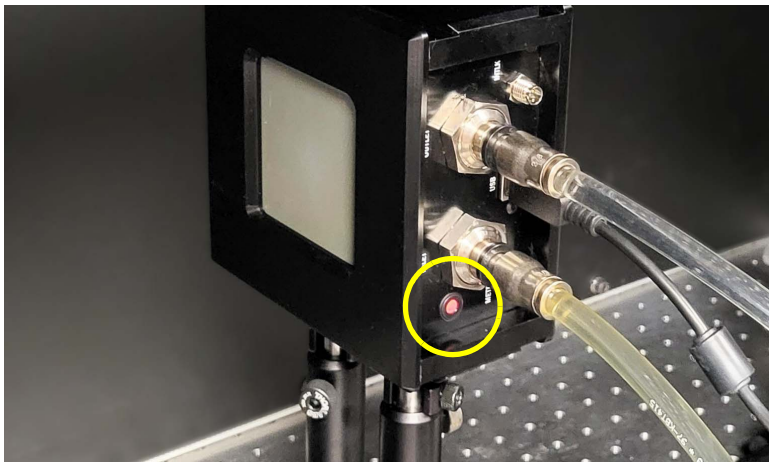


Figure 5-2. LED Indicator Light - Fault Condition Alarm (red)

5.2 Coherent Meter Connection Software Indicators

The latest version of the Coherent Meter Connection (CMC) software includes functionality, specifically to provide water temperature and flow indicators for the PM10K+ sensor systems. Correct temperature and flow values are critical to the operation of the sensor system.

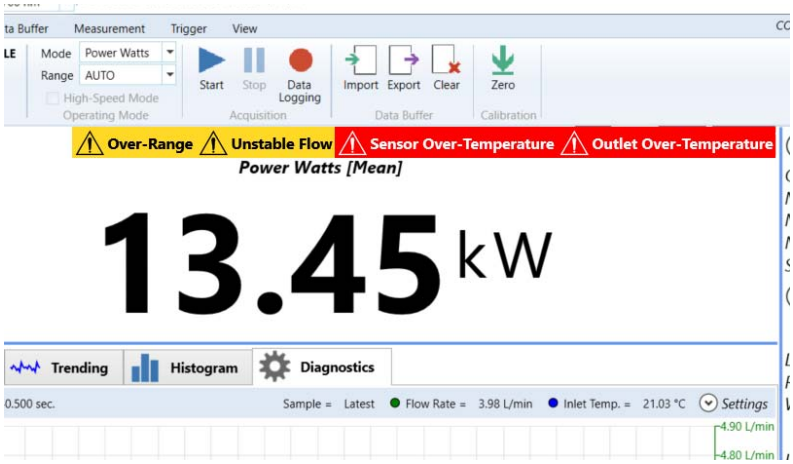


Figure 5-3. Warning and Fault Condition Indicator Examples

Figure 5-4. LED Indicator Light - Fault Condition Alarm (red)

For details about the indicators displayed, refer to ’Diagnostic Functions with PM10K+’ (p. 99).

6 Operation

This section provides instructions about how to prepare for and to take common power measurements with the PM10K+/PM15K+ Sensor Systems. In this section:

Before any measurements described in this section are taken, read and obey all safety precautions about working in a laser environment.

CAUTION!
Use of controls or adjustments or performance of procedures other than those specified can result in hazardous radiation exposure.

In addition to the detailed instructions, part two of a two-part training video series, that covers operation, is available at:

https://youtu.be/Pgz4J4FQ5xs

NOTICE
Unless noted otherwise, all examples in this chapter show the models of the PM10K+ without the backscatter shield.

6.1 Provide Cooling Water to the Sensor

These steps must be done to supply cooling water for correct operation of the sensor system.

1. Set the water supply/chiller to ON to test the pressure and flow. (Refer to ’Coolant Water Flow Rates’ (p. 36) for requirements.) Water lines must have flow. If not, measurement inaccuracies and damage to the sensor can occur.

2. Make sure that the sensor indicator light shows a yellow color as it comes up to correct flow. It then becomes green when it is at correct flow levels. Refer to 'Water Supply Specifications' (p. 35).

Figure 6-1. LED Status - Yellow as Flow Level Increases

3. If the indicator light continues to show orange color, make sure that the flow rate is stable and within specifications. Wait for the indicator to show green when these conditions are met.

Figure 6-2. LED Status - Green at Correct Flow Level

4. Look for water leaks. If there is a leak, set the cooling system to OFF and then re-install the hoses/fittings.
5. Look at any in-line flow gauge or flow meter to make sure that water flows at the specified rate of 1.5 GPM (gallons per minute) or 6 LPM (liters per minute).

6.2 Perform Beam Alignment – Vertical and Horizontal

The steps in this section are necessary to make sure that there is good alignment of the laser onto the beam absorber surface.

6.2.1 Align Aiming Beam (Units Without Backscatter Shield)

This procedure is done to do basic beam alignment with units not configured with a backscatter shield.

1. Set the aiming laser to ON.
2. Look at the location of the aiming beam on the sensor absorber surface. Refer to the examples in Figure 6-3.

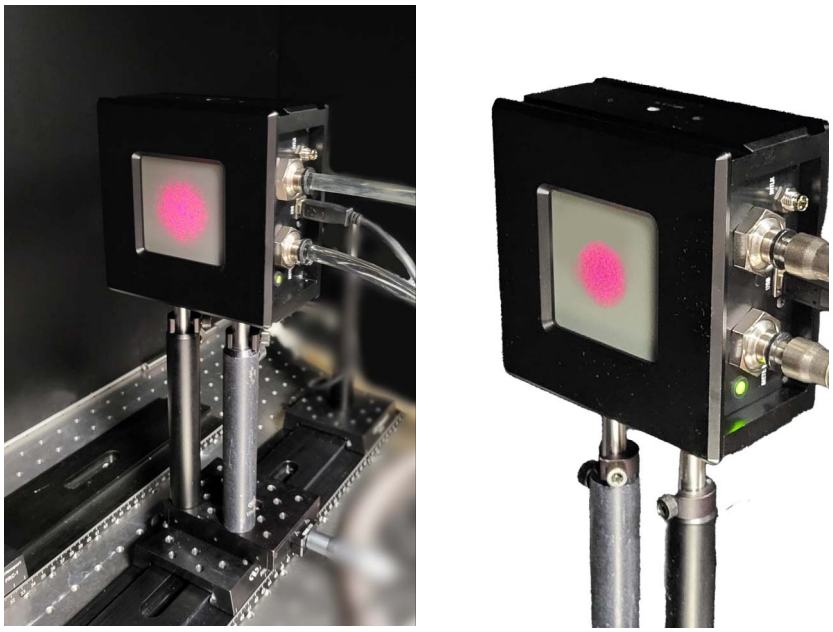


Figure 6-3. Aiming Laser On, Adjust Sensor for Beam Position

CAUTION!
Do NOT touch the sensor surface when the unit is handled. Contamination can cause damage and incorrect measurements.

3. Make sure that the aiming beam is in the center of sensor active surface.
4. If necessary, loosen, move, and re-tighten mount hardware, as necessary, until the beam is in the center.

NOTICE
Note that objects near the front of the detector can back reflect scattered light back toward the sensor and cause measurement errors.

5. As necessary, move hardware or objects to block or remove any retro-reflection back toward the sensor surface. If necessary, use a beam block.

NOTICE

The aiming beam cannot be relied upon to give the true laser beam diameter. The true laser beam profile is dependent on the specifications of the laser and delivery optics. Refer to the documentation for the laser being measured with the sensor.

6. Make sure that the laser beam diameter is appropriate for the anticipated laser power such that the beam does not clip the aperture (too big) or damage the sensor coating (too small).
7. When done, set the aiming laser to OFF.

6.2.2 Align the Beam for units with Backscatter Shield

This procedure is done to perform basic beam alignment with units configured with the backscatter shield.

1. Set the aiming laser to ON.
2. Make sure that the sensor is mounted square/perpendicular to the incoming beam.
3. Make sure that the beam enters in the center of the Backscatter Shield aperture.
4. Look at the location of the aiming beam on the sensor absorber surface. A business card, etc. can be used to ensure that the guide beam is centered in the aperture (the two images on the right show that).

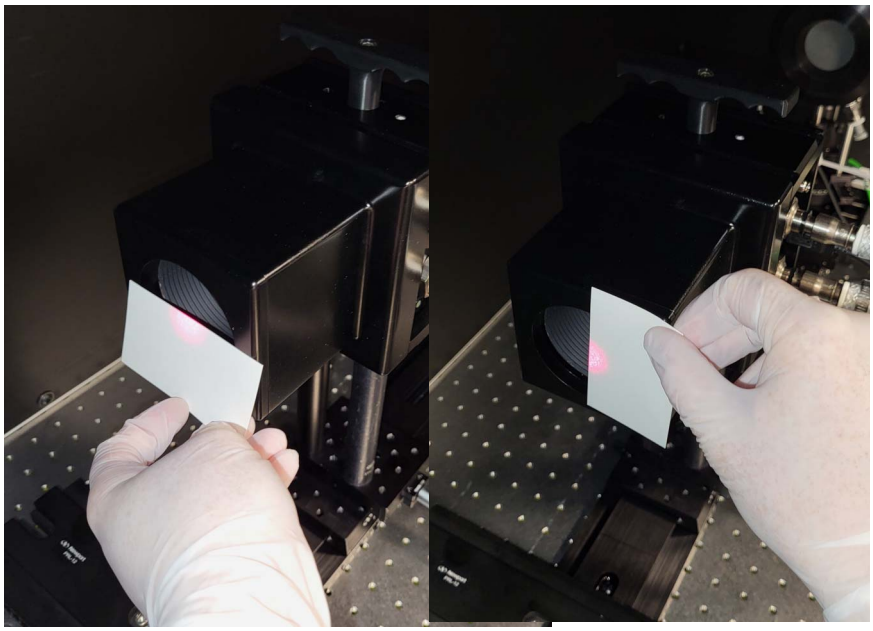


Figure 6-4. Aiming Laser On, Adjust Sensor for Beam Position with Scatter Shield

Make sure that the aiming beam is in center of sensor active surface. Loosen, move, and re-tighten mount hardware, as necessary. until the beam is in the center.

CAUTION!
It is critical that the beam size is not too small for the level of laser power. If it is too small, this can permanently damage the absorber surface.

5. Make sure that there are no surfaces that would cause any back-reflected light from the sensor surface to reflect again, back onto the sensor absorber surface.
6. Set the aiming laser to OFF.

6.3 Take a Power Measurement with CMC Software

This section gives instructions about how to take basic power measurements with the PM10K+/PM15K+ Sensor Systems.

6.3.1 Prepare the Power Sensor

1. Make sure that the laser is set to OFF.

CAUTION!
Make sure that the laser is OFF or the beam is blocked until ready to get a power measurement.

2. Make sure that the sensor is set up on a mount and in the beam path. Refer to 'Put the Sensor on a Mount' (p. 49).
3. Make sure that the beam is aligned. Refer to 'Perform Beam Alignment – Vertical and Horizontal' (p. 84).
4. If not on, set the water flow on the chiller to ON. Refer to 'Water Supply Specifications' (p. 35).

   The LED indicator on the sensor starts with an orange color and becomes green when the flow rate is correct. Refer to 'Front Panel Indicator' (p. 79) for descriptions of the LED indicator conditions.

NOTICE
Allow sufficient time for the water flow and sensor head to get to equilibrium. The water flow must run through the sensor for about two minutes before the sensor is set to zero and measurement is begun.

5. Make sure that there are no water leaks at the sensor inlet and outlet hose fittings. If there are leaks, set the chiller to OFF, and then uninstall and install the hoses.

6. Make sure that the LED indicator on the sensor shows green (refer to Figure 6-5), and the water flow rate (green line on Diagnostics tab in CMC software) is minimum 6 liters per minute.

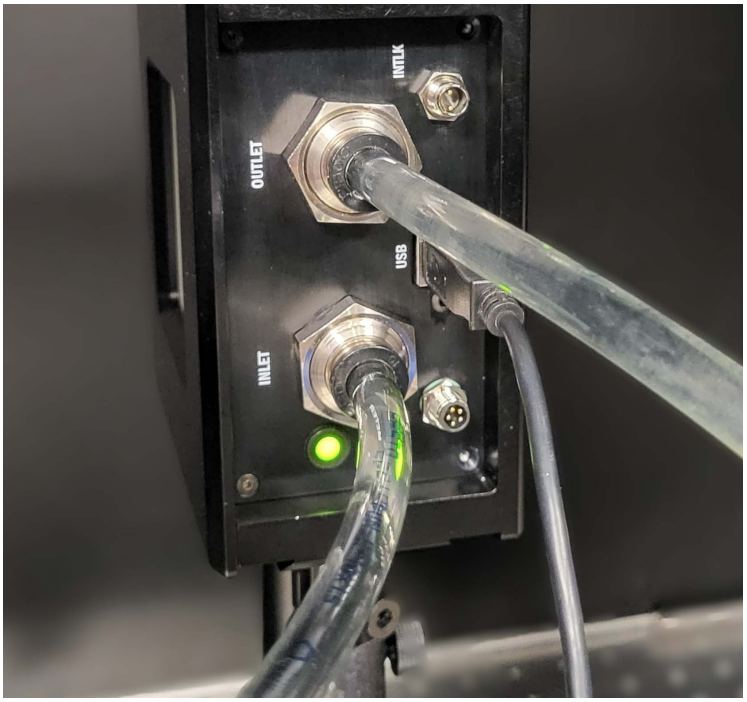


Figure 6-5. LED Status - Green

7. If the flow shows red on the LED, stop and go to ’Water Flow and Temperature Caution and Warnings’ (p. 125) in the troubleshooting chapter.

6.3.2 Start Measurement with Coherent Meter Connection

If a standalone meter with a display is used, follow the steps in ’Start Measurement with a Standalone Meter’ (p. 93).

When a USB or RS-232 connection is used with Coherent Meter Connection on a PC or workstation, do the following steps:

1. Click **Start** to start data acquisition. Refer to Figure 6-6. Refer to the water flow rate (green line) shown in the Diagnostics tab.

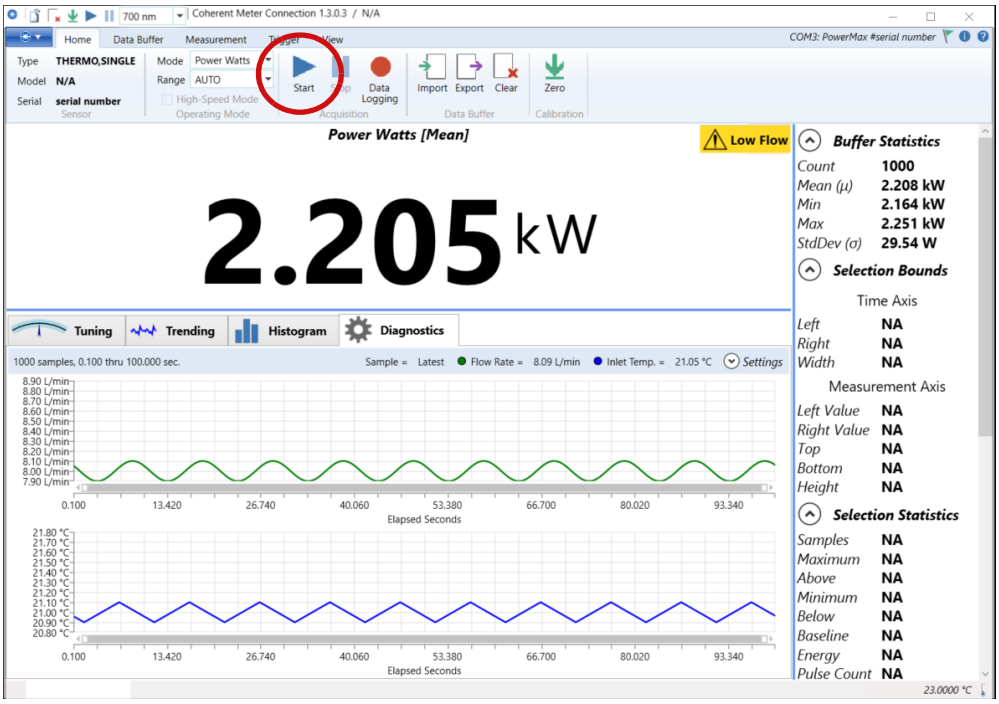


Figure 6-6. Water Flow Rate and Temperature in Diagnostics Tab

2. Look at the front panel LED (Figure 6-5) or Coherent Meter Connection for indicators of caution or warning states. Adjust water flow and temperature, if necessary.
3. When the flow and temperature conditions are in specification and there are no warning indicators, click the **Zero** button to set the sensor to Zero.
4. Look again at the front panel LED and Coherent Meter Connection Diagnostic tab.
5. Adjust the flow rate, and temperature, if necessary. Make sure that systems continue to operate with correct flow rate and temperature. Refer to 'Front Panel Indicator' (p. 79).
6. Look for any indicators on-screen and resolve. Refer to the example in Figure 6-6 that shows an 'Unstable Flow' caution indicator at top

right. For descriptions of on-screen indicators, refer to 'Diagnostic Functions with PM10K+' (p. 99).

Figure 6-7. Diagnostics Settings Sub-menu

WARNING!
Exposure to laser radiation can be cause injury. Direct eye contact with the output beam from a laser WILL cause eye injury and possible blindness. Follow all safety precautions. See 'Laser and Optical Safety' (p. 145).

7. When flow and temperature levels are stable and correct, set the laser to ON.
8. Click the **Trending** tab to see the power level trend line.

NOTICE
At first, the power trend line can appear unstable and in a low mW range. As the power level increases and the sensor begins to measure, the reading should increase into the kW range, then stabilize.

9. Wait for the power to become stable. The trend line increases and then becomes flat. Refer to the example in Figure 6-8.

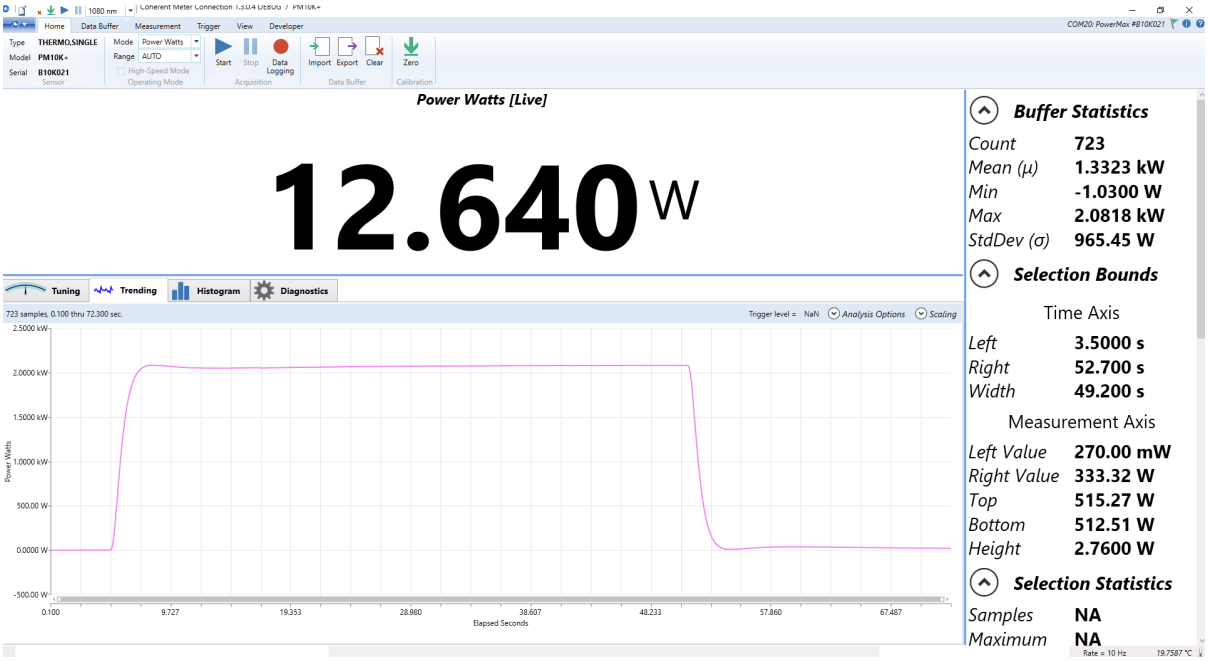


Figure 6-8. View Power Measurement Trend

10. When done, set the laser beam to OFF. The trend line slowly decreases.
11. Click **Stop** in the software to stop measurement and data collection.

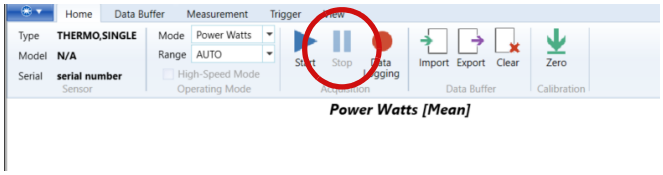


Figure 6-9. Stop Button Clicked

12. Refer to the Coherent Meter Connection User Manual for steps on how to save and export data files.

NOTICE

Coherent recommends that the water flow is set to OFF when the sensor is not in use.

13. Set water flow on the chiller to OFF.
14. Disconnect the sensor from power.

6.3.3 Export Data to .csv

Users can export a log of the measurements, including condition indicator data, to a .csv file. For instructions, refer to the Coherent Meter Connection User Manual, available at www.coherent.com.
15.

6.4 Start Measurement with a Standalone Meter

Use this procedure to get a standard power measurement with operation of a USB model of the power sensor and a standalone LabMax Touch meter with an external display.

NOTICE
Operation of the manual range option is preferred when measurements are taken with the PM10K+ and operation of a standalone meter. If auto-range is selected, this can result in higher measurement noise than with operation of a manually selected range setting.

1. Prepare the PM10K+ for operation. Refer to ’Prepare the Power Sensor’ (p. 88).
2. Connect the sensor to the meter with the DB25 cable. Refer to ’Connect DB25 for Operation with Meters (USB+DB25 Model)’ (p. 72).
3. Observe the front panel LED and adjust the flow rate, and temperature, if necessary. Refer to ’Front Panel Indicator’ (p. 79).

WARNING!
Direct eye contact with the output beam from a laser WILL cause eye injury and possible blindness. Follow all safety precautions. See ’Laser and Optical Safety’ (p. 145).

4. When flow rate and temperature are in specification, set the laser to ON.
5. Select the Trend view in the meter to see the power level trend line. Refer to example in Figure 6-10.

6. Press the Start button on the meter to begin measurement with the meter and look at the power trend. Refer to the operation or user manual for the meter that is used.

Figure 6-10. View Power Measurement Trend (LabMax Touch meter example)

7. When done, press Stop on the meter to stop data collection.
8. Refer to the manual for the meter for how to save and export data files.
9. Set the laser beam to OFF.

NOTICE

Coherent recommends that the water flow is set to OFF when work with the sensor is done.

10. Set the water flow on the chiller to OFF.
11. Disconnect the sensor from power.

7 External Computer Control/Software

7.1 Software Graphical User Interface

This section provides a description of the graphical user interface for the Coherent Meter Connection (CMC) software.The software offers an easy-to use Windows-based interface to perform a wide range of analysis functions for instrument control and measurement.

For more detailed information on the Coherent Meter Connection software, refer to the Coherent Meter Connection User Manual (PN 1343658) available at www.coherent.com/resources

7.1.1 Main Window

When Coherent Meter Connection is first started, the splash screen briefly shows, then a Main window shows (shown in the example in Figure 7-2).

The main window of the software shows quick start icons and information across the top of the window, plus a main drop-down menu. The tabbed areas in the tool bar and tabbed windows below the Graphics Panel display additional available controls within those tabs.

The figure below shows the main screen at startup with no sensor or meter selected

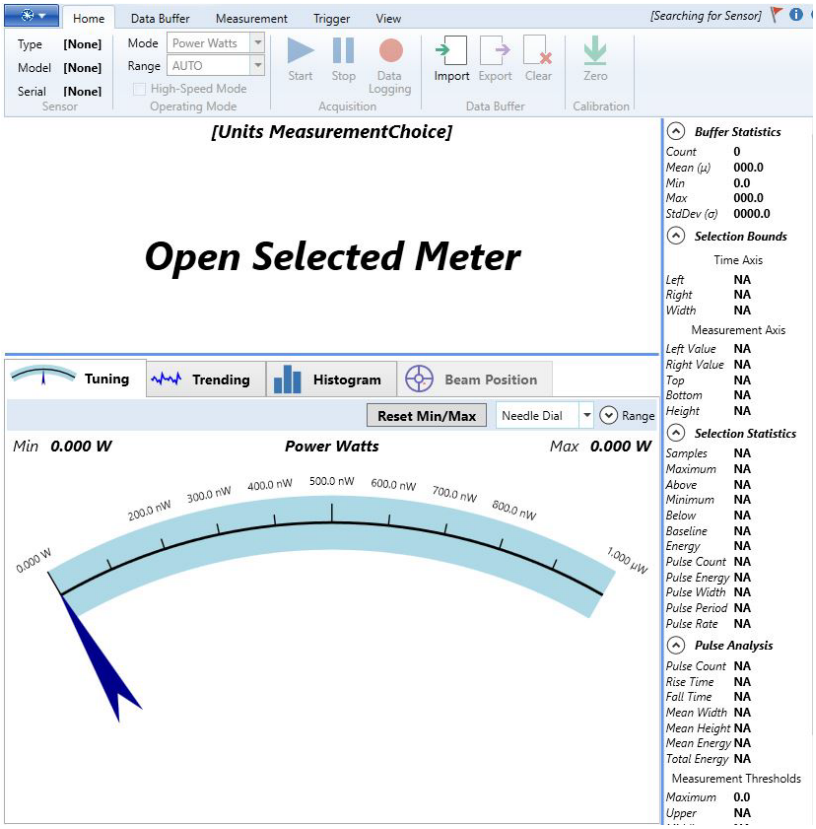


Figure 7-1. CMC Main Screen

When laser measurement is taken, the Measurement Panel at the top of the screen shows the levels.

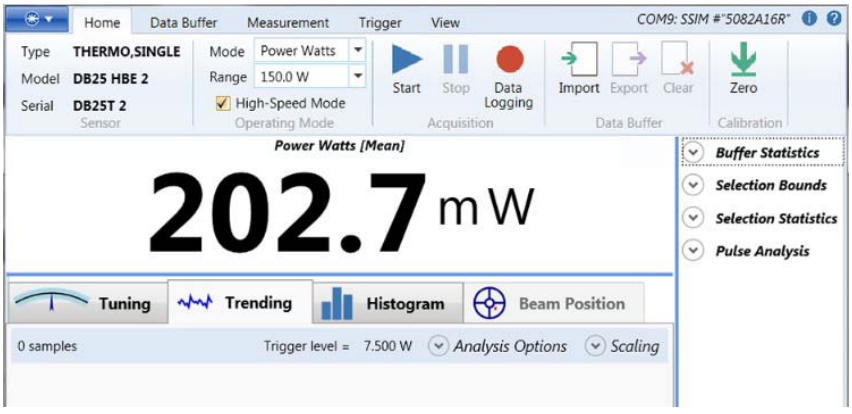


Figure 7-2. Coherent Meter Connection - Measurement Panel Data and Trending Tab

7.1.2 Quick Start Icons

Table 7-1 shows the quickstart icons and a brief description of each. The description also shows any alternate locations in the software for the same command.

Table 7-1. Quick Start Icons

Icon	Description	Same function as…
	Access to Windows system menu	Includes standard Windows actions: Restore, Move, Size, Minimize, Maximize, and Close.
	Opens a COM port connection to the meter	Drop-down menu > Open Meter command.
	Clear the contents of the Capture Buffer	Drop-down menu > Meter Operation > Clear Buffer command. Also on the Home Tab > Clear icon.
	Measure the sensor's zero baseline	Drop-down menu > Meter Operation > Zero Meter command. Also on the Home Tab > Zero icon.
	Start streaming measure-ments	Drop-down menu > Meter Operation > Start Measurements command. Also on the Home Tab > Start icon.
	Stop streaming measure-ments	Drop-down menu > Meter Operation > Stop Measurements command. Also on the Home Tab > Stop icon.

These icons are similar to commands in the drop-down menu or in the tool bars.

7.1.3 Top of the Window

Figure 7-3 shows data displayed across the top of the window:

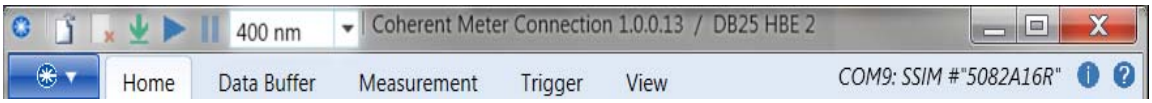


Figure 7-3. Data at Top of Main Window

A drop-down menu at the very top shows the available wavelengths, as shown in the example in Figure 7-4.

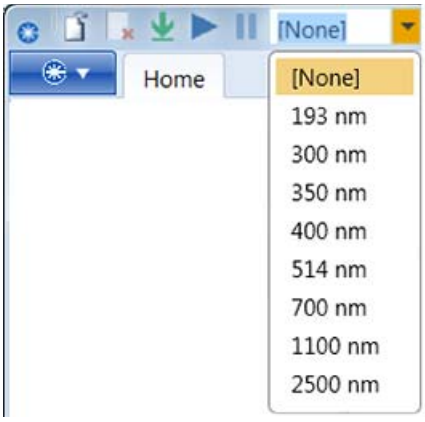


Figure 7-4. Quick Start —Laser Wavelength

If the wavelength for the laser being used is not visible, enter it in the list by either typing it directly or editing the Wavelength table. The wavelength point entered must be within the normal range of operation for the laser.

7.1.4 Diagnostic Functions with PM10K+

The Diagnostics tab only shows only when applicable meters such as the PM10K+ are used. It has sub-tabs that display water flow rate and inlet temperature data. Clicking Settings allows the user to individually select the data to plot.

Figure 7-5. Diagnostics Tab - Temperatures and Water Flow Settings

- Green line shows the water flow rate
- Blue line shows the water inlet temperature

The Measurement Panel has a display for intermittent fault warnings and cautions in the upper right corner. Refer to Figure 7-6.

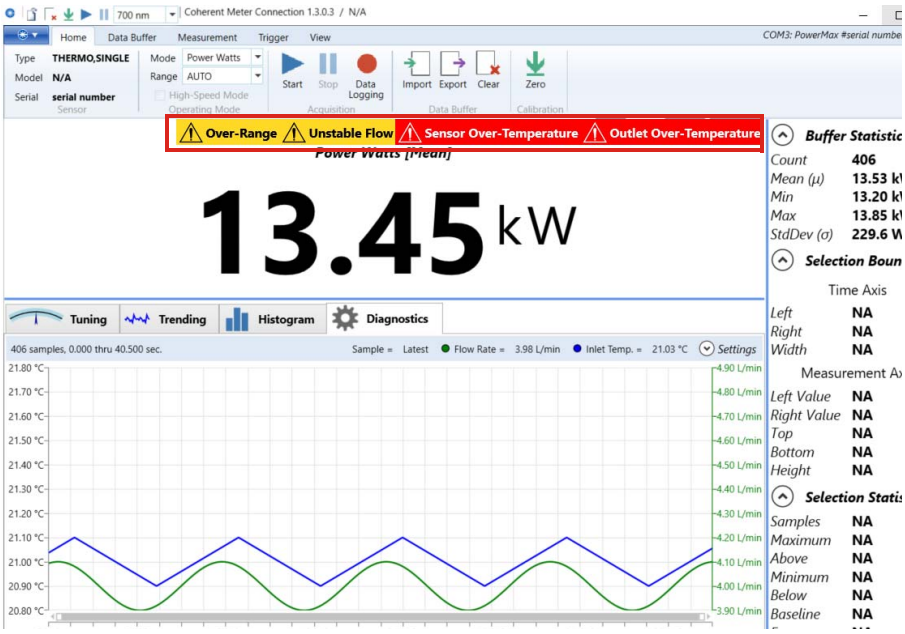


Figure 7-6. Measurement Panel - Warnings and Error Indicator Location

The screen in this example also shows the optional view of flow rate and outlet temperature plotted together on the graph.

When a user hovers the mouse over one of the indicators, a contextual pop-up provides information about the type of warning or caution and gives guidance on to resolve the issue Refer to Figure 7-7.

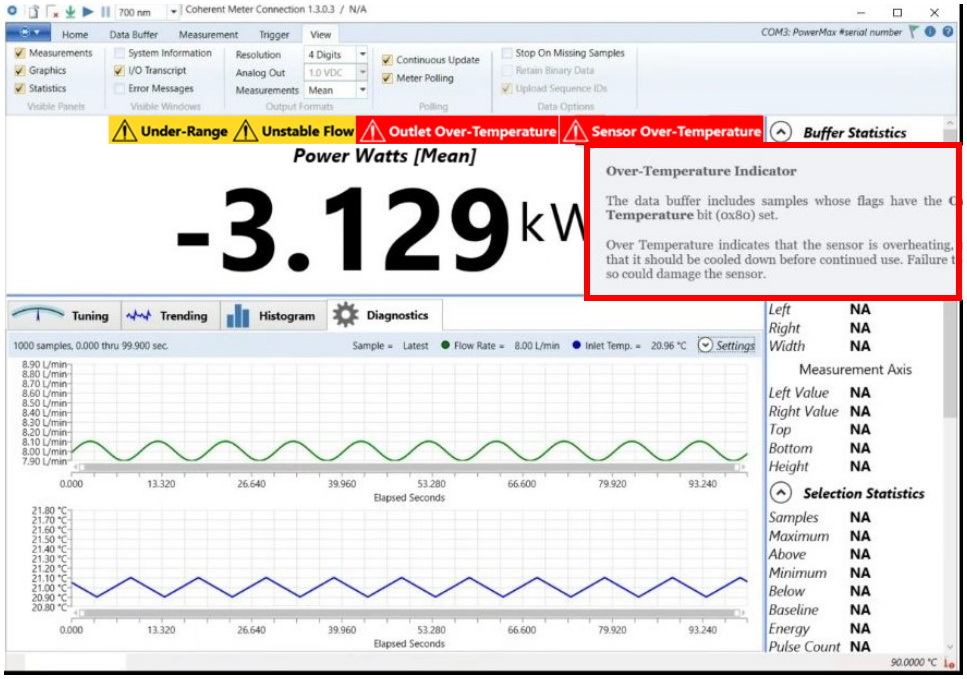


Figure 7-7. Measurement Panel - Contextual Indicator Popup Display

Note that although values for parameters such as body temperature and inlet is displayed as plotted via the trend line graph, indicators do display in the top right when adverse conditions for any parameters exist. The example in Figure 7-7 shows multiple indicators.

Table 7-2 and Table 7-3 show the indicator type and details for indicators that display on-screen in the Measurement Panel.

Table 7-2. Condition Indicators in Measurements Panel (All Sensors)

Icon	Description	Suggested Action
	The outlet water is too hot. The sensor may overheat if this condition persists. Flag: 0x80	Shut off the laser, and allow the sensor to cool.
	Measurement precision could be improved. If the meter is already in the highest range, then the measurement capacity of the instrument has been exceeded. Flag: 0x10	Reduce laser power.
	Measurement precision could be improved. If the measurement is negative, the sensor may need to be reset to zero. Flag: 0x20	Reset the meter to zero.
	The software was not able to keep up with the data stream from the instrument, and a buffer internal to the instrument overflowed.	Check cables, and minimize the use of hubs. If the problem persists, use the decimation setting in the Measurement tab to reduce the speed of the data stream.

Table 7-3. Condition Indicators in Measurements Panel (PM10K+/PM15K+)

Icon	Description	Suggested Action
	There is too much water flowing through the sensor to obtain a valid measurement. Flag: 0x10000	Decrease water flow.
	There is not enough water flowing through the sensor to obtain a valid measurement. Flag: 0x20000	Increase water flow.

Table 7-3. Condition Indicators in Measurements Panel (continued)(PM10K+/PM15K+)

Icon	Description	Suggested Action
	There is not enough water flowing through the sensor to operate safely. The sensor could be damaged if irradiated without proper water flow. Flag: 0x40000	Increase water flow.
	The water flow rate is changing too rapidly to obtain a valid measurement. Flag: 0x80000	Check water flow rate.
	The inlet water is too hot to obtain a valid measurement. If this condition persists, the sensor may overheat. Flag: 0x100000	Check water cooling system.
	The inlet water is too cold to obtain a valid measurement. Flag: 0x200000	Check water cooling system.
	The inlet water temperature is changing too rapidly to obtain a valid measurement. Flag; 0x400000	Check water cooling system.
	The sensor is overheating, and should be cooled down before continued use. Failure to do so could damage the sensor. Flag: 0x800000	Either increase the water flow rate, or decrease the laser power.
	The inlet water is warmer than the outlet water, which indicates the water is flowing in the wrong direction. This will result in a negative and/or inaccurate power measurement. Flag: 0x02000000	Check that the water lines are connected according to the labels on the sensor housing.

The example below shows a caution indicator for low water FLOW.

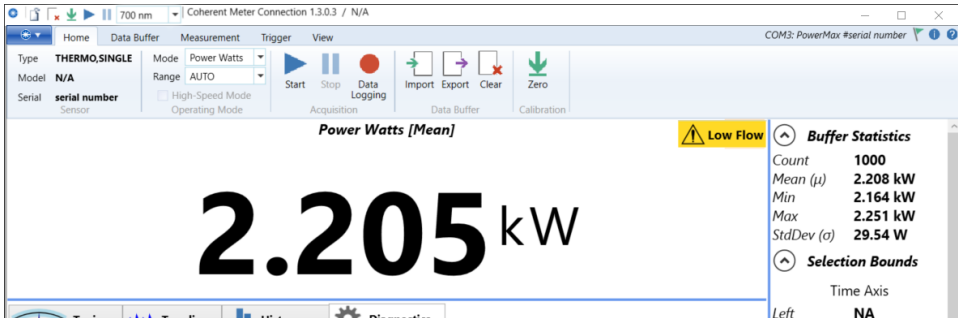


Figure 7-8. Diagnostics Tab - Water Flow Caution Indicator

The example below shows an OUTLET fault indicator for water over-temperature.

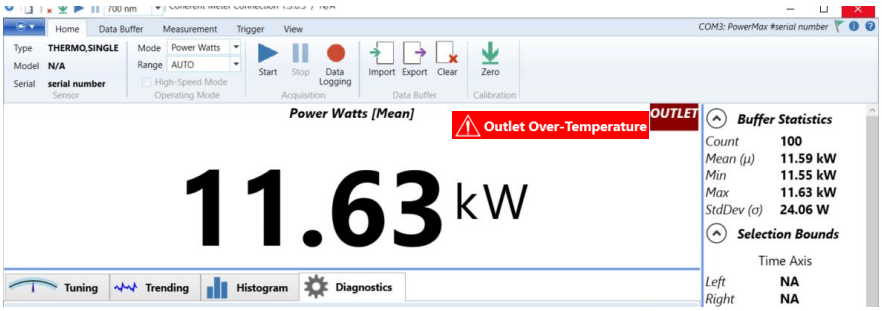


Figure 7-9. Diagnostics Tab - Outlet Over-Temperature Indicator

When the Settings button is clicked within the Diagnostics tab, the Settings overlay panel shows to provide view options. Refer to Figure 7-10.

Figure 7-10. Diagnostics Tab - Settings Overlay Menu

7.1.5 Trend Analysis

The Trending tab shows a graphical view of the measured power output over time.

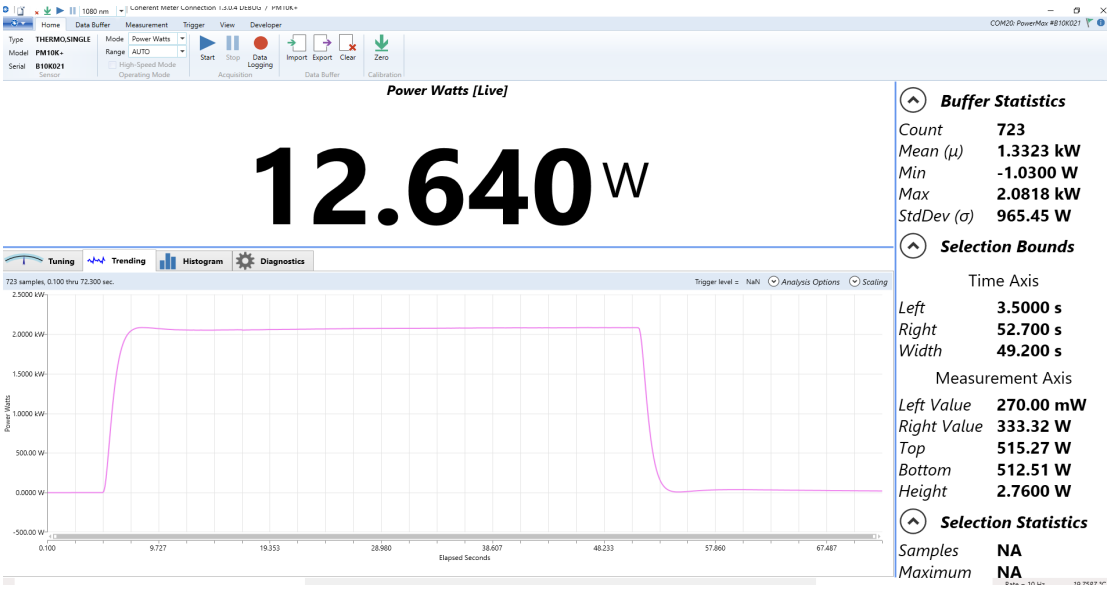


Figure 7-11. Trending Tab

For more information about Trending, refer to the Coherent Meter Connection User Manual.

7.2 Host Interface

7.2.1 Purpose and Scope

This section specifies the host interface commands, queries, and responses for PM10K+/PM15K+ Sensor Systems.

This specification defines the high-level host interface of the PM10K+. It defines high-level commands, responses, and behavior that a user or host computer could expect from the sensor. The low-level interface, which can cover RS232, USB, and other types of communication methods, is beyond the scope of this document except when it directly impacts the high-level interface.

7.2.2 Communication Protocol

The meter uses SCPI syntax, similar to other test and measurement equipment.

Commands are strings of ASCII characters. Commands are grouped into a hierarchy by functional area. Levels in the hierarchy are separated by colons (:). The protocol is case-insensitive; however, most commands have a long and a short form. It is customary (but not required) to:

- Capitalize the characters that are required for the short form.
- Use lowercase for the additional characters that may be sent for the long form.

For example, both are equally valid:

```
CONFigure:GAIN:FACTor 1.0
CONF:GAIN:FACT 1.0
```

Most commands can also be queried by appending a question mark:

```
CONFigure:GAIN:FACTor? // host sends a query
1.0

CONF:GAIN:FACT  // meter replies with the value
1.0
```

All communication is initiated by the host sending a command to the meter. The sensor simply responds to requests from the host.

7.3 Message Terminators

Messages between the sensor and the host computer are comprised entirely of ASCII string characters except for the data streaming transmission interface which sends unsolicited uniquely coded out-of-band data transmissions. Strictly binary messages are not supported. All message strings passing through the host interface are terminated to signal the end of a message string.

1.1 Messages Received by the Sensor

Messages received by the sensor must be terminated by a carriage return (decimal 13). Line feed characters (decimal 10) is discarded so message terminator flexibility can be attained. A command or query is considered incomplete without the terminator. The maximum length of any message received by the sensor is limited to 255 bytes.

1.1 Messages Sent by the Sensor

By default, all messages sent by the sensor are terminated by a carriage return and line feed pair. However, the message terminator is configurable by the user:

```
SYSTem:COMMunicate:LENDing {CRLF|CR|LF}
```

7.4 Data Streaming Transmission Interface

The SCPI interface is a well-known and popular interface standard with a shortcoming which is problematic for PM10K+. The SCPI interface definition does not provide a facility for unsolicited messages from the test equipment. Unsolicited device messages could interfere with parsing query replies. Also, there is not enough buffer memory in the sensor to store useful amounts of measurement data. It is for those reasons that an out-of-band interface is included: the data streaming transmission interface.

Data streaming transmission messages are ASCII formatted but not strictly. The high bit (mask 0x80) is always set for all bytes of all data streaming transmission messages including the terminators. That allows host software to easily differentiate between data streaming transmission messages and SCPI reply messages. The host may operate using the rule that if the high bit is set on any byte received from the sensor, it is part of a data streaming transmission message.

Data streaming transmission messages are sent to the host immediately as measurements are generated. Power measurements are output continuously at 10Hz. Each message includes the items currently selected by `CONF:ITEMselect`, and is terminated by an end-of-line marker (by default, a carriage-return/newline pair).

The data transmission is gated by the `INIT/ABORT` commands. For convenience when using standard terminal software (e.g. Putty, TeraTerm), a second pair of commands, `DST/DSP`, are provided that output plain ASCII text without the high bit set.

Table 7-4. Gating Commands for Data Transmission

Gating Commands	Output	Use Case
INIT/ABORT	ASCII text, with high bit set (0x80)	Host software application, which needs a reliable way to distinguish message types
DST/DSP	ASCII text	Simple human-readable output when using standard terminal software. Queries must not be sent while streaming is active.

7.5 Operational Parameters

The following table shows all operational parameters.

Table 7-5. Operational Parameters

Parameter	Power-on state
Speedup state (persistent)	Last Setting
Error count	0
Data streaming transmission interface state	Stopped/Disabled
Measurement data record selected items	MEAS,FLOW,ITEMP,FLAG,SEQ
Sync	0
SCPI handshaking	On
Zero	Factory setting
Current Wavelength (persistent)	Last granted setting

Table 7-5. Operational Parameters

Parameter	Power-on state
Gain compensation factor (persistent)	Last setting
Gain compensation state (persistent)	Last setting
RS232 Baud Rate (persistent)	Last setting
Line Ending (persistent)	Last Setting
Glycol compensation (persistent)	Last Setting
Glycol concentration (persistent)	Last Setting
Glycol type (persistent)	Last Setting

7.5.1 SCPI Interface

7.5.1.1 Initiate Streaming

```
Command: INITiate
```

This command enables data streaming interface transmission. This command is ignored if data streaming interface transmission is already enabled.

The output data is ASCII text, with the high bit (0x80) set in every character (including line terminators). Each line of output data is a measurement record, and the items within each record depend on CONFigure:ITEMselect.

For plain ASCII text without the high bit set, use DST instead.

7.5.1.2 Abort Streaming

```
Command: ABORt
```

This command disables data streaming interface transmission. This command is ignored if data streaming interface transmission is already disabled.

See also: DSP

7.5.1.3 Latest Reading

```
Query:   READ?
```

Query the latest measurement data record.

The fields returned depend on the CONFigure:ITEMselect setting.

7.5.1.4 Measurement Item Select and Format

```
Command: CONFigure:ITEMselect {token list}
Default: MEAS,FLOW,ITEMP,FLAG,SEQ
Query:   CONFigure:ITEMselect?
Reply:   {token list}
```

This command selects which items are included in the data streaming record. The command accepts one or more tokens, separated by commas. Available tokens are described in the table below. The order in table defines the order in which items are sent on the streaming interface.

Table 7-6. Measurement Item Select and Format

Token	Description	Ascii Mode
MEAS	Primary measurement value (Watts)	Decimal formatted real number
FLOW	Cooling water flow rate (L/min)	Decimal formatted real number
ITEMP	Inlet water temperature (deg C)	Decimal formatted real number
FLAG	SYSTem:STATus bitfield	Hexadecimal formatted integer
SEQ	Sequence number	Decimal formatted integer

7.5.2 Measurement Setup and Control

7.5.2.1 Sensor Zero

```
Command: CONFigure:ZERO
Default: 0.0
Query:   CONFigure:ZERO?
Reply:   {float}
```

This command sets the current measurement as the zero-baseline measurement.

This command returns OK immediately, and the zero procedure runs in the background. The procedure takes approximately 2 seconds to complete, during which time streaming data is not available.

The query returns the zero-baseline power measurement.

7.5.2.2 Wavelength

```
Command: CONFigure:WAVElength {MINimum|MAXimum|inte-
ger}
Default: 1070
Query:   CONFigure:WAVElength? [MINimum|MAXimum]
Reply:   {integer}
```

The command sets the current wavelength in nanometers, which is committed to persistent storage when it is changed. If the requested wavelength is greater than the upper wavelength limit, the current wavelength is set to the upper wavelength limit. Likewise, if the requested wavelength is less than the lower wavelength limit, the current wavelength is set to the lower wavelength limit. The minimum and maximum allowed wavelength may also be named as data arguments. The query gets the current, maximum allowed, or minimum allowed wavelengths depending on the optional query data argument.

7.5.2.3 Speedup

```
Command: CONFigure:SPEedup {DEFault|ON|OFF}
Default: OFF
Query:   CONFigure:SPEedup?
Reply:   {ON|OFF}
```

Set or get the speedup state.

7.5.2.4 Gain Compensation

7.5.2.4.1 Gain Compensation Factor

```
Command: CONFigure:GAIN:FACTor {DEFault|float}
Default: 1.0
Query:   CONFigure:GAIN:FACTor?
Reply:   {float}
```

Set or get the gain compensation factor. This is a unitless factor applied to the measurement to compensate for external gain or attenuation. Valid range is 0.001 to 100e3.

7.5.2.4.2 Gain Compensation State

```
Command: CONFigure:GAIN:COMPensation {DEFault|ON|OFF}
Default: OFF
Query:   CONFigure:GAIN:COMPensation?
Reply:   {ON|OFF}
```

Enable or disable gain compensation.

7.5.3 SCPI Common Commands

7.5.3.1 Identification Query

```
Query:   *IDN?
Reply:   Coherent, Inc - PowerMax {type} {comm} - {ver-
sion} - {date}
```

This query gets the sensor's identification string, which includes the manufacturer name, model name, firmware version, and firmware date.

- type - either 10kW or 15kW, depending on the maximum power rating
- comm - host connection, either USB or RS
- version - firmware version, V{major}.{minor}.{patch}
- date - {3 character month name} {day of month} {4 digit year}

Note that the reply string is not quoted.

For example:

```
*IDN?
Coherent, Inc – PowerMax 10kW - V1.3.0 - Jul 01 2023
OK
```

7.5.3.2 Reset Command

```
Command: *RST
```

This command resets all operational parameters to their power-on states. Reset does not affect factory settings.

7.5.4 System Commands

7.5.4.1 Communication Settings

7.5.4.1.1 Handshaking

```
Command: SYSTem:COMMunicate:HANDshaking
{DEFault|ON|OFF}
Default: ON
Query:   SYSTem:COMMunicate:HANDshaking?
Reply:   {ON|OFF}
```

Enable handshaking to get immediate feedback on whether a command passed or failed. If enabled, the sensor either responds with OK or ERR{N} after each command, where N is an integer error code that identifies the type of failure. This can also be useful for synchronizing the host with the sensor.

7.5.4.1.2 Line Ending

```
Command: SYSTem:COMMunicate:LENDing {CRLF|CR|LF}
Default: CRLF
Query:   SYSTem:COMMunicate:LENDing?
Reply:   {CRLF|CR|LF}
```

Set or get the line ending that terminates all sensor-to-host messages, including both SCPI responses and data streaming messages.

- CRLF - Carriage Return (decimal 13), Line Feed (decimal 10) pair
- CR - Carriage Return (decimal 13)
- LF - Line Feed (decimal 10)

The new line ending takes effect immediately. If handshaking is ON, then the OK response is returned with the new line ending.

7.5.4.1.3 RS232 Baud Rate

```
Command: SYSTem:COMMunicate:BAUD
{9600|19200|38400|57600|115200}
Default: 115200
Query:   SYSTem:COMMunicate:BAUD?
Reply:   {9600|19200|38400|57600|115200}
```

Set or get the baud rate for the RS232 interface.

This setting has no effect when using the USB interface.

The new baud rate takes effect immediately. If handshaking is ON, then the OK response is returned at the new baud rate.

7.5.4.2 Flow Rate

```
Query:   SYSTem:FLOWrate?
Reply:   {float}
```

Get the flow rate of the cooling water in liters per minute.

7.5.4.3 Information

7.5.4.3.1 Calibration Date

```
Query:   SYSTem:INFormation:CDATe?
Reply:   {quoted string}
```

Get the calibration date.

7.5.4.3.2 Default Wavelength

```
Query:   SYSTem:INFormation:WAVElength?
Reply:   {integer}
```

Get the default wavelength in nanometers.

7.5.4.3.3 Manufacture Date

```
Query:   SYSTem:INFormation:MDATe?
Reply:   {quoted string}
```

Get the manufacture date.

7.5.4.3.4 Model Name

```
Query:   SYSTem:INFormation:MODel?
Reply:   {quoted string}
```

Get the sensor model name.

7.5.4.3.5 Part Number

```
Query:   SYSTem:INFormation:PNUMber?
Reply:   {quoted string}
```

Get the sensor part number.

7.5.4.3.6 Sensor Type

```
Query:   SYSTem:INFormation:TYPE?
Reply:   "THERMO,SINGLE"
```

Get the sensor type.

7.5.4.3.7 Serial Number

```
Query:   SYSTem:INFormation:SNUMber?
Reply:   {quoted string}
```

Get the sensor serial number.

7.5.4.4 Interlock

7.5.4.4.1 Interlock State

```
Query:   SYSTem:INTerlock:STATe?
Reply:   {ON|OFF}
```

Get the current state of the interlock. ON means the interlock is open.

This is the same as querying bit 24 (0x01000000) of SYSTem:STATus?

7.5.4.5 System Error Queue

7.5.4.5.1 All Errors

```
Query:   SYSTem:ERRor:ALL?
Reply:   {error code},{quoted error string}
```

Return all errors in the error queue, and clear the queue.

Table 7-7. Error Codes

Error Code Number	Quoted Error String	Error Description
-350	"Queue overflow"	Error queue is full
-310	"System error"	Unexpected or unrecoverable hardware or software fault
-200	"Execution error"	Command is out of order
0	"No error"	No error
100	"Unrecognized command/query"	The command or query is not recognized
101	"Invalid parameter"	The command or query parameter is invalid
102	"Data error"	A data error was encountered

7.5.4.5.2 Clear

```
Command: SYSTem:ERRor:CLEar
```

Clear the error queue, and SYSTem:FAULt register.

7.5.4.5.3 Error Count

```
Query:   SYSTem:ERRor:COUNt?
Reply:   {integer}
```

This query gets the number of error records in the error queue at the time of the query.

7.5.4.5.4 Next Error

```
Query:   SYSTem:ERRor:NEXT? [count]
Reply:   {error code},{quoted error string}
```

Remove and return the next error from the queue.

Optional argument is the number of errors to return. Default is 1.

7.5.4.6 System Faults

```
Query:   SYSTem:FAUlt?
Reply:   {hex integer}
```

Get the system fault register.

Returns the bitwise OR of faults that have occured since the last time the register was cleared.

The register is initialized to zero on power-up, and may be cleared using SYSTem:ERRor:CLEar.

Table 7-8. System Faults

Bit	Mask	Name	Description
0	0x01	I2C Timeout	Internal I2C device was unresponsive
1	0x02	Host Timeout	Device attempted to send data, but the host was unresponsive
2	0x04	Host Disconnected	Device attempted to send data, but the host was disconnected
3	0x08	EEPROM Error	Internal EEPROM error
4	0x10	Watchdog Reset	Device reset automatically because firmware was unresponsive
5	0x20	Firmware Fault	Device reset automatically because firmware attempted an invalid memory access

7.5.4.7 System Restore

```
Command: SYSTem:RESTore
```

This command restores the persistent data back to the factory settings, which erases user defined settings.

7.5.4.8 System Status

```
Query:   SYSTem:STATus?
Reply:   {hex integer}
```

Get the systems status bitmask. This is the FLAG field from the data streaming record.

For compatibility with other meters and sensors, the lower word is reserved for common flags.

Table 7-9. System Status

Bit	Mask	Description
4	0x00000010	power over range
5	0x00000020	negative power reading
6	0x00000040	Measurement is sped up
7	0x00000080	housing over temp

The upper word contains device-specific flags, that apply only to PM10K+/PM15K+ Sensor Systems.

Table 7-10. System Status (continued)

Bit	Mask	Description
16	0x00010000	flowrate over range
17	0x00020000	flowrate under range (warning)
18	0x00040000	flowrate under range (alarm)
19	0x00080000	flowrate unstable
20	0x00100000	inlet over temp
21	0x00200000	inlet under temp
22	0x00400000	inlet temp unstable
23	0x00800000	outlet over temp
24	0x01000000	Interlock is active (open)
25	0x02000000	Reverse flow

7.5.4.9 System Sync

```
Command: SYSTem:SYNC
Query:   SYSTem:SYNC?
Reply:   {integer}
```

This command resets the sequence number to zero. This query gets the current sequence number.

The sequence number increments by one on every sample interval (100ms)

7.5.4.10 Self Test

```
Command: SYSTem:TEST
Query:   SYSTem:TEST?
Reply:   {list of results}
```

Note that the command starts the tests, and the query returns the last test status.

7.5.4.11 Temperature

7.5.4.11.1 Inlet Temperature

```
Query:   SYSTem:TEMPerature:INLet?
Reply:   {float}
```

Get the temperature of the inlet water in degrees Celsius.

7.5.4.12 Syntax and Notation Conventions

Syntax and notation conventions specified by the SCPI Standard are followed for all SCPI commands and queries unless otherwise specified. Refer to the SCPI Standard for more information.

The base-10 numeric data format specification is used heavily in this document. Unless otherwise specified, numeric data items are represented as:

- integer values
- non-scientific notation floating point values

- scientific notation floating point values (upper or lower case E)

For example, the following data values are functionally equivalent:

- 31256
- 31256.0
- 3.1256E4
- 31.256E3
- +3.1256E+4.

Unless otherwise specified, non-numeric data items (typically referred to as strings) are not quoted.

Enumerated values must match exactly using the long form/short form comparison rules defined under the SCPI Standard.

7.6 Index of Commands

```
*IDN?
*RST
*ind
ABORt
CONFigure:GAIN:COMPensation {DEFault|ON|OFF}
CONFigure:GAIN:COMPensation?
CONFigure:GAIN:FACTor {DEFault|float}
CONFigure:GAIN:FACTor?
CONFigure:ITEMselect {token list}
CONFigure:ITEMselect?
CONFigure:SPEedup {DEFault|ON|OFF}
CONFigure:SPEedup?
CONFigure:WAVElength {MINimum|MAXimum|integer}
CONFigure:WAVElength? [MINimum|MAXimum]
CONFigure:ZERO
CONFigure:ZERO?
DSP
DST
INITiate
READ?
SYSTem:COMMunicate:BAUD {9600|19200|38400|57600|115200}
SYSTem:COMMunicate:BAUD?
SYSTem:COMMunicate:HANDshaking {DEFault|ON|OFF}
SYSTem:COMMunicate:HANDshaking?
SYSTem:COMMunicate:LENDing {CRLF|CR|LF}
SYSTem:COMMunicate:LENDing?
SYSTem:ERRor:ALL?
SYSTem:ERRor:CLEar
SYSTem:ERRor:COUNt?
SYSTem:ERRor:NEXT? [count]
SYSTem:FAUlt?
SYSTem:FLOWrate?
SYSTem:INFormation:CDATe?
SYSTem:INFormation:MDATe?
SYSTem:INFormation:MODel?
SYSTem:INFormation:PNUMber?
SYSTem:INFormation:SNUMber?
SYSTem:INFormation:TYPE?
SYSTem:INFormation:WAVElength?
SYSTem:INTerlock:STATe?
SYSTem:RESTore
SYSTem:STATus?
SYSTem:SYNC
SYSTem:SYNC?
SYSTem:TEMPerature:BODY?
```

```
SYSTem:TEMPerature:INLet?
SYSTem:TEMPerature:OUTLet?
```

8 Troubleshooting and Error Messages

This section provides information about how issues are reported by the PM10K+/PM15K+ to assist in troubleshooting.

For Technical Support assistance, see ’Obtain Service’ (p. 138) for information about various ways to contact Coherent.

8.1 Device Not Found

A device not found error displays on-screen in the software if the sensor is not detected.

***To clear the error**:*

Unplug and replug the source of power to the sensor.

Make sure that the device manager shows the device display under COM objects (as Coherent PowerMax sensor).

If the device is still not found, uninstall and then re-install the Coherent Meter Connection Software. Refer to ’Install Software’ (p. 78).

8.2 Water Flow and Temperature Caution and Warnings

A front panel LED status indicator, on the sensor, gives information about status and water flow. Also, Coherent Meter Connection status indicators viewed in the Diagnostics tab in the PC application provide water flow and temperature indicators.

***To clear the error**:*

First, an orange color displays, if the flow rate is close to specification; when flow is increased slightly and the flow rate is correct, the LED becomes green.

Adjust the chiller temperature and flow rates, as necessary.

For information about the indicators and status refer to ’Controls and Indicators’ (p. 79).

8.3 Negative Power Reading

If there is a negative value in the power level, it is likely that the water supply and return tubes were installed in reverse. This can also be the case when the measured inlet water is a higher temperature than the outlet water.

To resolve this, set the laser system to OFF, set the chiller to OFF, and then remove and reinstall the water hoses to the correctly labeled ports.

8.4 Recalibration or Repair

If a unit needs re-calibration or repair, it must be shipped to Coherent for service. Refer to 'Product Shipment Instructions' (p. 139).

8.5 LED Indicator Displays solid Red

For indicator on the sensor displays solid red color, there is a startup/boot failure, or low water flow. When the sensor is powered from a standalone meter through the DB25 cable, it is normal for the LED to display a solid color. In this case, solid red could simply mean low water flow.

To clear the error:

Install the firmware update.

Adjust the chiller temperature and flow rates, as necessary.

8.6 Coherent Meter Connection Application Failure

If the software crashes or is forced to stop, PM10K+ sensors connected to the computer can be left in an undefined condition.

To clear the error*:*

Disconnect and then reconnect the USB cable on each of the used sensors.

8.7 Error Message Displays when Sensor is Removed

The Coherent Meter Connection software show a communications error if the PM10K+/PM15K+ sensors are removed from the computer while the software is in operation. This error message operates as a reminder that there are no sensors available for data collection.

***To clear the error**:*

Select **OK** in the error window(s).

Reconnect the sensor to the computer and then click the **Select Sensor** button to continue.

8.8 Error Message Displays When a Sensor Is Removed While Getting Data

The Coherent Meter Connection software shows an error window if a sensor is removed while that sensor is streaming data. Data collection must be stopped before removing a sensor that is being used to collect data.

***To clear the error**:*

Click **OK** in the error window(s).

Reconnect the sensor to the computer and then click the **Select Sensor** button to continue; or, select **File** > ***Exit***, to exit the software.

8.9 Failed Communications Error

The Coherent Meter Connection software shows an error if a communications failure occurs while reading sensor parameters.

***To clear the error**:* Click the **OK** button.

9 Maintenance and Service

This section includes information about annual calibration, extended warranty, how to obtain service, maintenance and product shipment.

Unless otherwise noted, illustrations in this chapter reflect the base configuration of the PM10K+ that does not have the backscatter shield.

9.1 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, it is important to have measurement systems serviced and re-calibrated once a year.

A large percentage of Coherent calibrations are performed within five business days, and expedited service is available, to minimize customer downtime.

9.1.1 Scope of Calibration

Calibration of a Coherent power and energy laser measurement product includes:

- Calibration to original uncertainty levels
- Minor repairs (see more information, below)
- Extended 12 month warranty, on eligible products
- Fast calibration turn around time.

Minor repairs includes fixing manufacturer's defects, hardware updates, firmware, software updates, damaged connectors, and other small repairs. Detector element replacement due to laser damage and damage caused by negligent use is not covered – for customer caused damage, an additional repair service charge is applied.

This level of service results in an overall lower cost of ownership, with many owners realizing a lifetime warranty for their products.

9.1.2 Re-certify Once Per Year

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, and to ensure compliance with your quality and ISO certification, it is important to have measurement systems serviced and re-certified once per year.

Extended use of laser power and energy meters and sensors, as well as environmental factors, can have an adverse effect on accuracy and also result in wear and/or damage to parts critical to optimum performance.

9.1.3 Coherent Calibration Facilities and Capabilities: ISO 17025 Accredited

Coherent calibration facilities contain the widest possible range of light sources from 193 nm to 10,600 nm, with powers ranging nanowatts to kilowatts.

Coherent Wilsonville, Oregon, and its satellite sites, are fully accredited to ISO/IEC 17025:2017 by ANAB - The ANSI National Accreditation Board. ANAB is a signatory of the International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC) multilateral recognition arrangements. ANAB has signed the MRAs of the InterAmerican Accreditation Cooperation (IAAC) and the Asia Pacific Accreditation Cooperation (APAC). Accreditation to ISO/IEC 17025 is the formal recognition that a calibration laboratory is technically competent to carry out specific calibrations.

A detailed discussion of the Scope of Accreditation and the Technical Requirements of ISO 17025 Accreditation can be found on the Coherent ISO 17025:2017 Accreditation web page.

In addition, Coherent team delivers the industry's best service, with a knowledgeable and responsive staff, and rapid turnaround.

9.1.4 Extended Warranty Program

To qualify for an Extended Warranty, a Customer must return the Product to the Company for recalibration and recertification. For information, refer to 'Extended Warranty Program' (p. 131).

9.2 Drain Water After Use

CAUTION!
Do not use forced air to clear the sensor water line. This can cause damage to the sensor system.

This procedure should be done when the sensor is removed from the system and will not be used for a period of time.

1. Make sure that the laser is set to OFF.
2. Remove all other cables from the interface, such as power supply, USB, interlock, etc. The sensor should not be connected to power.
3. Install the protective cover over the sensor surface.

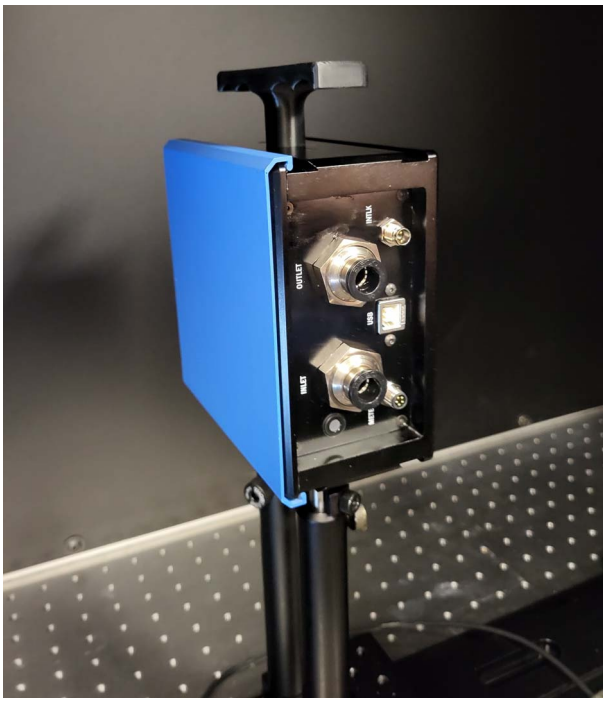


Figure 9-1. Protective Cover Reinstalled

4. Hold a towel under the hose end (or quick-connect fittings, if used) to catch any water that leaks, when the hose is removed.

Figure 9-2. Remove Water Hoses from Sensor Fittings

5. Push in the plastic ring on the push-to-connect fitting on the sensor, to release the hose. Then, pull and remove the hose from the sensor.

NOTICE

The use of customer-supplied quick-disconnect hose fitting kits can be helpful for easy and spill-free disconnection removal of the sensor from the mount.

6. If a customer-supplied quick-disconnect fitting kit is used, push the buttons on the fittings to unlock them and then pull the two hose sections apart. See the examples in Figure 9-3.

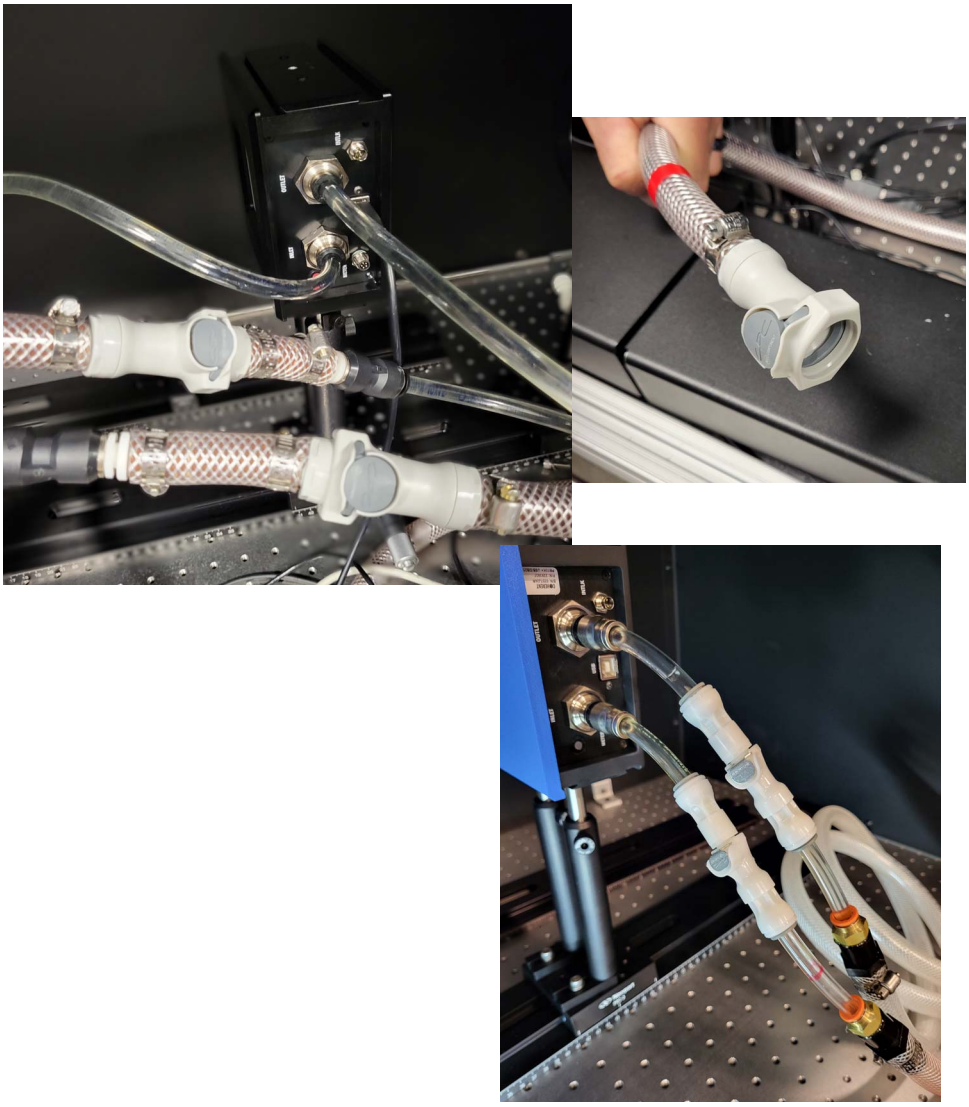


Figure 9-3. Push Buttons on Optional Quick-Disconnects

7. Loosen the mounts for the sensor.

Figure 9-4. Loosen Mounts (PM10K+ example)

CAUTION!
Do NOT touch the sensor surface when the unit is handled. Contamination can cause damage and incorrect measurements.

8. Install the cap plugs to the push-to-connect fittings This keeps water from spilling out

.

Figure 9-5. Water Cap Plugs Installed

9. Carefully remove the sensor from the mounts. Use care so that water does not spill from the inlet/outlet.

Figure 9-6. Remove Sensor from Mount (Post-mount setup)

10. Bring the sensor to a location where the water can be drained.
11. Remove the water plug caps again. Push in the plastic ring on the push-to-connect fitting on the sensor, to release the plug.

Figure 9-7. Remove Protective Plug Caps

12. Hold the sensor over a container and then turn the sensor until all of the water is drained.

Figure 9-8. Pour Water from Sensor System

CAUTION!
When the power sensor is installed or reinstalled, make sure that there is no visible water present at the interface connection. Water on electrical connections can cause damage when power is supplied.

13. Use a clean cloth or a wipe to remove any spilled or excess water from the sensor interface panel.
14. If the unit will not be reinstalled immediately, push the two protective caps in fully to the push-to-connect fittings to re-install them.

Figure 9-9. Reinstall Install Protective Plug Caps

9.3 Clean Procedures

If necessary, clean the absorber surface with clean dry air. Do not wipe or touch the surface.

Figure 9-10. Clean with Clean Dry Air

CAUTION!
It is critical to prevent dust, debris, and other contamination from getting inside the sensor cavity and onto the sensor element. In all instructions when the power sensor is set up, NEVER touch the sensor element. This can deposit natural oils from fingertips onto the absorber surface. Also, do NOT use solvents to clean the surface.

9.4 Obtain Service

In order to obtain service under this 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) and 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 months of time of sale or during an extended twelve month warranty period.

A Returned Material Authorization number (RMA) assigned by the Company must be included on the outside of all shipping packages and containers. Items returned without an RMA number are subject to return to the sender. Refer to 'Product Shipment Instructions' (p. 139).

Table 9-1. Coherent Service Centers

Location	Phone	E-mail
USA	(800) 343-4912 or (503) 454-5700	LSMservice@Coherent.com or Customer.Support@coherent.com
Outside of USA	Germany: +49–6071–968–0 Japan: +813–5635–8680	

9.5 Product Shipment Instructions

NOTICE

Unless noted otherwise, example images in this section show the standard PM10K+ sensor configuration. The PM10K+ with Backscatter shield and PM15K+ models are packaged similarly, with modified foam cutouts.

To prepare the product for shipping to Coherent:

1. Contact Coherent Customer Service (refer to Table 9-1) 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 that was received from Coherent Customer Service.

NOTICE

The protective cover that the sensor was shipped with is shown to reduce sensor surface damage during shipment. If the cover or shipment handle are not available, they can be ordered from Coherent. Refer to 'Obtain Service' (p. 138).

3. If not installed, locate the protective cover for the absorber surface.Locate the ship/stow handle (PN 2319333) that was installed when the unit was unpacked. The handle has a hex screw (1/4-20, 1 3/8-in. long socket head cap).

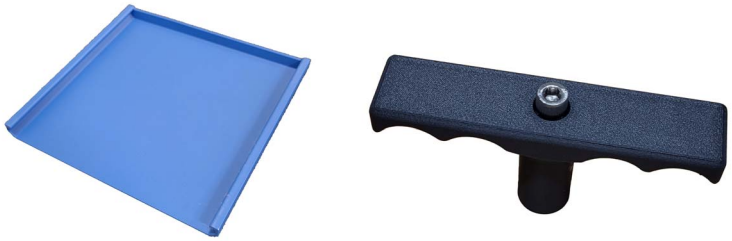


Figure 9-11. PM10K+ with Protective Cover Plate

4. Make sure that the unit is emptied of water. Refer to 'Drain Water After Use' (p. 131).
5. Slide the protective cover in place over the absorbersurface of the unit, along the rails, as shown in Figure 9-12.

Figure 9-12. Protective Cover Plates Installed

6. Make sure that the water line plugs (2314439) are installed.

Figure 9-13. Sensor with Protective Cover and Water Plugs

7. Set the unit on its side so the 1/4-in. mount holes are accessible.
8. Reinstall the handle to the device. Attach it to the middle mount screw hole on the side of the sensor. Tighten the hex screw on the handle.

Figure 9-14. Hex Screw on Handle

9. Use the attached handle to move and stow the sensor system.
10. If the original packing material and carton 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. Use material to provide cushion to 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, top, and bottom.

11. If the original packing material is available:

    a.) Remove the foam except for the bottom tray. Hold the sensor with the handle and put it in place in the cutout for the sensor

Figure 9-15. Set Sensor Into Bottom Foam Tray

Make sure that the blue cover is set toward the inside of the box, and the handle is up. See additional examples in Figure 4-3.

b.) Put the top inner tray over the bottom foam layer and sensor.

Figure 9-16. Put Top Inner Foam Tray Over Sensor

c.) Put any cable and power supply accessories, as well as the quickstart guide into the cutouts in the top foam tray. Refer to the example in Figure 4-1 (p. 46).

12. Use shipping tape to make a seal on the shipping carton or use an industrial stapler.

13. Ship the product to:

    Coherent, Corp.
    27650 SW 95th Ave.
    Wilsonville, OR 97070

    Attn: RMA # (*add the RMA number that was received from Coherent Customer Service*)

Appendix I: Safety

This section describes requirements for safety for persons setting up or operating the PM10K+/15K+ Sensor System, and includes:

- 'Laser and Optical Safety' (p. 145)
- 'Electrical Safety' (p. 146)
- 'Safety Features and Compliance with Government Requirements' (p. 147)

- Users must review these laser safety sections thoroughly BEFORE operating the PM10K+ sensor. Carefully follow all safety instructions presented throughout this manual.

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

For the PM10K+/15K+ sensors, 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.

I.1 Laser and 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.

At all times, make sure 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!
LASER RADIATION - AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION CLASS 4 LASER PRODUCT!

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 the laser system. 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.

For safety information specific to the use of lasers, read and obey all respective documentation provided by the manufacturer of the laser system being used.

CAUTION!
Laser safety eyewear protects the user from accidental exposure to laser radiation by blocking light at the laser wavelengths.

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

I.2 Electrical Safety

The PM10K+/PM15K+ sensors do not have dangerous voltages.

CAUTION!
The PM10K+ sensor is designed to be operated as assembled; there are no user-serviceable components in the device. DO NOT disassemble the enclosure. *The Warranty is void if the enclosure is disassembled!*

I.2.1 ESD Protection

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

CAUTION!
Electrostatic charges as high as 4000 volts easily collect on the human body and equipment and can discharge without detection.

Although the electronics features have input protection, permanent damage can occur on devices subjected to high-energy electrostatic discharges. You must take correct ESD precautions to prevent damage or performance degradation.

The most common ESD damage occurs when handling a device during installation or use. Take the necessary measures to protect the system from ESD.

Dry air and carpet also create a higher potential for ESD. Remember to take precautions or shielding not only for operations, but for demonstrations or trade show exhibitions.

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 x 10^9 ohms).

I.3 Safety Features and Compliance with Government Requirements

The following features are incorporated into the instrument to conform to government requirements:

European Union:
The European Community requirements for product safety are specified in the Low Voltage Directive (LVD) (published in 2014/35/EU). The Low Voltage 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 IEC 60825-1 “Safety of Laser Products”. Compliance of this laser with the European Union requirements is certified by the CE mark.

I.4 Safety Label and Information

The bottom of the PM10k+/15k+ Sensor Systems have a product la-bel that provides serial number, safety and compliance information. Refer to the example in Figure I-1.

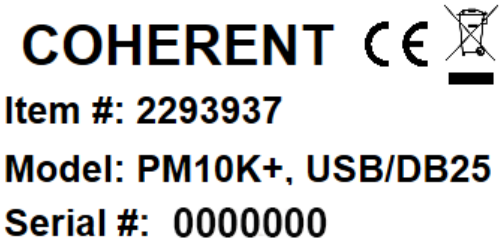


Figure I-1. PM10k+/15k+ Sensor Systems Product Label

I.5 Declaration of Conformity

Declaration of Conformity certificates are available upon request.

Appendix II: Compliance

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

For additional information about Coherent Compliance, please visit:

https://www.coherent.com/company/environmental

II.1 Compliance to Standards Relevant to CE and UKCA Marks

The PM10K+/PM15K+ Sensor Systems are tested and marked as independent products in the European Community (CE) and the United Kingdom (UKCA). For specific details regarding what applicable compliance directives and standards the products have been tested to, refer to the EU Declaration of Conformity and/or the UKCA Declaration of Conformity which are available upon request from Coherent, per contact information on p. ii of this manual.

Compliance to applicable standards for a particular laser tool incorporating PM10K+/PM15K+ Sensor System Operator’s Manual must be demonstrated by the manufacturer of the complete system. The primary issue for the system integrator is to design covers, shielding, grounding, routing of electrical cable assemblies, and control elements with the proper safety features so that during subsequent testing the system meets the appropriate standards.

II.2 Electromagnetic Compatibility

Compliance of this product with the Electromagnetic Compatibility (EMC) requirements is certified by the CE mark and the UKCA mark.

Each application and installation is unique, and in some cases, the user may experience Electromagnetic Interference (EMI) noise being emitted from various electronic components. This laser may use high-frequency

RF. While adequate countermeasures have been taken to suppress this emission to meet the requirements stated on the Declaration of Conformity, the user may wish to employ additional measures to suppress the EMI to reduce the emissions further. Standard methods of reducing the EMI are:

1. Use of shielded control cables grounded on both ends
2. Addition of appropriate ferrite beads to cables connected to the beam source.

II.3 Environmental Compliance

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

II.3.1 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.

Coherent product(s) conform to all applicable requirements of the EU-REACH Regulation, (1907/2006). Declarations of Compliance are available upon request.

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.

II.3.2 RoHS Compliance

Coherent product(s) conform to all applicable requirements of the EU-RoHS Directive (2011/65/EU) and subsequent Amendment Directives including Directive (EU) 2015/863. Compliance Declarations are available upon request.

II.3.3 China RoHS Compliance

Coherent product(s) conform to all applicable requirements of Restriction of Hazardous Substances Regulation SJ/T 11364-2014 commonly referred to as China RoHS.

Hazardous substances (if applicable) in the PM10K+/PM15K+ Sensor System Operator's Manual are listed in the material declaration table included with the equipment, REACH Compliance.

Coherent product(s) conform to all applicable requirements of the EU-REACH Regulation, (1907/2006). Compliance Declarations are available upon request.

Any hazardous substances in Coherent products (if applicable) are shown on the product label. Refer to the example shown in Figure II-1:

	产品中有害物质的名称及含量					
部件名称 Part Name	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	O	O	O	O	O
电缆装配 Cable Assembly	X	O	O	O	O	O
硬件 Hardware	X	O	O	O	O	O
电源 Power Supply	X	O	O	O	O	O
本表格依据 SJ/T 11364 的规定编制 O: 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 II-1. China RoHS Label

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

II.3.4 Waste Electrical and Electronic Equipment (WEEE, 2002)

Coherent product(s) conform to all applicable requirements of the EU Waste Electrical and Electronic Equipment (WEEE)- Directive (2012/19/EU). WEEE management also covers EU Directive

2006/66/EC-EU Battery Directive and Directive 94/62/EC on Packaging and Packaging Waste. Do not dispose of these products or packaging as unsorted municipal waste.

Coherent joins approved compliance organizations to meet its collection and recycling obligations. For further information, please contact:

Email: info@rene-europe.com
Phone: +49 (0) 8266-869806
Website: www.rene-europe.com

This directive is represented by a crossed-out garbage container label, shown in Figure II-2.

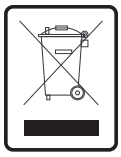


Figure II-2. WEEE Label

CAUTION!
Do not dispose of these products as unsorted municipal waste. Contract Coherent or a local distributor for procedures to recycle this equipment.

Appendix III: Parts and Accessories

This section describes parts and accessories for the PM10K+/PM15K+. This section also describes how to replace the battery in the meter.

III.1 Shipped with the Sensor

Table III-1 shows accessories that are supplied with the PM10K+/PM15K+ Sensor Systems. For more information about cables, see 'Cables and Interfaces' (p. 24).

Table III-1. Accessories Included with PM10K+/PM15K+

PN	Component
2237377	Cable, RS-232 DB9 (for RS232 models)
1105557	Power Supply 5V (for RS232 models)
1112697	Cable, USB 2.0, Type A-B (for USB models)
2311500	Cable, DB-25, 2m (for USB models)
2320728	Side-locked rail carriage for 66 mm rails with 6-32, 8-32, & 1/4"-20 (M6) tapped holes
2282786	3/8-in. Pipe, Inlet Adapter, 3/8 NPT male; High-Temperature, Straight Adapter, 10mm Stem OD, 50mm length (quantity 2)
2303643	PM10K+/PM15K+ Sensor Systems Quickstart Guide
	Certificate of Calibration
	Protective Cover Plate

III.2 Recommended Meters

Coherent recommends the use of the following meters with the PM10K+/PM15K+ Sensor Systems:

- Field MaxII
- LabMax-Pro SSIM
- LabMax Touch/Touch Pro
- FieldMax Touch/Touch Pro

III.3 Shop.Coherent (US Customers Only)

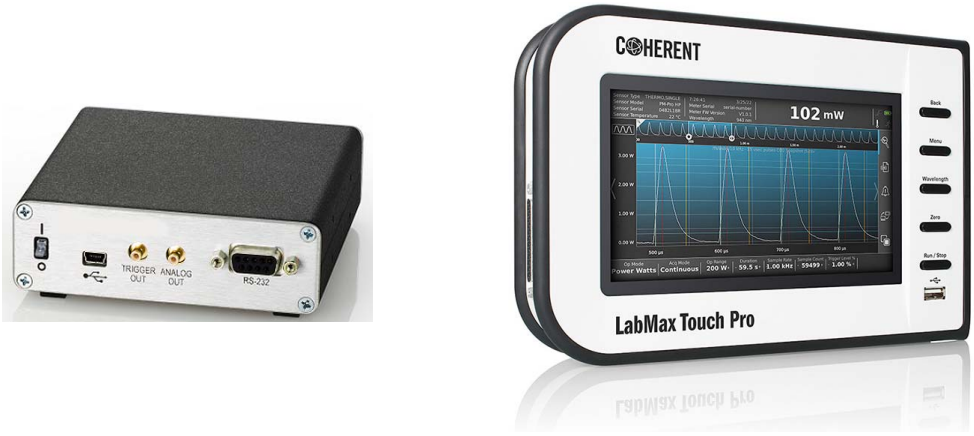


Figure III-1. LabMax-Pro SSIM and LabMax Touch Pro Meters

These accessories or product bundles, as well as power measurement devices can be ordered on the Shop.coherent.com website.

SHOP COHERENT

Shop.coherent is the official e-commerce website for Coherent lasers, energy meters and sensors, fiber optics, and accessories. Available for US customers, the e-commerce service offers product search, product-specific filtering, and fast-and-easy checkout with prompt order and shipping confirmations.

Appendix IV: Warranty

IV.1 Limited Warranty

Coherent, Corp. (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 as specified in the sales agreement.

Coherent, Corp. 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.

IV.2 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 sensor elements 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.

Appendix V: Extended Warranty Program

Coherent, Corp. (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, and 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.

For information about calibration and recertification services, refer to ’Calibration’ (p. 129).

Index

PM10K+/PM15K+Sensor System Operator’s Manual

Part No. 2303642 Rev. AC

COHERENT

INNOVATIONS THAT RESONATE

2303642 AC

PM10K+/PM15K+ Sensor System Operator's Manual

Part No. 2303642 Rev. AC