Operation Manual

Thorlabs Instrumentation

Optical Power Meter

PM300

2007

THORLABS

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Contents **page**

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to live up to your expectations and develop our products permanently we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Thorlabs

This part of the instruction manual contains every specific information on the PM300 optical power meter. A general description is followed by explanations of how to operate the unit manually. You will also find information about a simple remote control of the unit.

☝Attention☝

This manual contains 'WARNINGS" and 'ATTENTION" labels in this form, to indicate danger for persons or possible damage to equipment.

Please read these advises carefully!

NOTE

This manual also contains 'NOTES" and 'HINTS" written in this form.

1 General Information

The PM300 Benchtop Optical Power Meter is designed to measure the optical power of laser light or other monochromatic or near monochromatic light sources.
The dual channel design and compatibility to all Thorlabs Photodiode and Thermal power meter sensors and common Photodiode detectors, combined with a fast USB device interface open a wide range of applications in Manufacturing, Quality Control, Quality Assurance, and R&D.
The provided software, including drivers and applications for LabVIEW and C makes it easy to integrate the instrument in test and measurement systems.

1.1 Safety

☝ Attention ☝

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly.

Before applying power to your PM300 system, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth contact of the socket outlet! Improper grounding can cause electric shock with damages to your health or even death!

Also make sure that the line voltage setting of the fuse holder at the rear panel agrees with your local supply and that the corresponding fuses are inserted. If not, please change the line voltage setting (see section 6.2) and the mains fuses (see section 6.3).

The power meter PM300 must not be operated in explosion endangered environments!

Sensor, photodiode and control inputs and outputs must only be connected with duly shielded connection cables.

Only with written consent from Thorlabs may changes to single components be carried out or components not supplied by Thorlabs be used.

Do not obstruct the air ventilation slots in housing!

Do not remove covers!

Refer servicing to qualified personal!

This precision device is only dispatchable if duly packed into the complete original packaging including the plastic form parts. If necessary, ask for a replacement package.

☝ Attention ☝

Mobile telephones, cellular phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to IEC 61326-1.

This product has been tested and found to comply with the limits according to IEC 61326-1 for using connection cables shorter than 3 meters (9.8 feet).

☝ Attention ☝

The following statement applies to the products covered in this manual, unless otherwise specified herein. The statement for other products will appear in the accompanying documentation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules and meets all requirements of the Canadian Interference-Causing Equipment Standard ICES-003 for digital apparatus. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- **Reorient or relocate the receiving antenna.**
- **Increase the separation between the equipment and receiver.**
- **Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.**
- **Consult the dealer or an experienced radio/T.V. technician for help.**

Thorlabs GmbH is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and equipment other than those specified by Thorlabs GmbH. The correction of interference caused by such unauthorized modification, substitution or attachment will be the responsibility of the user.
The use of shielded I/O cables is required when connecting this equipment to any and all optional peripheral or host devices. Failure to do so may violate FCC and ICES rules.

1.2 Ordering Codes and Accessories

Ordering code	Short description
PM300	**PM300 Dual Channel Benchtop Power Meter**
PM320	**PM300 + S120B Sensor; 400 – 1100nm; 50nW – 50mW**
PM321	**PM300 + S121B Sensor; 400 – 1100nm; 500nW – 500mW**
PM322	**PM300 + S122B Sensor; 700 – 1800nm; 50nW – 50mW**
PM340	**PM300 + S140A Sensor; 400 – 1100nm; 1µW – 1W**
PM344	**PM300 + S144A Sensor; 800 – 1700nm; 1µW – 1W**
PM300-3	**PM300 + S210B Sensor; 250 – 10600nm; 3W**
PM300-10	**PM300 + S212B Sensor; 250 – 10600nm; 10W**
PM300-30	**PM300 + S213B Sensor; 250 – 10600nm; 30W**
S120B	**Si Photodiode Optical Sensor, 400 - 1100nm, 50nW-50mW**
S121B	**Si Photodiode Optical Sensor, 400 - 1100nm, 500nW-500mW**
S122B	**Ge Photodiode Optical Sensor, 700 - 1800nm, 35nW - 35mW**
S130A	**Slim Sensor with Si Detector, 400 - 1100nm, 5nW to 500mW**
S132A	**Slim Sensor with Ge Detector, 700 - 1800nm, 5nW to 500mW**
S140A	**Integrating Sphere with Si Detector, 400 - 1100nm, 1mW to 1W FC Adapter**
S144A	**Integrating Sphere with InGaAs Detector, 800 - 1700nm, 1mW to 1W FC Adapter**
S210A	**3W Thermal Sensor 250nm - 10.6µm**
S212A	**10W Thermal Sensor 250nm - 10.6µm**
S213A	**30W Thermal Sensor 250nm - 10.6µm**

Please visit our homepage http://www.thorlabs.com for further information.

2 Getting Started

2.1 Unpacking

Inspect the shipping container for damage.

If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the PM300 mechanically and electrically.

Verify that you have received the following items:

1. 1 PM300
2. 1 power cord, connector according to ordering country
3. Replacement mains fuses
4. 1 operation manual
5. 1 CD
6. (Sxxx power meter sensor when unit was shipped as a console - sensor set)

2.2 Preparation

☝Attention☝

Prior to switching on your PM300 please check if the line voltage set with the voltage selector at the rear panel corresponds to your mains voltage!

Prior to starting operation with the PM300 optical power meter, check if the line voltage set with the voltage selector at the rear panel agrees with your local supply and if the appropriate fuses are inserted. (See chapter 6.2 on page 58 to change the line voltage and chapter 6.3 on page 59 to exchange the mains fuses.)

Turn the unit on by pressing the line switch.
After switching on the unit, the graphics display will show the device status and then jump to the dual channel screen.
The PM300 is immediately ready to use after turning on. The rated accuracy is reached, however, after a warming-up time of approx. 10 minutes.

Via the banana connector jack of the chassis ground the external optical build-up can be connected to ground potential, if required.

2.3 Physical Overview

2.3.1 Operating Elements at the Front Panel

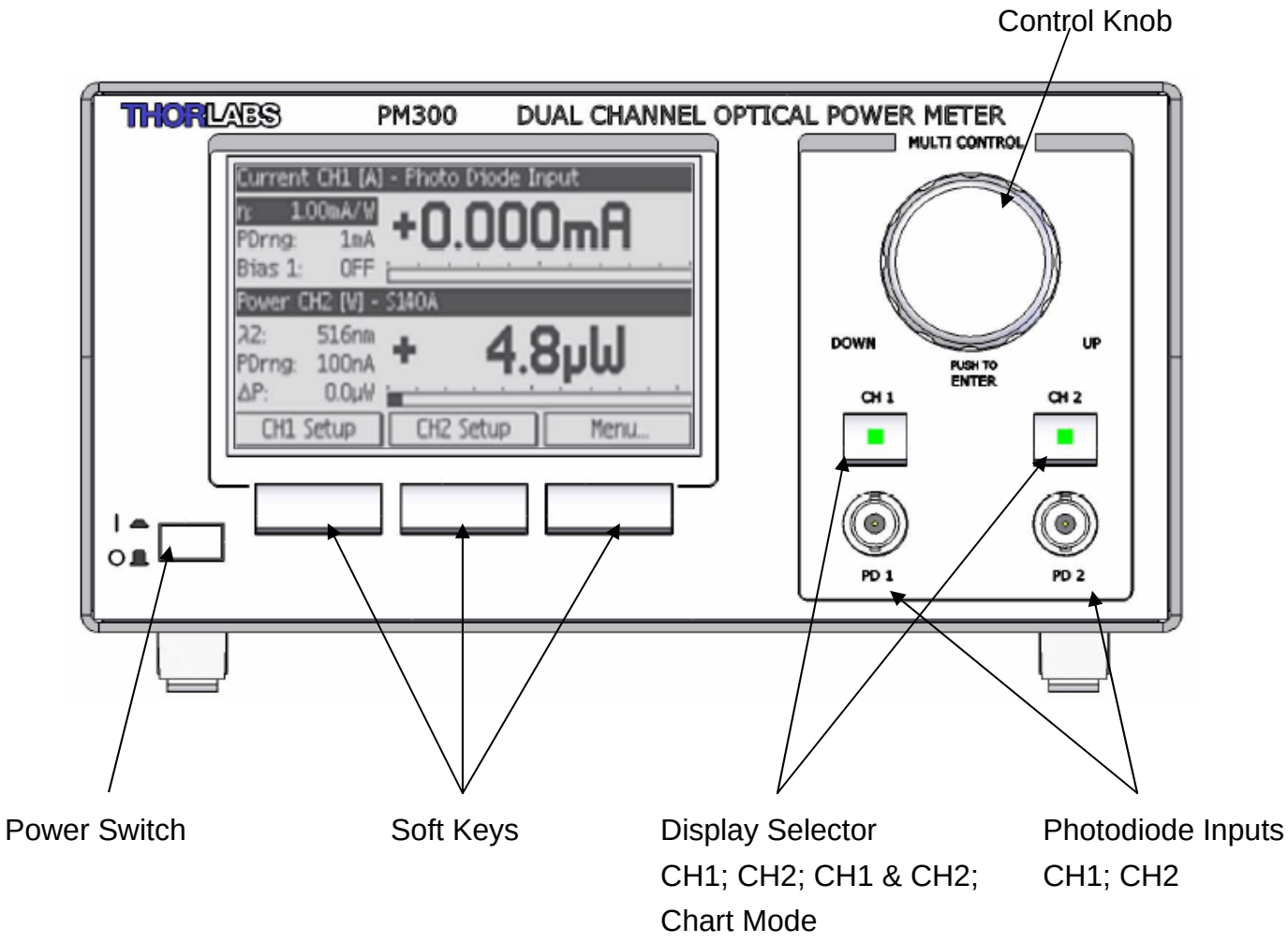


Figure 1 Display and Operating Elements at the Front Panel

2.3.2 Operating Elements at the Rear Panel

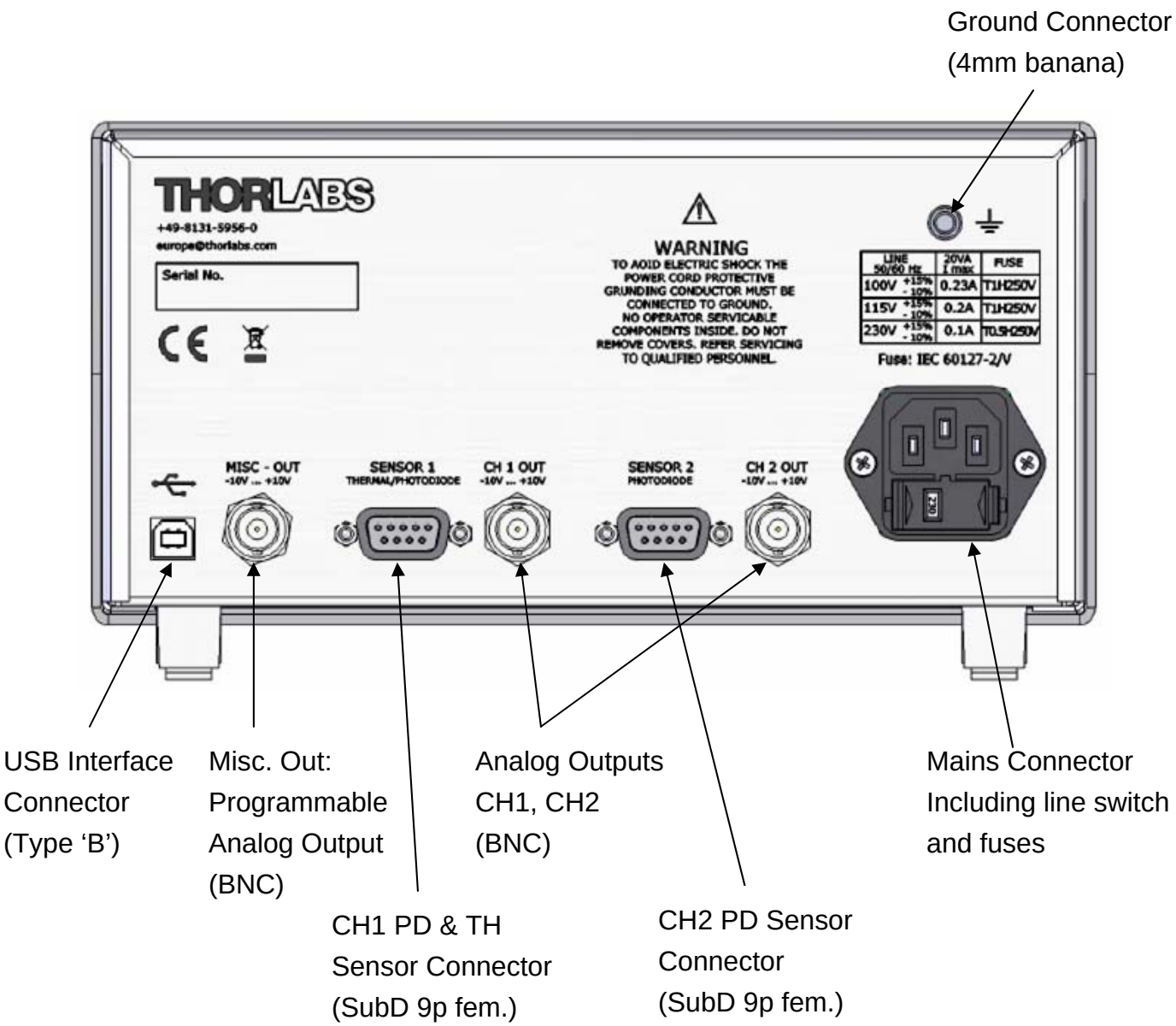


Figure 2 Operating Elements at the Rear Panel

2.3.3 Main Screens

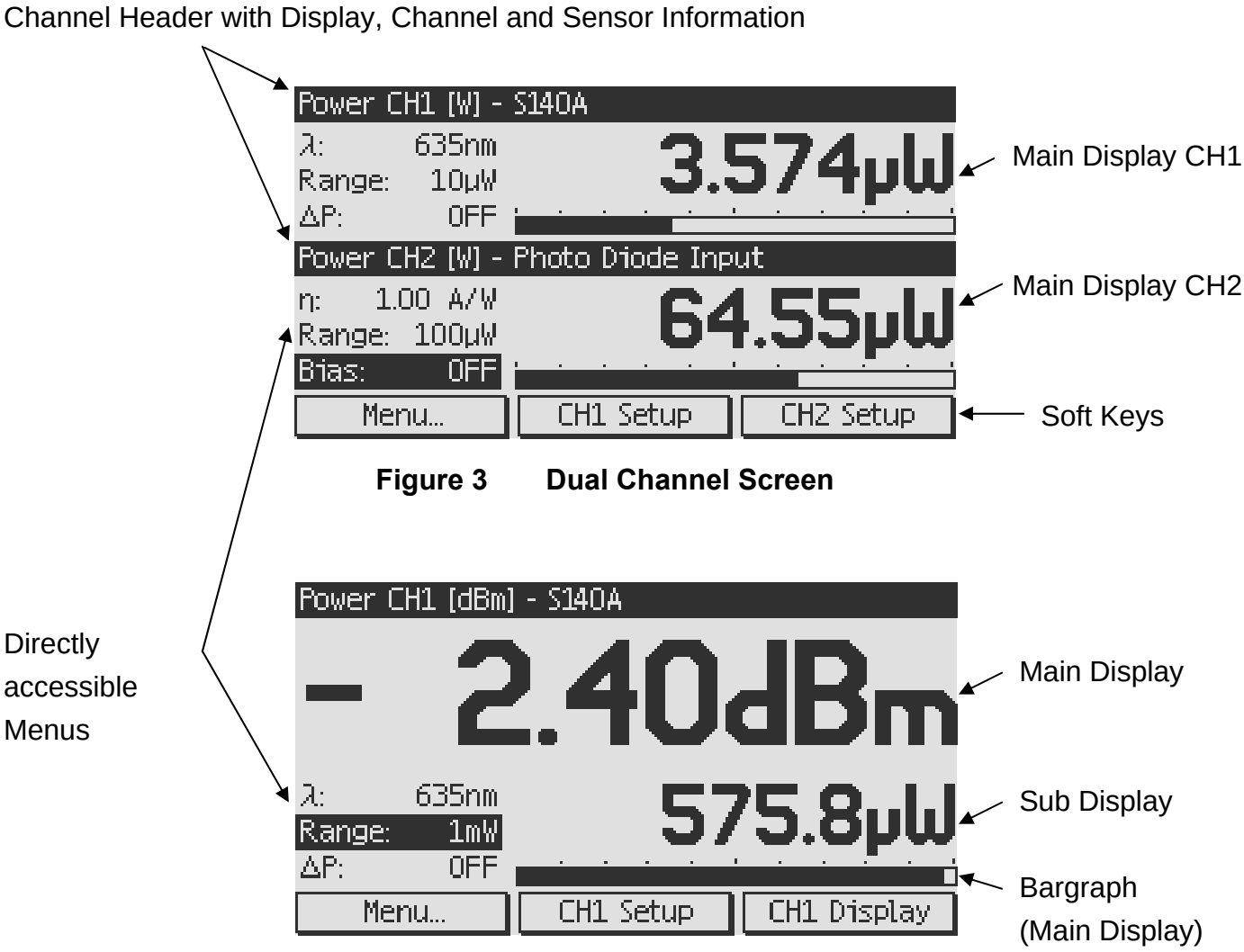


Figure 3 Dual Channel Screen

Figure 4 Single Channel Screen (CH1)

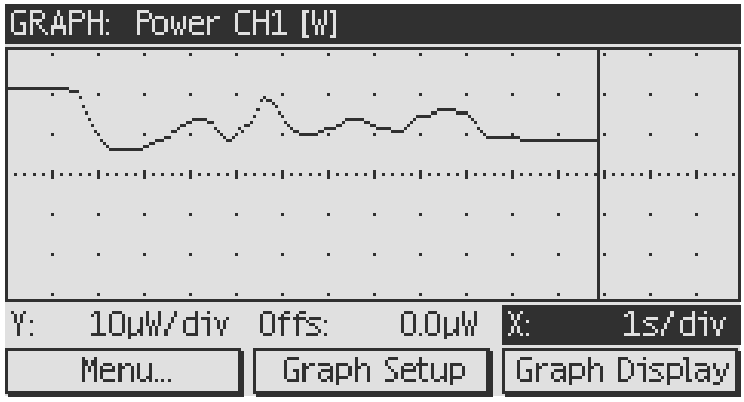


Figure 5 Trend Graph Channel 1

3 Operating the PM300

3.1 Sensor independent Operation and Settings

3.1.1 Navigating the Menus

The PM300 is controlled by three display/menu dependent soft buttons below the graphics display and/or the control knob including a push button with an Edit/Enter functionality. All displays have directly accessible menus by navigating and clicking with the Multi-Control knob.
To select the channel and the graph displays two buttons CH1 and CH2 with LED indicators are used (ON means lit LED; pressing the buttons toggles the LEDs):

CH 1	CH 2	Display
ON	OFF	Channel 1; Single Channel Screen
OFF	ON	Channel 2; Single Channel Screen
ON	ON	Channel 1 + Channel 2; Dual Channel Screen
OFF	OFF	Trend Graph Screen; Measurement value according <Graph Setup> menu or toggling the <Graph Display> soft button

3.1.2 System Settings

To enter the system settings press the Menu button that is located at the left soft button position in the channel and graph screens. The following sub-menus will appear:

- **Channel 1 Setup**
  Depending on the connected sensor the displays and the sensor specific parameters can be set
- **Channel 2 Setup**
  Depending on the connected sensor the displays and the sensor specific parameters can be set
- **Graphics Configuration**
  Configures the measurement value, time-base, offset shift and gain for the graphical representation.
- **User Wavelength**
  Allows to enter five correction wavelengths for quick access.

- **Miscellaneous Output Configuration**
  Configures the measurement value, sensitivity and offset of the programmable analog output (MISC OUT).
- **System Configuration**
  Contains hard-ware adjustments like LCD illumination and 50/60Hz line filter setting; and system information.

3.1.3 Readout Configuration

The main-display can be configured in terms of units of measure and also with mathematical functions between the two channels. To select the main display toggle the <CHx Display> button or go to the <CHx Setup> and chose the 'Main Display' menu.
The sub display that is visible as small read out value in the single channel screen can be configured in the <CHx Setup> and the 'Sub Display' menu. For this display the power value can be set in linear (W) and logarithmic (dBm) mode

The following main displays can be selected, the channel headers show the information of the current display:

Sensor	Main Display (CH 1)	Main Display (CH 2)
All	Power [dBm]	Power [dBm]
All	Power [W]	Power [W]
All	Delta Power [dB]	Delta Power [dB]
All	Delta Power [W]	Delta Power [W]
All	Ratio CH1/CH2 [dB]	Ratio CH1/CH2 [dB]
All	Power Difference CH1-CH2 [W]	Power Difference CH1-CH2 [W]
PD Input	Current [A]	Current [A]
TH Adapter	Voltage [V]	N/A

3.1.4 Range Setting

The PM300 provides sensor dependent up to seven power corresponding current and up to four power corresponding voltage measurement ranges that can be selected in manual- and auto-range mode. To select a range or switch to the auto-range mode navigate to the 'Range' menu or in the setup screen to the 'Power Range' menu and click the button to edit the range setting menu. Depending on the sensor type you can chose between several power ranges and the auto-range mode either by turning the control knob or using the <Down> and <Up> soft keys. The

selected range immediately gets active after selecting. To leave the menu press the control knob or the <ok> soft key.
When power-meter sensors are connected the ranges will show in Watts; for the photodiode inputs in Ampere, for the thermal head adapter in Volts.

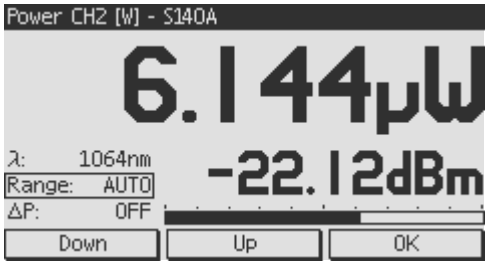


Figure 6 Range Setting with a photodiode sensor

3.1.5 Relative Power Measurement

This feature can be used to observe power drifts, adjust power to a certain level, or quickly subtract ambient light.
Navigating to the 'ΔP' menu and clicking the Multi-Control knob toggles between relative and absolute power measurement. When the relative power measurement is activated by clicking the Multi-Control knob the header changes to 'Delta Power', the current power reading gets zeroed, the bar-graph goes to a zero middle-position, the subtracted value gets indicated in the 'ΔP' menu and the measurement range switches one range down. From this point of time the main display and the bar-graph shows the difference to the subtracted power in W or dBm. The sub display still shows the absolute power level. A Range setting is still possible as described in the paragraph above.

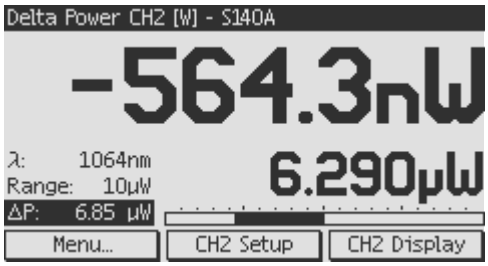


Figure 7 Relative Power Measurement with a photodiode sensor

3.1.6 Setting an Attenuation Factor

The Attenuation Menu enables to set a user calibration factor to the power reading. This is very convenient when wanting to read the 'real' laser power, but having an additional filter or beam splitter in the system.
To enter an attenuation factor, press the <CHx Setup> soft button, navigate and click the 'Attenuation' menu. Set the desired attenuation in dB and press <ok> or click the control button. Exit the setup menu.

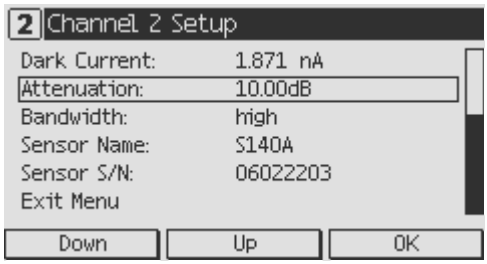


Figure 8 Attenuation

3.2 Operation with a Photodiode Sensor

Photodiode sensors of the Thorlabs S1xx series can be connected to each of the Sub-D jacks in the rear panel. The sensor will be recognized immediately after plugging. When a power meter sensor is plugged the related photo-diode input in the front panel gets inactive.

☝ Attention ☝

Refer to the sensor data sheet and pay attention to the optical damage threshold!

Exceeding these values will permanently destroy the sensor!

For the measurement of small power levels up to approximately 1-2 W photodiode sensors have a lot of advantages against thermal sensors. The sensors are built up in a combination of a photodiode and a neutral density filter or a photodiode in combination with an integrating sphere. They provide linearity over several decades

and show a great sensitivity for very small power levels down to the nW range. Handling fairly small power levels the form factor can be held small, further the response time of such a sensor is in the ns to µs range.
Photodiodes, neutral density filters and also integrating sphere materials show a wavelength dependent behaviour and therefore each sensor is individually calibrated over the spectral working range in 5nm steps. Each sensors spectral responsivity data gets stored in a non-volatile memory inside the DB-9 sensor connector and downloaded to the PM300 when plugged to the unit. To perform an accurate measurement it is necessary to enter the operating wavelength that the PM300 can calculate the laser power from the measured photo current and the right responsivity value from the wavelength calibration table.

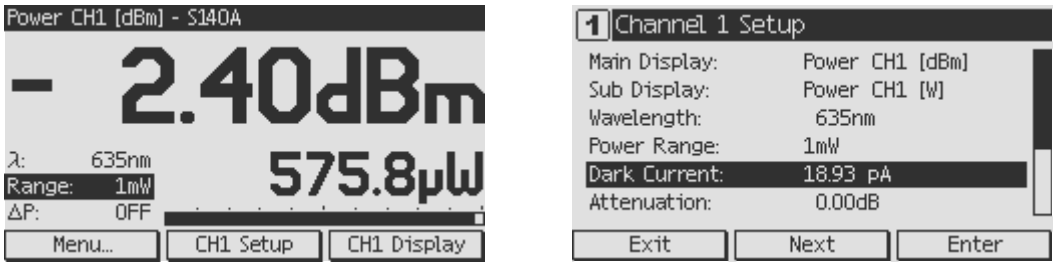


Figure 9 Readout and Setup Screen for a Photodiode Sensor

3.2.1 Wavelength Correction

As described above it is necessary to enter the wavelength of the light to measure for an accurate calibrated measurement.
The wavelength setting can be edited by navigating to the 'λ' Menu in the measurement displays or the channel setup and clicking on the control knob. The menu gets a blinking frame and the value can be increased or decreased with by turning the control knob. Further two soft buttons with <prev. λuser> and <next λuser> appear; pressing these buttons the correction wavelength can be toggled between the 5 preconfigured wavelengths from the systems menu 'user wavelength'.
The new wavelength setting gets active when pressing the control button or the <ok> soft-key.

Figure 10 Wavelength Editing Mode

3.2.2 Dark Current Adjustment

Photodiode sensors emit very small current levels, when no photons hit the active area – the so called dark current, that is temperature dependent and in the region of some nA for silicon and InGaAs sensors and up to some µA for germanium sensors.
When measuring smallest power levels the dark current of a photodiode sensor may have an influence on the measurement result.
Therefore when measuring very small power levels this dark current can have an influence on the measurement result and must be compensated by the dark current adjustment. The function the PM300 delivers by entering the <CHx Setup> and navigating to the 'Dark Current' menu can also be used to subtract ambient light.
To perform the adjustment, cover the sensor with the protection cap or when a fiber connector is assembled, plug a fiber (laser switched off) and press the Control knob or press the <Enter> soft button. The PM300 will automatically switch down to the smallest possible measurement range, measure the photo current and from now on take in account this value when calculating the power reading. Exit the setup menu.

Figure 11 Dark Current Adjustment

3.2.3 Bandwidth Setting

The analog bandwidth can be set in the channel setup to ‘high’ (range dependent bandwidth) and ‘low’ (15 Hz bandwidth). The bandwidth setting mainly influences the analog outputs to for example subtract noise from the mains. The digital power readings and the bar graph have a digital filtering (including a selectable 50/60Hz line filter) that’s combined bandwidth approximately corresponds to the ‘low’-bandwidth setting.

3.3 Operation with a Thermal Sensor

Thermal sensors of the Thorlabs S2xx series can be connected (only) to the CH1 Sub-D jack in the rear panel. The sensor will be recognized immediately after plugging. When a power meter sensor is plugged the related photo-diode input in the front panel gets inactive.

☝ Attention ☝

Refer to the sensor data sheet and pay attention to the optical damage threshold!

Exceeding these values will permanently destroy the sensor!

Thermal sensors absorb the incident laser power, whereby the developing heat gets turned into a small voltage caused by heat flow through thermocouple elements between absorbing area and sensor heat sink. The Thorlabs S2xx series thermal sensors contain a black broad band coating as absorber and do not need a wavelength correction because the response is nearly flat from the UV to the mid-IR.
The output voltage of a thermal sensor is linear to the incident laser power, as long the thermal system is properly zeroed. The main operation of thermal sensors are high power applications from 100mW.

3.3.1 Zeroing

Thermopile sensors need to be zeroed, when thermal differences between active area (thermal disk) and the sensor heat sink appear when no light hits the active area or when the heat sink gets hot under light exposure. An indicator that the sensor needs to be zeroed is when with switched off laser either a strong 0.000W reading or a reading greater than zero is displayed.
To perform the zero adjustment, press the <CH1 Setup> button, navigate to the ‘Zero Voltage’ menu and press the Control knob or the <Enter> soft-key. A new zero value will appear in the menu.
The zero value will be negative when the heat sink is hotter than the active area and positive, when the active area is hotter than the heat sink. When both heat sink and active area are at room temperature the a zero voltage of some µV is normal.

3.3.2 Readout acceleration

Thermal sensors show a fairly slow response, when laser power hits the active area it takes up to some 6 seconds until the system has settled and the power reading shows the right value.
Through special circuitry this time can be shortened to approximately 1 second by 'predicting' the final power value. In this 'High Speed' mode, the resulting power reading is more noisy.
To select the response behaviour enter the <CH1 Setup> and navigate to the 'Mode' menu. Toggle between 'Low Noise', where the acceleration circuit is switched off, and 'High Speed' with acceleration circuit.

3.3.3 Custom Thermal Elements

Additionally to using Thorlabs thermal power meter sensors it is possible to connect any thermal elements up to 100mV output voltage. Therefore connect the thermal element to the CH1 DB-9 connector pins 5 (plus pole) and 3 (ground). Further short-cut pins 2 and 6 with a wire connection → see sensor pin-out chapter 7.4
The PM300 will recognize a 'Thermal Head Adapter' with the possibility to read the measurement value in Volts or by entering a responsivity factor in V/W also as power value in Watts or dBm.

3.4 Operation with Photodiodes

Common photo-diodes or Thorlabs packaged photo-diodes of the SM05PD and SM1PD series can be connected to the two BNC jacks in the front panel. The BNC input is automatically active when no power meter sensor or adapter is connected to the related DB9 connector in the rear. The photodiode input supports both anode ground and cathode ground polarities, further a bias voltage can be applied to the connected photodiode.
For adjusting the dark current and setting the measurement bandwidth, please refer to the corresponding chapters in the photodiode sensor section.

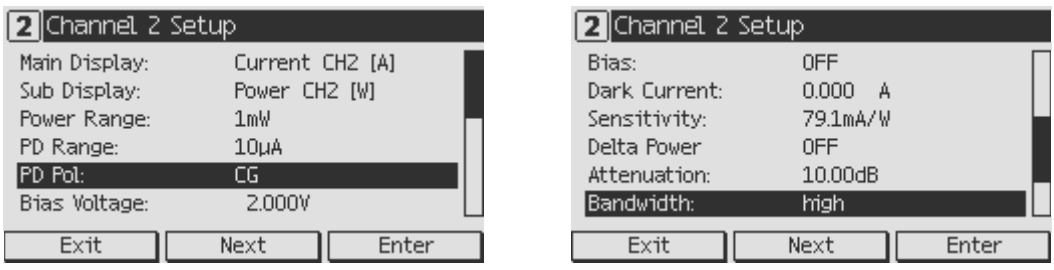


Figure 12 Setup for Photodiode Input

3.4.1 Photodiode Polarity

The photodiode polarity must be set that the measured current shows a positive reading, otherwise the display will show '------' when switching to a power display in mW or dBm. To set the polarity enter the <CHx Setup> and navigate to the 'PD Pol' menu. Change the value to AG (anode grounded) and CG (cathode grounded)

3.4.2 Setting the Photodiode Responsivity

The photocurrent can be displayed as a power level in Watts or dBm, when the polarity has been set that the current reading is positive and the responsivity value (η) has been adjusted to the current setup conditions (default is 1A/W).
To change the responsivity value navigate to the 'η' menu and press the control knob to edit the value. Set the responsivity according the desired wavelength and the photodiode data sheet. Confirm with <ok> or clicking the control knob.
The current range and the power range can also be changed in the <CHx Setup> under the corresponding menus.

3.4.3 Bias

A bias voltage from 0 to 10V can be applied to the photodiode. The voltage can be set in the <CHx Setup> under the 'Bias Voltage' menu. To switch the bias voltage navigate to the 'Bias' menu in the channel screens or in the channel setups.

☝ Attention ☝

Proof for a positive current reading prior to applying a bias voltage. Refer to the diode data sheet for the maximum bias voltage.

The photo diode may be permanently damaged when applying a wrongly poled or too high bias voltage.

3.5 Analog Outputs

The analog outputs CH1 OUT and CH2 OUT provide the amplified photo-diode current (CH1 and CH2) or the amplified thermal sensor voltage (CH1 only) with the

selected bandwidth. With thermal sensors the analog output shows the direct response from the thermal sensor without the accelerator circuit. This signal is not wavelength corrected. The voltage is range dependent and can go from -10V to +10V.

3.6 Miscellaneous Analog Output

The MISC OUT is a programmable analog output that provides a voltage from -10V to +10V depending on the selected function. The voltage from this output can be configured in the 'Misc Output Configuration' in the main 'Menu' in terms of each possible power read out (Measurement Value), gain (Output Sensitivity) and offset (Offset Voltage).

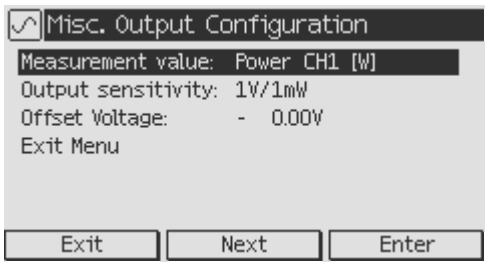


Figure 13 Miscellaneous Output Configuration

3.7 Chart Mode

The chart mode can be accessed when switching off both CH1 and CH2 display selector knobs. The read out type, gain, offset and time-base can be configured either by the soft buttons or by accessing the 'Graphics Configuration' in the main 'Menu'.

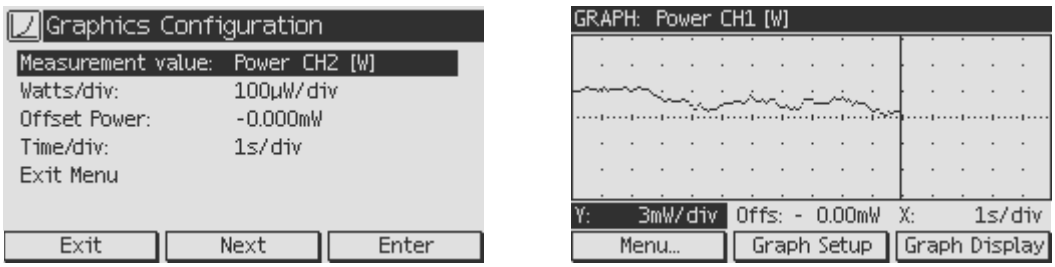


Figure 14 Chart Mode

Changing of the ‘Y’, ‘X’ and ‘Offs’ parameters get immediately active in the editing mode. Clicking the control button resets the graph.
The time base can be set from 100ms/div up to 1h/div so that up to 16 hours can be monitored on one screen.

3.8 System Configuration

The system configuration menu contains of the following items:

Item	Value	Description
LCD Brightness	0 – 100%	Sets Backlight of the LCD
Sound	ON/OFF	
Local Operation/ Remote Operation	/ Go To Local	Shows Remote State
Line Filter	50Hz / 60Hz	Sets line filter to the mains conditions to suppress unwanted aliasing effects in the read outs

All other items are for information only and show for example serial number and software versions.

4 Computer Interface

The PM300 optical power meter has a USB 2.0 interface that allows to send commands from a host computer to the instrument. The connection between PC and PM 300 is accomplished by a USB cable with a male type ‘A’ connector at the PC side and a type ‘B’ connector on the instrument side.

There are two categories of command types:

- Set commands that bring the PM300 to the desired configuration
- Query commands that get data from the PM300. These commands are always terminated by a question mark (?).

4.1 Connecting a Computer

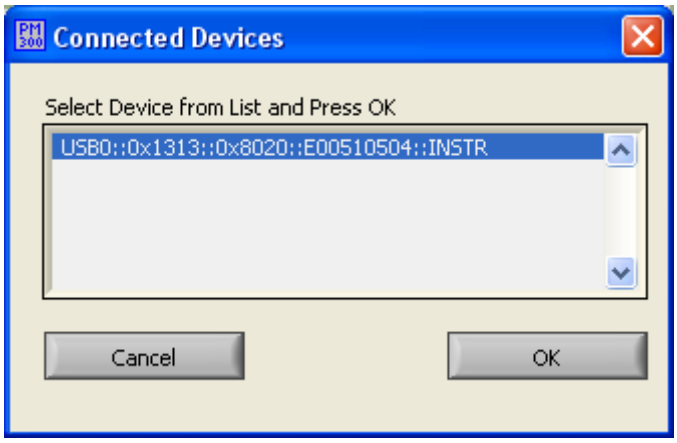
To successfully complete the install of the PM300 USB driver you must have Administrator privileges on the PC which you are performing the install.

Prior to connecting the PM300 with the PC, please insert the CD that shipped with the instrument and install the PM300 drivers. When the following message appears after the installation you have also to install NI-VISA form the distribution CD or from the National Instruments web site

After successfully installing the software connect the PM300 to a USB port of your PC. The PC will find sequentially a PM300 and a DFU device. Please follow the instructions of the dialog screens and allow the installing.

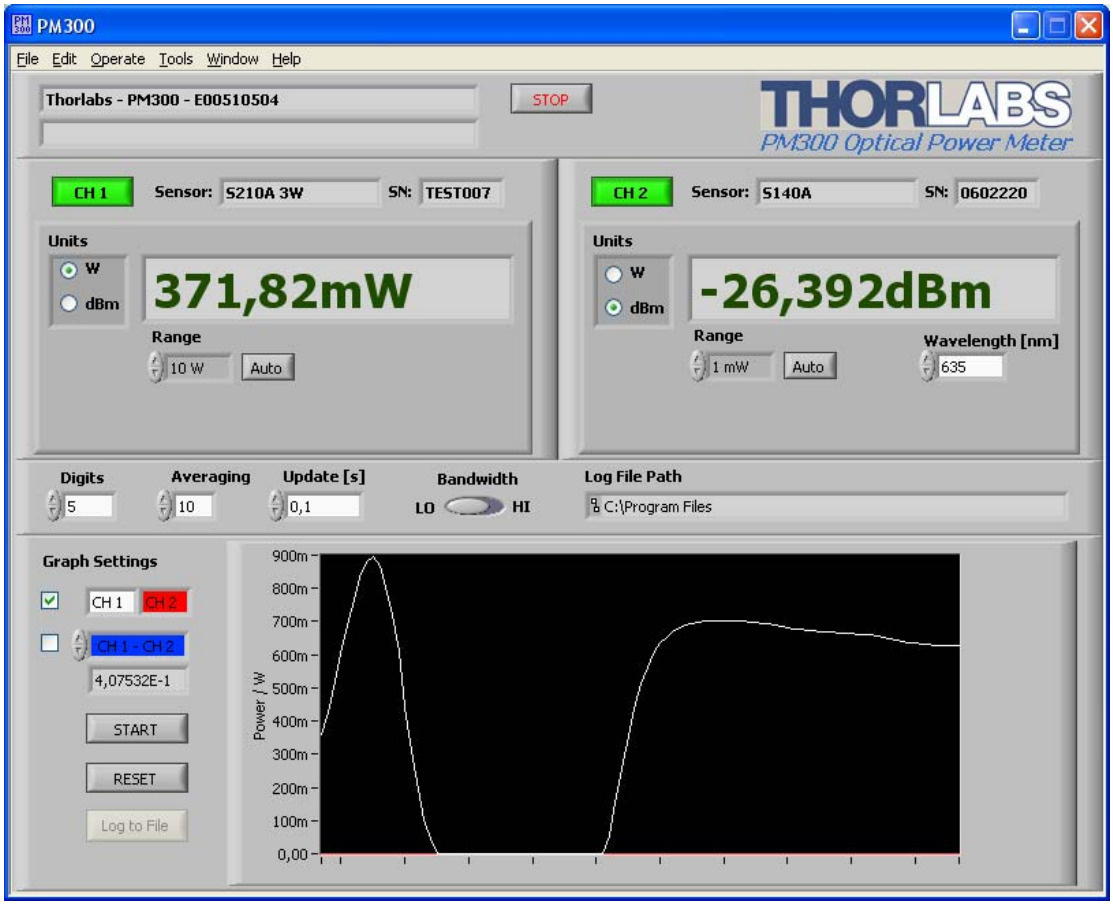
4.2 PM300 Utility Software

The PM300 comes with a utility software that easily enables operating the PM300 and visualizing and logging measurement data. The software is written in LabVIEW 7.1 and can either be installed from the CD as executable where LabVIEW isn't required on the PC; or can be run with LabVIEW 7.1 or higher. In any case it is necessary to install the drivers as described in chapter 4.1.
The source code of the application is included on the CD and can be used to build own applications or to modify the utility program to customer requirements.
After launching the PM300 utility program it will automatically screen for connected PM300 devices. Select the desired PM300 and press o.k.



The utility software will recognize and update connected sensors while the program is running.

The display data can be logged to a file after pressing the <START> and <Log To File> buttons.



4.3 Firmware Update

Firmware upgrades can be done by the user via the USB interface. Therefore install the DFU (device firmware upgrade) wizard from the distribution CD.

Connect the PM300 to a USB port of your PC and launch the DFU wizard from the start bar. Follow the wizard instructions.

Please refer to www.thorlabs.com for the latest PM300 firmware version.
When proceeding the DFU wizard the first time a new DFU device will be recognized, please allow installing.
Do not switch off the PM300 or disconnect the USB cable during the firmware download.

4.4 Command Reference

4.4.1 Common IEEE488.2 Commands

The device supports several IEEE488.2 common commands and queries. Additional descriptive information may be found in the IEEE488.2-1992-§10 standard.

4.4.1.1 Command List

Command	Description

***IDN?**	Identification query. (IEEE488.2-1992-§10.14)
***TST?**	Selftest query. (IEEE488.2-1992-§10.38)
***OPC**	Operation complete command. (IEEE488.2-1992-§10.18)
***OPC?**	Operation complete query. (IEEE488.2-1992-§10.19)
***WAI**	Wait command. (IEEE488.2-1992-§10.39)
***RST**	Reset command. (IEEE488.2-1992-§10.32)
***SRE**	Service Request Enable command. (IEEE488.2-1992-§10.34)
***SRE?**	Service Request Enable query. (IEEE488.2-1992-§10.35)
***STB?**	Read Status Byte query. (IEEE488.2-1992-§10.36)
***ESE**	Standard Event Status Enable command. (IEEE488.2-1992-§10.10)
***ESE?**	Standard Event Status Enable query. (IEEE488.2-1992-§10.11)
***ESR?**	Standard Event Status Register query. (IEEE488.2-1992-§10.12)
***CLS**	Clear Status command. (IEEE488.2-1992-§10.3)

4.4.1.2 Description

4.4.1.2.1 Identification Query

Command syntax: ***IDN?**

Response syntax: **<ARBITRARY ASCII RESPONSE DATA>**

Description: Identification query (see also IEEE488.2-1992-§10.14).
The response is organized into four fields separated by commas.
(Manufacturer, Model, Serial number, Firmware level)

4.4.1.2.2 Selftest Query

Command syntax: ***TST?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Selftest query (see also IEEE488.2-1992-§10.38 and chapter 'Selftest Results' in this document).
A return value of '0' means success.

4.4.1.2.3 Operation Complete Command

Command syntax: ***OPC**

Description: Sets the ‘OPC’ bit in the ‘Standard Event Status Register’ (see also IEEE488.2-1992-§10.18).

4.4.1.2.4 Operation Complete Query

Command syntax: ***OPC?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: The Operation Complete Query places a ‘1’ into the device’s output queue (see also IEEE488.2-1992-§10.19).

4.4.1.2.5 Wait Command

Command syntax: ***WAI**

Description: This command is required for IEEE488 compatibility and has no effect. (see also IEEE488.2-1992-§10.39).

4.4.1.2.6 Reset Command

Command syntax: ***RST**

Description: This command resets the device. (see also IEEE488.2-1992-§10.32).

4.4.1.2.7 Service Request Enable Command

Command syntax: ***SRE <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the device’s Service Request Enable Register (see also IEEE488.2-1992-§10.34 and chapter ‘Status Reporting’ in this document).

4.4.1.2.8 Service Request Enable Query

Command ***SRE?**

syntax:

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Service Request Enable Register (see also IEEE488.2-1992-§10.35 and chapter 'Status Reporting' in this document).

4.4.1.2.9 Read Status Byte Query

Command syntax: ***STB?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Status Byte (see also IEEE488.2-1992-§10.36 and chapter 'Status Reporting' in this document).

4.4.1.2.10 Standard Event Status Enable Command

Command syntax: ***ESE <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the device's Standard Event Status Enable Register (see also IEEE488.2-1992-§10.10 and chapter 'Status Reporting' in this document).

4.4.1.2.11 Standard Event Status Enable Query

Command syntax: ***ESE?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Standard Event Status Enable Register (see also IEEE488.2-1992-§10.11 and chapter 'Status Reporting' in this document).

4.4.1.2.12 Standard Event Status Register Query

Command syntax: ***ESR?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Standard Event Status Register (see also

IEEE488.2-1992-§10.12 and chapter 'Status Reporting' in this document).

4.4.1.2.13 Clear Status Commend

Command syntax: **`*CLS`**

Prerequisite: None

Description: Clears the following device's status registers (see also IEEE488.2-1992-§10.3):

- Standard Event Status Register
- Device Error Event Register
- Device Operation Event Register
- Device Error Queue

4.4.2 Measurement Commands

4.4.2.1 Command List

Command	Description
`:AVER[1,2]?`	Query the channel 1/2 averaging rate
`:AVER[1,2]`	Set the channel 1/2 averaging rate
`:POW[1,2]:VAL?`	Query the channel 1/2 measured power [W]
`:CURR[1,2]:VAL?`	Query the channel 1/2 measured current [A]
`:VOLT1:VAL?`	Query the channel 1 measured voltage [V]
`:ZERO[1,2]:VAL?`	Query the channel 1/2 Zero Offset Value
`:ZERO[1,2]:ADJ`	Performs a Zero Offset Value adjustment for channel 1/2

4.4.2.2 Description

4.4.2.2.1 Query the Averaging Rate

Command syntax: **`:AVER[1,2]?`**

Response currently used Averaging Rate **`<NR1 NUMERIC RESPONSE DATA>`**

syntax:

Description: Queries the currently used averaging rate for channel 1/2.

4.4.2.2.2 Set the Averaging Rate

Command syntax: **:AVER[1,2] <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the averaging rate for channel 1/2.
Note: The averaging rate does not influence the front panel display. The instrument measures at 500Hz rate. Use this value to achieve an appropriate line filtering. To achieve a good 60Hz filtering use a multiple of 25. To achieve a good 50Hz filtering use a multiple of 10.

4.4.2.2.3 Power Query

Command syntax: **:POW[1,2]:VAL?**

Response syntax: Optical power **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the channel 1/2 measured optical power value in Watt [W].
Note: If an overflow occures the value `'+Inf'` or `'-Inf'` is returned.

4.4.2.2.4 Current Query

Command syntax: **:CURR[1,2]:VAL?**

Response syntax: Photodiode current **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the channel 1/2 measured photodiode current in Ampere [A].
Note: If an overflow occurs the value `'+Inf'` or `'-Inf'` is returned.

4.4.2.2.5 Voltage Query

Command syntax: **:VOLT1:VAL?**

Response syntax: Thermopile voltage **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the channel 1 measured thermopile voltage in Volt [V].
Note: If an overflow occurs the value `'+Inf'` or `'-Inf'` is returned.

4.4.2.2.6 Query the Zero Offset Value

Command syntax: **:ZERO[1,2]:VAL?**

Response syntax: Zero offset value **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the currently used channel 1/2 zero offset value in Ampere/Volt.

4.4.2.2.7 Perform a Zero Offset Value Adjustment

Command syntax: **:ZERO[1,2]:ADJ**

Description: Performs a zero offset value adjustment for channel 1/2.
Note: The zero offset value adjustment will take some seconds to complete.

4.4.3 Device Setup Commands

4.4.3.1 Command List

Command	Description
:PRANGE[1,2]	Set the channel 1/2 power range.
:PRANGE[1,2]?	Query the channel 1/2 power range.
:PRANGE[1,2]:MIN?	Query the channel 1/2 minimum settable power range.
:PRANGE[1,2]:MAX?	Query the channel 1/2 maximum settable power range.
:IRANGE[1,2]	Set the channel 1/2 current range.
:IRANGE[1,2]?	Query the channel 1/2 current range.
:IRANGE[1,2]:MIN?	Query the channel 1/2 minimum settable current range.
:IRANGE[1,2]:MAX?	Query the channel 1/2 maximum settable current range.
:URANGE1	Set the channel 1 voltage range.
:URANGE1?	Query the channel 1 voltage range.

:URANGE1:MIN?	Query the channel 1 minimum settable voltagerange.
:URANGE1:MAX?	Query the channel 1 maximum settable voltage range.
:WAVEL[1,2]:VAL	Set the wavelength for channel 1/2
:WAVEL[1,2]:VAL?	Query the currently used wavelength for channel 1/2
:WAVEL[1,2]:RNG?	Query the channel 1/2 wavelength range
:ATTEN[1,2]:VAL	Set the channel 1/2 power attenuation
:ATTEN[1,2]:VAL?	Query the channel 1/2 power attenuation
:ATTEN[1,2]:RNG?	Query the channel 1/2 power attenuation range
:PDBANDW[1,2]	Set the channel 1/2 photodiode input/photodiode sensor bandwidth.
:PDBANDW[1,2]?	Query the channel 1/2 photodiode input/photodiode sensor bandwidth.
:PDPOL[1,2]	Set the channel 1/2 photo diode input polarity
:PDPOL[1,2]?	Query the channel 1/2 photo diode input polarity
:PDRESP[1,2]:VAL	Set the photodiode responsivity for channel 1/2
:PDRESP[1,2]:VAL?	Query the currently used photodiode responsivity for channel 1/2
:PDRESP[1,2]:RNG?	Query the channel 1/2 photodiode responsivity range
:PDBIAS[1,2]	Set the channel 1/2 photodiode input BIAS state
:PDBIAS[1,2]?	Query the channel 1/2 photodiode input BIAS state
:PDBIAS[1,2]:VAL	Set the channel 1/2 photodiode input BIAS voltage
:PDBIAS[1,2]:VAL?	Query the channel 1/2 photodiode input BIAS voltage
:PDBIAS[1,2]:RNG?	Query the channel 1/2 photodiode input BIAS voltage range
:THACCEL1	Set the channel 1 thermopile accelerator state.
:THACCEL1?	Query the channel 1 thermopile accelerator state.
:THRESP[1,2]:VAL	Set the thermopile responsivity for channel 1/2
:THRESP[1,2]:VAL?	Query the currently used thermopile responsivity for channel 1/2
:THRESP[1,2]:RNG?	Query the channel 1/2 thermopile responsivity range

4.4.3.2 Description

4.4.3.2.1 Set Channel 1/2 Power Range

Command syntax: **:PRANGE[1,2] <CHARACTER PROGRAM DATA> [AUTO,R1NW,R10NW,R100NW,R1UW,R10UW,R100UW,R1MW,R10MW,R100MW, R1W,R10W,R100W,R1KW]**

Description: Sets the power range for channel 1/2.

4.4.3.2.2 Query Channel 1/2 Power Range

Command syntax: **:PRANGE[1,2]?**

Response syntax: **<CHARACTER RESPONSE DATA> [AUTO,R1NW,R10NW,R100NW,R1UW,R10UW,R100UW,R1MW,R10MW,R100MW, R1W,R10W,R100W,R1KW]**

Description: Queries the channel 1/2 power range.

4.4.3.2.3 Query Channel 1/2 Minimum Power Range

Command syntax: **:PRANGE[1,2]:MIN?**

Response syntax: **<CHARACTER RESPONSE DATA> [AUTO,R1NW,R10NW,R100NW,R1UW,R10UW,R100UW,R1MW,R10MW, R100MW, R1W,R10W,R100W,R1KW]**

Description: Queries the channel 1/2 minimum settable power range.

4.4.3.2.4 Query Channel 1/2 Maximum Power Range

Command syntax: **:PRANGE[1,2]:MAX?**

Response syntax: **<CHARACTER RESPONSE DATA> [AUTO,R1NW,R10NW,R100NW,R1UW,R10UW,R100UW,R1MW,R10MW, R100MW,**

R1W,R10W,R100W,R1KW]

Description: Queries the channel 1/2 maximum settable power range.

4.4.3.2.5 Set Channel 1/2 Current Range

Command syntax: **:IRANGE[1,2] <CHARACTER PROGRAM DATA> [AUTO,R10NA,R100NA,R1UA,R10UA,R100UA,R1MA,R10MA]**

Description: Sets the current range for channel 1/2.

4.4.3.2.6 Query Channel 1/2 Current Range

Command syntax: **:IRANGE[1,2]?**

Response syntax: **<CHARACTER RESPONSE DATA> [AUTO,R10NA,R100NA,R1UA,R10UA,R100UA,R1MA,R10MA]**

Description: Queries the channel 1/2 current range.

4.4.3.2.7 Query Channel 1/2 Minimum Current Range

Command syntax: **:IRANGE[1,2]:MIN?**

Response syntax: **<CHARACTER RESPONSE DATA> [AUTO,R10NA,R100NA,R1UA,R10UA,R100UA,R1MA,R10MA]**

Description: Queries the channel 1/2 minimum settable current range.

4.4.3.2.8 Query Channel 1/2 Maximum Current Range

Command syntax: **:IRANGE[1,2]:MAX?**

Response syntax: **<CHARACTER RESPONSE DATA> [AUTO,R10NA,R100NA,R1UA,R10UA,R100UA,R1MA,R10MA]**

Description: Queries the channel 1/2 maximum settable current range.

4.4.3.2.9 Set Channel 1 Voltage Range

Command syntax: **:URANGE1 <CHARACTER PROGRAM DATA> [AUTO,R100UV,R1MV,R10MV,R100MV]**

Description: Sets the voltage range for channel 1.

4.4.3.2.10 Query Channel 1 Voltage Range

Command: **:URANGE1?**

Response syntax: **<CHARACTER RESPONSE DATA> [AUTO,R100UV,R1MV,R10MV,R100MV]**

Description: Queries the channel 1 voltage range.

4.4.3.2.11 Query Channel 1 Minimum Voltage Range

Command syntax: **:URANGE1:MIN?**

Response syntax: **<CHARACTER RESPONSE DATA>**
[AUTO,R100UV,R1MV,R10MV,R100MV]

Description: Queries the channel 1 minimum settable voltage range.

4.4.3.2.12 Query Channel 1 Maximum Voltage Range

Command syntax: **:URANGE1:MAX?**

Response syntax: **<CHARACTER RESPONSE DATA>**
[AUTO,R100UV,R1MV,R10MV,R100MV]

Description: Queries the channel 1 maximum settable voltage range.

4.4.3.2.13 Set Channel 1/2 Wavelength

Command syntax: **:WAVEL[1,2]:VAL <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the channel 1/2 wavelength [nm] to use for calculating the sensor sensitivity.

4.4.3.2.14 Query Channel 1/2 Wavelength

Command syntax: **:WAVEL[1,2]:VAL?**

Response syntax: currently used wavelength **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the channel 1/2 currently used wavelength [nm].

4.4.3.2.15 Query Channel 1/2 Wavelength Range

Command syntax: **:WAVEL[1,2]:RNG?**

Response syntax: minimum settable wavelength [nm] **<NR3 NUMERIC RESPONSE DATA>,**
maximum settable wavelength [nm] **<NR3 NUMERIC RESPONSE DATA>,**
currently used wavelength [nm] **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries channel 1/2 wavelength range.

4.4.3.2.16 Set Channel 1/2 Power Attenuation

Command syntax: **:ATTEN[1,2]:VAL <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the channel 1/2 power attenuation [dB].

4.4.3.2.17 Query Channel 1/2 Power Attenuation

Command syntax: **:ATTEN[1,2]:VAL?**

Response syntax: currently used power attenuation **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the channel 1/2 currently used power attenuation [dB].

4.4.3.2.18 Query Channel 1/2 Power Attenuation Range

Command syntax: **:ATTEN[1,2]:RNG?**

Response syntax: minimum settable power attenuation [dB] **<NR3 NUMERIC RESPONSE DATA>,**
maximum settable power attenuation [dB] **<NR3 NUMERIC RESPONSE DATA>,**
default power attenuation [dB] **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries channel 1/2 power attenuation range.

4.4.3.2.19 Set Channel 1/2 Photodiode Input/Sensor Bandwidth

Command syntax: **:PDBANDW[1,2] <CHARACTER PROGRAM DATA> [LOW,HIGH]**

Description: Sets the photo diode input/sensor bandwidth setting.

4.4.3.2.20 Query Channel 1/2 Photodiode Input/Sensor Bandwidth

Command syntax: **:PDBANDW[1,2]?**

Response syntax: **<CHARACTER RESPONSE DATA> [LOW,HIGH]**

Description: Queries the photo diode input/sensor bandwidth setting.

4.4.3.2.21 Set Channel 1/2 Photodiode Input Polarity

Command syntax: **:PDPOL[1,2] <CHARACTER PROGRAM DATA> [AG,CG]**

Description: Sets the photodiode input polarity to anode ground/cathode ground..

4.4.3.2.22 Query Channel 1/2 Photodiode Input Polarity

Command syntax: **:PDPOL[1,2]?**

Response syntax: **<CHARACTER RESPONSE DATA> [AG,CG]**

Description: Queries the photodiode input polarity.

4.4.3.2.23 Set Channel 1/2 Photodiode Responsivity

Command syntax: **:PDRESP[1,2]:VAL <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the channel 1/2 photodiode responsivity [A/W].

4.4.3.2.24 Query Channel 1/2 Photodiode Responsivity

Command syntax: **:PDRESP[1,2]:VAL?**

Response syntax: currently used photodiode responsivity **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the channel 1/2 currently used photodiode responsivity [A/W].

4.4.3.2.25 Query Channel 1/2 Photodiode Responsivity Range

Command syntax: **:PDRESP[1,2]:RNG?**

Response syntax: minimum settable photodiode responsivity [A/W] **<NR3 NUMERIC RESPONSE DATA>,**
maximum settable photodiode responsivity [A/W] **<NR3 NUMERIC RESPONSE DATA>,**
currently used photodiode responsivity [A/W] **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries channel 1/2 photodiode responsivity range.

4.4.3.2.26 Set Channel 1/2 Photodiode Input BIAS State

Command syntax: **:PDBIAS[1,2] <CHARACTER PROGRAM DATA> [ON,OFF]**

Description: Switches the photodiode input BIAS voltage on/off..

4.4.3.2.27 Query Channel 1/2 Photodiode Input BIAS State

Command syntax: **:PDBIAS[1,2]?**

Response syntax: **<CHARACTER RESPONSE DATA> [ON,OFF]**

Description: Queries the photodiode input BIAS state.

4.4.3.2.28 Set Channel 1/2 Photodiode Input BIAS Voltage

Command syntax: **:PDBIAS[1,2]:VAL <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the channel 1/2 photodiode input BIAS voltage [V].

4.4.3.2.29 Query Channel 1/2 Photodiode Input BIAS Voltage

Command syntax: **:PDBIAS[1,2]:VAL?**

Response syntax: currently used BIAS voltage **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the channel 1/2 currently used photodiode input BIAS voltage [V].

4.4.3.2.30 Query Channel 1/2 Photodiode Input BIAS Voltage Range

Command syntax: **:PDBIAS[1,2]:RNG?**

Response syntax: minimum settable BIAS voltage [V] **<NR3 NUMERIC RESPONSE DATA>,**
maximum settable BIAS voltage [V] **<NR3 NUMERIC RESPONSE DATA>,**
default BIAS voltage [V] **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries channel 1/2 photodiode input BIAS voltage range.

4.4.3.2.31 Set Channel 1 Thermopile Sensor Accelerator State

Command syntax: **:THACCEL1 <CHARACTER PROGRAM DATA> [OFF,ON]**

Description: Sets the thermopile sensor accelerator state.

4.4.3.2.32 Query Channel 1 Thermopile Sensor Accelerator State

Command syntax: **:THACCEL1?**

Response syntax: **<CHARACTER RESPONSE DATA> [OFF,ON]**

Description: Queries the thermopile sensor accelerator state.

4.4.3.2.33 Set Channel 1 Thermopile Responsivity

Command syntax: **:THRESP1:VAL <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the channel 1 thermopile responsivity [V/W].

4.4.3.2.34 Query Channel 1 Thermopile Responsivity

Command syntax: **:THRESP1:VAL?**

Response syntax: currently used thermopile responsivity **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the channel 1 currently used thermopile responsivity [V/W].

4.4.3.2.35 Query Channel 1 Thermopile Responsivity Range

Command syntax: **:THRESP1:RNG?**

Response syntax: minimum settable thermopile responsivity [V/W] **<NR3 NUMERIC RESPONSE DATA>,**
maximum settable thermopile responsivity [V/W] **<NR3 NUMERIC RESPONSE DATA>,**
currently used thermopile responsivity [V/W] **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries channel 1 thermopile responsivity range.

4.4.4 Sensor Commands

4.4.4.1 Command List

Command	Description
:SENS[1,2]:TYPE?	Query the channel 1/2 optical sensor's type.
:SENS[1,2]:NAME?	Query the channel 1/2 optical sensor's name.
:SENS[1,2]:SERNR?	Query the channel 1/2 optical sensor's serial number.
:SENS[1,2]:RANGE?	Query the channel 1/2 optical sensor's range data.

4.4.4.2 Description

4.4.4.2.1 Query Channel 1/2 Optical Sensor Type/ID

Command syntax: **:SENS[1,2]:TYPE?**

Response syntax: Sensor-Type/ID **<HEXADECIMAL NUMERIC RESPONSE DATA>**

Description: Queries the sensor type and ID.

Value	Sensor
0000 $_{hex}$	Photo diode adaptor
0001 $_{hex}$	Photo diode input
00FF $_{hex}$	Thermopile adaptor
0101 $_{hex}$	S120A Silicon sensor
0201 $_{hex}$	S122A Germanium sensor
1100 $_{hex}$	S210A 3W thermopile sensor
1200 $_{hex}$	S211A 10W thermopile sensor
1300 $_{hex}$	S212A 30W thermopile sensor
nn10 $_{hex}$	Generic thermopile sensor (nn = sensor specific ID)
nn11 $_{hex}$	Generic photo diode sensor (nn = sensor specific ID)
FFFF $_{hex}$	No/unknown sensor connected

4.4.4.2.2 Query Channel 1/2 Optical Sensor Name

Command syntax:	**:SENS[1,2]:NAME?**
Response syntax:	**<ARBITRARY ASCII RESPONSE DATA>**
Description:	Queries the name of the connected optical sensor.

4.4.4.2.3 Query Channel 1/2 Optical Sensor Serial Number

Command syntax:	**:SENS[1,2]:SERNR?**
Response syntax:	**<ARBITRARY ASCII RESPONSE DATA>**
Description:	Queries the serial number of the connected optical sensor.

4.4.4.2.4 Query Channel 1/2 Optical Sensor Range

Command syntax:	**:SENS[1,2]:RANGE?**
Response syntax:	Minimum wavelength [m] **<NR3 NUMERIC RESPONSE DATA>** , Maximum wavelength [m] **<NR3 NUMERIC RESPONSE DATA>** , Minimum power [W] **<NR3 NUMERIC RESPONSE DATA>** , Maximum power [W] **<NR3 NUMERIC RESPONSE DATA>**
Description:	Queries the optical sensor head wavelength and power ranges.

4.4.5 MISC-Output Commands

4.4.5.1 Command List

Command	Description
:MISCOUT:MODE	Set the MISC-Output operating mode
:MISCOUT:MODE?	Query the MISC-Output operating mode
:MISCOUT:SENS:WATT	Set the MISC-Output sensitivity for Watt modes
:MISCOUT:SENS:WATT?	Query the MISC-Output sensitivity for Watt modes
:MISCOUT:SENS:DBM	Set the MISC-Output sensitivity for dBm modes
:MISCOUT:SENS:DBM?	Query the MISC-Output sensitivity for dBm modes
:MISCOUT:SENS:DB	Set the MISC-Output sensitivity for dB modes
:MISCOUT:SENS:DB?	Query the MISC-Output sensitivity for dB modes
:MISCOUT:OFFS:VAL	Set the MISC-Output offset voltage
:MISCOUT:OFFS:VAL?	Query the MISC-Output offset voltage
:MISCOUT:OFFS:RNG?	Query the MISC-Output offset voltage range

4.4.5.2 Description

4.4.5.2.1 Set MISC-Output Operating Mode

Com-mand syntax: **:MISCOUT:MODE <CHARACTER PROGRAM DATA>**
[POW1W,POW1DBM,SUB12,RATIO12,POW2W,POW2DBM,SUB21,RATIO21,OFFSET]

Descrip-tion: Sets the MISC-Output operating mode according to the following list:

POW1W	Power channel 1 [W]
POW1DBM	Power channel 1 [dBm]
SUB12	Power difference channel 1 – channel 2 [W]
RATIO12	Power ratio channel 1 / channel 2 [dB]
POW2W	Power channel 2 [W]
POW2DBM	Power channel 2 [dBm]
SUB21	Power difference channel 2 – channel 1 [W]
RATIO21	Power ratio channel 2 / channel 1 [dB]
OFFSET	Offset voltage [V]

4.4.5.2.2 Query MISC-Output Operating Mode

Command syntax: **:MISCOUT:MODE?**

Response syntax: **<CHARACTER RESPONSE DATA>**
[POW1W,POW1DBM,SUB12,RATIO12,POW2W,POW2DBM,SUB21,RATIO21,OFFSET]

Description: Queries the MISC-Output operating mode.

4.4.5.2.3 Set MISC-Output sensitivity (Watt modes)

Command syntax: **:MISCOUT:SENS:WATT <CHARACTER PROGRAM DATA>**
[R1NW,R3NW,R10NW,R30NW,R100NW,R1UW,R3UW,R10UW,R30UW,R100UW,R1MW,R3MW,R10MW,R30MW,R100MW,R1W,R3W,R10W,R30W,R100W]

Description: Sets the MISC-Output sensitivity for Watt modes according to the following table:.

R1NW	1V / 1nW
R3NW	1V / 3nW
R10NW	1V / 10nW
R30NW	1V / 30nW
R100NW	1V / 100nW
R300NW	1V / 300nW
R1UW	1V / 1µW
R3UW	1V / 3µW
R10UW	1V / 10µW
R30UW	1V / 30µW
R100UW	1V / 100µW
R300UW	1V / 300µW
R1MW	1V / 1mW
R3MW	1V / 3mW
R10MW	1V / 10mW
R30MW	1V / 30mW
R100MW	1V / 100mW
R300MW	1V / 300mW
R1W	1V / 1W
R3W	1V / 3W
R10W	1V / 10W

R30W	1V / 30W
R100W	1V / 100W

4.4.5.2.4 Query MISC-Output sensitivity (Watt modes)

Command syntax: **:MISCOUT:SENS:WATT?**

Response syntax: **<CHARACTER RESPONSE DATA>**
[R1NW,R3NW,R10NW,R30NW,R100NW,R1UW,R3UW,R10UW,R30UW,R100UW,
R1MW,R3MW,R10MW,R30MW,R100MW,R1W,R3W,R10W,R30W,R100W]

Description: Queries the MISC-Output sensitivity for Watt modes.

4.4.5.2.5 Set MISC-Output sensitivity (dBm modes)

Command syntax: **:MISCOUT:SENS:DBM <CHARACTER PROGRAM DATA>**
[R0_1DBM,R0_3DBM,R1DBM,R3DBM,R10DBM]

Description: Sets the MISC-Output sensitivity for dBm modes according to the following table:

R0_1DBM	1V / 0.1dBm
R0_3DBM	1V / 0.3dBm
R1DBM	1V / 1dBm
R3DBM	1V / 3dBm
R10DBM	1V / 10dBm

4.4.5.2.6 Query MISC-Output sensitivity (dBm modes)

Command syntax: **:MISCOUT:SENS:DBM?**

Response syntax: **<CHARACTER RESPONSE DATA>**
[R0_1DBM,R0_3DBM,R1DBM,R3DBM,R10DBM]

Description: Queries the MISC-Output sensitivity for dBm modes.

4.4.5.2.7 Set MISC-Output sensitivity (dB modes)

Command syntax: **:MISCOUT:SENS:DB <CHARACTER PROGRAM DATA>**
[R0_1DB,R0_3DB,R1DB,R3DB,R10DB]

Description: Sets the MISC-Output sensitivity for dB modes according to the following table:

R0_1DB	1V / 0.1dB

R0_3DB	1V / 0.3dB
R1DB	1V / 1dB
R3DB	1V / 3dB
R10DB	1V / 10dB

4.4.5.2.8 Query MISC-Output sensitivity (dB modes)

Command syntax: **:MISCOUT:SENS:WATT?**

Response syntax: **<CHARACTER RESPONSE DATA>**
[R0_1DB,R0_3DB,R1DB,R3DB,R10DB]

Description: Queries the MISC-Output sensitivity for dB modes.

4.4.5.2.9 Set MISC-Output Offset Voltage

Command syntax: **:MISCOUT:OFFS:VAL <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the MISC-Output offset voltage [V].

4.4.5.2.10 Query MISC-Output Offset Voltage

Command syntax: **:MISCOUT:OFFS:VAL?**

Response syntax: offset voltage **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the currently used MISC-Output offset voltage [V].

4.4.5.2.11 Query MISC-Output Offset Voltage Range

Command syntax: **:MISCOUT:OFFS:RNG?**

Response syntax: minimum offset voltage [V] **<NR3 NUMERIC RESPONSE DATA>,**
maximum offset voltage [V] **<NR3 NUMERIC RESPONSE DATA>,**
default offset voltage [V] **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the MISC-Output offset voltage range.

4.4.6 Device Status Commands

4.4.6.1 Command List

Command	Description
:STAT:ERR:CND?	Query the Device Error Condition register.
:STAT:ERR:EVT?	Query the Device Error Event register.
:STAT:ERR:ENA?	Query the Device Error Event Enable register.
:STAT:ERR:ENA	Set the Device Error Event Enable register.
:STAT:OPER:CND?	Query the Device Operation Condition register.
:STAT:OPER:EVT?	Query the Device Operation Event register.
:STAT:OPER:ENA?	Query the Device Operation Event Enable register.
:STAT:OPER:ENA	Set the Device Operation Event Enable register.

4.4.6.2 Description

4.4.6.2.1 Query Device Error Condition Register

Command syntax: **:STAT:ERR:CND?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Error Condition Register (see also chapter 'Status Reporting' in this document).

4.4.6.2.2 Query Device Error Event Register

Command syntax: **:STAT:ERR:EVT?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Error Event Register (see also chapter 'Status Reporting' in this document).

4.4.6.2.3 Set Device Error Event Enable Register

Command **:STAT:ERR:ENA <DECIMAL NUMERIC PROGRAM DATA>**

syntax:

Description: Sets the device's Error Event Enable Register (see also chapter chapter 'Status Reporting' in this document).

4.4.6.2.4 Query Device Error Event Enable Register

Command syntax: **:STAT:ERR:ENA?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Error Event Enable Register (see also chapter 'Status Reporting' in this document).

4.4.6.2.5 Query Device Operation Condition Register

Command syntax: **:STAT:OPER:CND?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Operation Condition Register (see also chapter 'Status Reporting' in this document).

4.4.6.2.6 Query Device Operation Event Register

Command syntax: **:STAT:OPER:EVT?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Operation Event Register (see also chapter 'Status Reporting' in this document).

4.4.6.2.7 Set Device Operation Event Enable Register

Command syntax: **:STAT:OPER:ENA <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the device's Operation Event Enable Register (see also chapter chapter 'Status Reporting' in this document).

4.4.6.2.8 Query Device Operation Event Enable Register

Command syntax: **:STAT:OPER:ENA?**

Response syntax: **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's Operation Event Enable Register (see also chapter 'Status Reporting' in this document).

4.4.7 General System Commands

4.4.7.1 Command List

Command	Description
:SYST:ERR?	Query the device's error queue.
:SYST:OPTIONS?	Query the hardware and software options.
:SYST:CALDATE?	Query the calibration date.
:SYST:NCALDATE?	Query the next calibration date.
:SYST:BIRGHT	Set the display brightness.
:SYST:INFO?	Query descriptive device information.
:SYST:LINEFILTER	Set the line filter setting
:SYST:LINEFILTER?	Query the line filter setting

4.4.7.2 Description

4.4.7.2.1 Error Query

Command syntax: **:SYST:ERR?**

Response syntax: Error number **<NR1 NUMERIC RESPONSE DATA>** ,
Error text **<ARBITRARY ASCII RESPONSE DATA>**

Description: Queries the device's error queue (see also: chapter 'Error Reporting' in this document).

4.4.7.2.2 Query Options

Command syntax: **:SYST:OPTION?**

Response syntax: Hardware Options **<HEXADECIMAL NUMERIC RESPONSE DATA>**, Software Options **<HEXADECIMAL NUMERIC RESPONSE DATA>**, Mainboard ID **<NR1 NUMERIC RESPONSE DATA>**

Description: Queries the device's hardware option bitmap, software option bitmap and the mainboard ID. For further information see chapters 'Hardware Options', 'Software Options' and 'Supported Mainboard IDs' in this document.

4.4.7.2.3 Query Calibration Date

Command syntax: **:SYST:CALDATE?**

Response syntax: **<ARBITRARY ASCII RESPONSE DATA>**

Description: Queries the device's calibration date. The response data is either '`not assigned`' if the date is not assigned or in the format '`MM-DD-YYYY hh:mm:ss`', where `MM` is the month, `DD` is the day of the month, `YYYY` is the year, `hh` is the hour, `mm` is the minute, `ss` is the second.

4.4.7.2.4 Query Next Calibration Date

Command syntax: **:SYST:NCALDATE?**

Response syntax: **<ARBITRARY ASCII RESPONSE DATA>**

Description: Queries the date of the next calibration of the device. The response data is either '`not assigned`' if the date is not assigned or in the format '`MM-DD-YYYY hh:mm:ss`', where `MM` is the month, `DD` is the day of the month, `YYYY` is the year, `hh` is the hour, `mm` is the minute, `ss` is the second.

4.4.7.2.5 Set Display Brightness

Command syntax: **:SYST:BRIGHT <DECIMAL NUMERIC PROGRAM DATA>**

Description: Sets the display brightness in the range of 0 (backlight off) and 100.

4.4.7.2.6 Query Descriptive Device Information

Command syntax: **:SYST:INFO?**

Response syntax: **<ARBITRARY ASCII RESPONSE DATA>**

Description: Queries descriptive device information.

4.4.7.2.7 Set Linefilter

Command syntax: **:SYST:LINEFILTER <CHARACTER PROGRAM DATA> [50HZ,60HZ]**

Description: Sets the device line filter setting.
Note: For optimum device operation set the line filter to your local mains frequency.

4.4.7.2.8 Query Linefilter

Command syntax: **: SYST:LINEFILTER?**

Response syntax: **<CHARACTER RESPONSE DATA>[50HZ,60HZ]**

Description: Queries the device line filter setting

5 Measurement Considerations

5.1 Measurement of Pulsed Signals

The PM300 will read the average value of a pulsed signal when the following conditions apply. For a thermal sensor pulse length, repetition rate and peak power is uncritical as long as the peak power is lower than the damage threshold of the sensor. A thermal sensor reacts very slow and will integrate the power incident on the active area of the sensor.
With a photodiode sensor that can follow short pulses in the ns range it is important that the pulse peak power is within the maximum power range of the sensor. It is also important that the power range is set that the peak power is within this range, otherwise the reading will clip at the range end and lead to a wrong average value. Please do not use the Auto range mode. Further depending on the pulse-length and repetition rate the bandwidth setting will influence the power reading. It is recommended to use the low bandwidth setting for a stable display; when the pulse should be monitored via the analog output, the bandwidth should be set to high.

5.2 Line-width of Light Sources

The line-width of light sources can be neglected only for broadband thermal sensors. Photodiode sensors show a strong dependency of the operating wavelength so if the line-width of light sources is greater than 10nm (e.g. LED) there may be an influence on the displayed power. To achieve the best result for broadband light sources with a photodiode sensor it is necessary that the response curve is nearly linear over the line-width. When entering the center wavelength of the light source as operation wavelength the PM300 will show the right optical power for a Gaussian shape.

5.3 Temperature Effects on Thermal Sensors

Thermal sensors react on any temperature differences that occur between thermal disc and heat-sink. Influence to the measurement result can be caused by airflow disturbances or by heating up the heat-sink through long enough exposure of the laser beam to the thermal disc.
To avoid disturbances it is recommended to shield the sensor as good as possible from airflow and to zero it properly in the operating condition. That means for short term measurements zero the cold sensor, for long term measurements zero the sensor when it is in a state of thermal stability (e.g. after 10 minutes light exposure).

5.4 Ambient and Stray Light

Ambient or stray light can strongly affect the measurement accuracy in free-space applications. A permanent background light level can be subtracted by conducting a dark current adjustment. More complicated is varying ambient light like daylight or turning on/off room light. In such cases the only possibility is a proper shielding of the sensor.

5.5 Backreflection

Photodiodes, ND filters and even the black coatings of thermal sensors show a certain kind of back reflection of the incoming light. Back reflection to a diode or HeNe laser can distort the power stability of the laser, therefore it is recommended to tilt the power meter sensor in the laser beam.
When back reflection must be avoided it is advised to use an integrating sphere based S14xA series sensor where the incoming light gets nearly completely absorbed in the sensor.

5.6 Fiber Based Measurements

Laser light emits from an optical fiber in a conical shape, with an angle twice the acceptance angle of the fiber. The acceptance angle is calculated by the numerical aperture of the fiber and is defined as the inverse sine of the numerical aperture.
Fore typical single mode fibers the total angle of the emitted light is between 15° and 25°, for an angled connector (APC) the cone shifts by approximately 4° from the fiber axis.
This expansion of the beam has to be considered to avoid overfilling the detector and getting wrong results.
Thorlabs offers fiber adapters with the most common connectors that are verified with the S12xB series optical sensors. For very large divergence angles it is recommended to use an integrating sphere based sensor from the S14xA series.

6 Maintenance and Repair

6.1 Maintenance

Protect the PM300 from adverse weather conditions. The PM300 is not water resistant.

☝ Attention ☝

To avoid damage to the PM300, do not expose it to spray, liquids or solvents!

The unit does not need a regular maintenance by the user.

If necessary the unit and the display can be cleaned with a cloth dampened with water.

The PM300 does not contain any modules that could be repaired by the user himself. If a malfunction occurs, the whole unit has to be sent back to *Thorlabs*. Do not remove covers!

To guarantee the specifications given in chapter 7.3 over a long period it is recommended to have the unit calibrated by *Thorlabs* every year.

6.2 Line voltage setting

The PM300 optical power meter operates at fixed line voltages of
100 V +10% -10% (90 V … 115 V), 115 V +10% -10% (104 V … 132 V) or
230 V +10% -10% (207 V … 264 V).

The line voltage setting can be changed on the rear without opening the unit.

1. Turn off the PM300 and disconnect the mains cable.
2. The fuse holder (see Figure 15) is located below the 3-pole mains power jack. Release the fuse holder by pressing its plastic retainers with the aid of a small screwdriver. The retainers are located on the right and left side of the holder and must be pressed towards the center.
3. Unplug the line voltage switch/indicator (containing the left fuse) from the fuse holder, rotate it until the appropriate voltage marking (100V, 115V, or 230V) is on target for the window of the fuse holder, and plug it back into the fuse holder. Press in the fuse holder until it locks on both sides. The appropriate line voltage marking must be visible in the window of the fuse holder.

☝ Attention ☝

If you have changed to or from 230 V, also change the mains fuses to the correct value given in section 6.3 of this manual.!

6.3 Replacing the mains fuses

The two power input fuses are externally accessible. If they have opened due to line distortions, incorrect line voltage or other causes, they can be replaced from the rear without opening the unit.

☝Attention☝

To avoid risk of fire the appropriate fuses for the corresponding line voltage must be used.

1. Turn off the PM300 and disconnect the mains cable.
2. The fuse holder (see Figure 15) is located below the 3-pole power connector of the mains jack. Release the fuse holder by pressing its plastic retainers with the aid of a small screwdriver. The retainers are located on the right and left side of the holder and must be pressed towards the center.
3. Replace the defective or wrong fuses and press in the fuse holder until locked on both sides. Take care to maintain the correct rotation of the line voltage indicator / switch which contains the left fuse and is plugged into the fuse holder. The appropriate line voltage marking must be visible in the window of the fuse holder.

Fuse types

100 V	1000 mA, time-lag, 250V	T1A250V
115 V	1000 mA, time-lag, 250V	T1A250V
230 V	500 mA, time-lag, 250V	T0.5A250V

All fuses must meet IEC specification 60127-2/III, time characteristic: time-lag (T), 250V AC, size 5 x 20 mm.

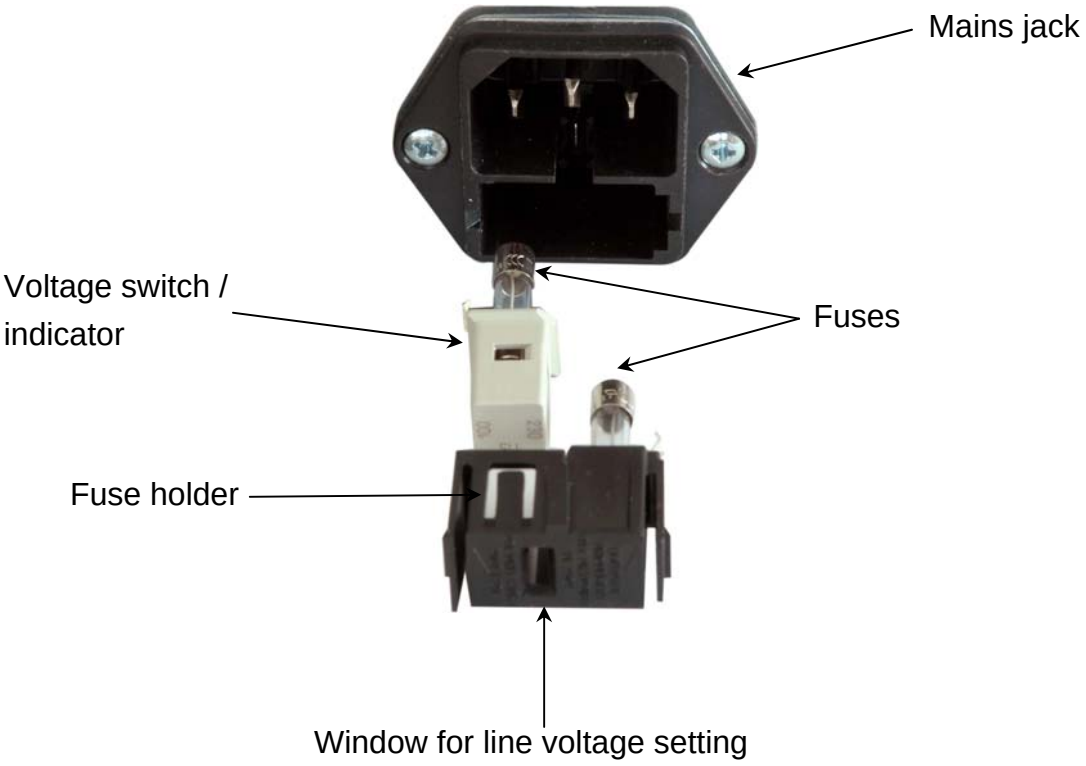


Figure 15 Setting the line voltage or changing the mains fuses

6.4 Troubleshooting

In case that your PM300 shows malfunction please check the following items:

◆ Unit does not work at all (no display at the front):

- ➢ PM300 connected properly to the mains?
  - ▪ Check the mains cable and the line voltage setting (please refer to section 6.2 on page 58)

- ➢ PM300 turned on?
  - ▪ Turn on your PM300 with the mains-switch.

- ➢ Check the fuses at the rear panel (see chapter 6.3 on page 59).
  - ▪ If blown replace the fuses by the correct type.

➔ (refer to chapter 6.2 on page 58 to select the appropriate fuse type)

◆ Power reading is zero (-----)

- ➢ A photodiode sensor is connected
  - ▪ Check if the channel display is in the right mode to display absolute power
  - ▪ Conduct the dark current adjustment procedure

- ➢ A thermal sensor is connected
  - ▪ Check if the channel display is in the right mode to display absolute power
  - ▪ Conduct the dark current adjustment procedure

- ➢ A photodiode is connected
  - ▪ Check the polarity setting. If not known, switch to the current display. The displayed current must be positive, otherwise change the polarity.

◆ A thermal sensor is not recognized

- ➢ The sensor must be connected to channel 1

If you don't find the error source by means of the trouble shooting list please first contact the *Thorlabs-Hotline (europe@thorlabs.com)* before sending the PM300 for checkup and repair to *Thorlabs* - Germany.

➔ (refer to section 7.9, 'Addresses" on page 82)

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7 Appendix

7.1 Warranty

Thorlabs warrants material and production of the PM300 for a period of 24 months starting with the date of shipment. During this warranty period *Thorlabs* will see to defaults by repair or by exchange if these are entitled to warranty.
For warranty repairs or service the unit must be sent back to *Thorlabs (Germany)* or to a place determined by *Thorlabs*. The customer will carry the shipping costs to *Thorlabs*, in case of warranty repairs *Thorlabs* will carry the shipping costs back to the customer.
If no warranty repair is applicable the customer also has to carry the costs for back shipment.
In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs warrants the hard- and software determined by *Thorlabs* for this unit to operate fault-free provided that they are handled according to our requirements. However, *Thorlabs* does not warrant a fault free and uninterrupted operation of the unit, of the soft- or firmware for special applications nor this instruction manual to be error free. *Thorlabs* is not liable for consequential damages.

Restriction of warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. *Thorlabs* does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs reserves the right to change this instruction manual or the technical data of the described unit without notice.

7.2 Certifications and compliances

Certifications and compliances

Category	Standards or description	
EC Declaration of Conformity – EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:	
	EN 61326:1997 +A1:1998 +A2:2001 +A3:2003	Electrical equipment for measurement, control and laboratory use – EMC requirements: Immunity: complies with immunity test requirements for equipment intended for use in industrial locations [1]. Emission: complies with EN 55011 Class B Limits [1,3], IEC 610003-2 and IEC 61000-3-3.
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion B)
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance Criterion A) [5]
	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity (Perf. Criterion A)
	IEC 61000-4-5	Power Line Surge Immunity (Performance Criterion A)
	IEC 61000-4-6	Conducted RF Immunity (Performance Criterion A)
	IEC 61000-4-8	Power Frequency Magnetic Field Immunity (Perf. Criterion A)
	IEC 61000-4-11	Voltage Dips, Short Interruptions and Voltage Variations Immunity (Performance Criterion A / C [6])
	IEC 61000-3-2	AC Power Line Harmonic Emissions
	IEC 61000-3-3	Voltage Fluctuations and Flicker
FCC EMC Compliance	Emissions comply with the Class B Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B [1,3].	
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC, amended by 93/68/EEC	
	EN 61010-1:2001	Safety requirements for electrical equipment for measurement, control and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	UL 61010-1 2nd ed.	Safety requirements for electrical equipment for measurement, control, and laboratory use.
	ISA-82:02.01	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Canadian Certification	CAN/CSA C22.2 No. 61010-1-04	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Additional Compliance	IEC 61010-1:2001	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Equipment Type	Test and measuring	
Safety Class	Class I equipment (as defined in IEC 60950-1:2001)	

[1] Compliance demonstrated using high-quality shielded interface cables shorter than 3 meters.

[3] Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

[5] MOD IN port capped at IEC 61000-4-3 test.

[6] Performance Criterion C was reached at additional test levels according to EN 61326-1:2006 table 2

7.3 Technical data

7.3.1 Common Data

Line voltage (selectable)	100 V / 115 V / 230 V (-10%, +10 %)
Line frequency	50 ... 60 Hz
Power consumption (max.):	20VA
Supply mains over voltage	Category II (Cat II)
Operating temperature [1)]	0 ... +40 °C
Storage temperature	-40°C ... +70 °C
Relative Humidity	Max. 80% up to 31 °C, decreasing to 50% at 40 °C
Pollution Degree (indoor use only)	2
Operation altitude	< 3000 m
Warm-up time for rated accuracy	10 min
Weight	≤ 4 kg
Dimensions (W x H x D) without operating elements	220 x 110 x 290 mm³
Dimensions (W x H x D) with operating elements	220 x 122 x 325 mm³

7.3.2 Technical Data

Current Inputs

Full scale current measurement ranges	10nA … 10mA (in decade steps)
Maximum display resolution	1pA
Photodiode polarity	cathode grounded (CG) or anode grounded (AG)
Display units	A, W, dBm
Bias voltage	0 … -10V (CG), 0 .. +10V (AG)
Max. photodiode capacitance	10nF
Input impedance	~0 Ω (virtual ground)

Current Range	Resolution	Gain	Accuracy	Bandwidth
10 mA	1 µA	1 x 10^2 V/A	+/- 0.2% f.s.	100 kHz / 25 Hz
1 mA	100 nA	1 x 10^3 V/A	+/- 0.2% f.s.	100 kHz / 25 Hz
100 µA	10 nA	1 x 10^4 V/A	+/- 0.2% f.s.	100 kHz / 25 Hz
10 µA	1 nA	1 x 10^5 V/A	+/- 0.2% f.s.	100 kHz / 25 Hz
1 µA	100 pA	1 x 10^6 V/A	+/- 0.2% f.s.	10 kHz / 25 Hz
100 nA	10 pA	1 x 10^7 V/A	+/- 0.5% f.s.	1 kHz / 25 Hz
10 nA	1 pA	1 x 10^8 V/A	+/- 0.5% f.s.	150 Hz / 25 Hz

[1)] non condensing

Voltage Input

Full scale current measurement ranges	100µV … 100mV (in decade steps)
Maximum display resolution	0.1µV
Display units	V, W, dBm
Thermopile sensitivity	
Input impedance	1MΩ

Voltage Range	Resolution	Gain	Accuracy	Bandwidth
100 mV	10 µV	1 x 10^0	+/- 0.5% f.s.	15 Hz
10 mV	1 µV	1 x 10^1	+/- 0.5% f.s.	7 Hz
1 mV	100 µV	1 x 10^2	+/- 0.5% f.s.	0.7 Hz
100µV	100 nV	1 x 10^3	+/- 1% f.s.	0.07 Hz

Analog Outputs

Analog output photocurrent CH1 / CH2	0 … +/- 10V
Programmable MISC Analog Output	0 … +/- 10V
Minimum load resistance	10 kΩ

Connectors

Photodiode sensor / Thermal sensor input	DB9 female
Photodiode input	BNC
Analog output	BNC
Programmable analog output	BNC
Chassis ground	4mm banana jack
Mains input	IEC 60320
Interface	USB B

Display

Type	Graphical LCD 240 x 128 pixels
Update Rate	up to 20Hz (mode depending)

Supported Sensors

S1xxX Photodiode Sensors
S2xxX Thermal Sensors
Anode and Cathode grounded Photodiodes
Custom Thermopiles

7.4 Pin Assignment of the Sensor Connector

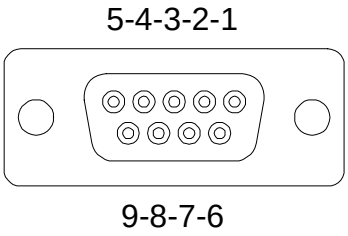

Figure 16 Pin assignment of the sensor connector jack(s) (female)

pin	connection	
	power meter sensors	
3	photodiode ground (anode), thermal sensor ground, analog ground	
4	photodiode cathode	
5	thermal sensor +	
	special functions	
2	MOSI	→ connect this pin to pin 6 (MISO) to enable connecting a custom thermal head at the sensor connector (CH1 only)
6	MISO	→ connect this pin to pin 7 (DGND) to enable connecting a floating or anode grounded photodiode at the sensor connector
7	DGND	digital ground

The following described pins are uniquely used for the memory in the sensor head and may not be used. Connecting these pins may cause malfunction of the PM300.

1	EEPROM VDD (3.3V)	
8	EEPROM SCK	
9	EEPROM CS	

7.5 Thorlabs Power Sensors

7.5.1 S120B / S121B Silicon Sensor

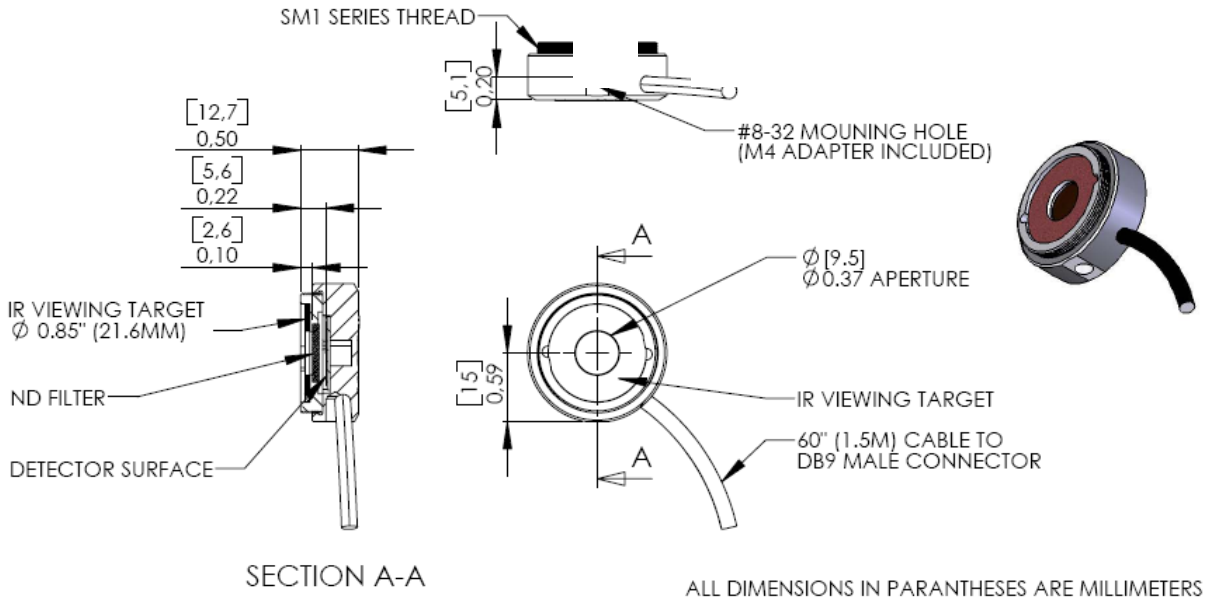

Figure 17 S120B / S121B Mechanical Drawing

Specifications:

Spectral range:	400 – 1100nm
Sensor:	Silicon
Sensor size:	10mm x 10mm sq. (0.39” x 0.39”)
Input aperture:	∅ 9.5mm (0.374”)
Distance to ND filter:	2.6mm (0.1”)
Distance to detector:	5.6mm (0.22”)
Aperture thread	1.035-40 Outer Thread (SM1 compatible)
Optical power range:	S120B: 50nW – 50mW (@ 980nm)
	S121B: 500nW – 500mW (@ 980nm)
Resolution:	100pW (S120B)/ 1nW (S121B)
Optical Damage Threshold:	50W/cm²
Measurement Standard:	NIST traceable
Measurement uncertainty:	+/- 5%
Operating temperature:	5°C to 40°C
Weight:	0.07kg (0.155lbs)

Notes:

The sensor contains an IR viewing target with absorption bands from 400 to 640nm and 800 to 1700nm that can be removed by carefully levering in the side hole with a small screw driver.

The sensors can be equipped with fiber adapters from the S120 series.
(Order Codes: S120-FC, S120-SMA, S120-SC)

For use with metric posts insert the 8-32 to M4 adapter.

7.5.2 S122B Germanium Sensor (PM122)

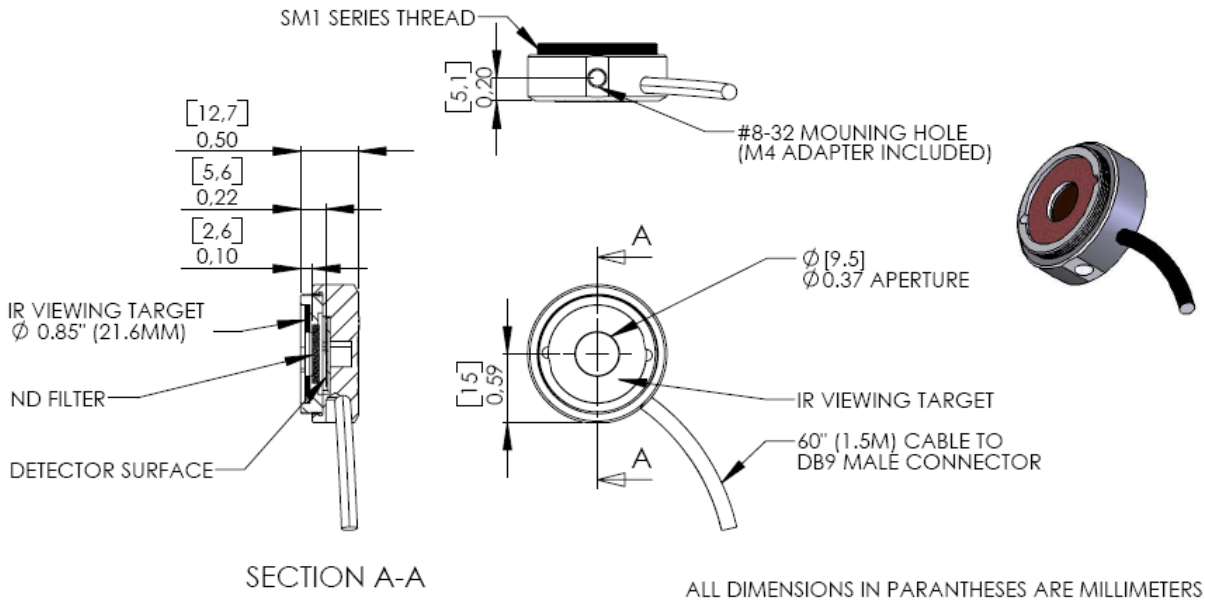

Figure 18 S122B Mechanical Drawing

Specifications:

Spectral range:	700 – 1800nm
Sensor:	Germanium
Sensor size:	10mm x 10mm sq. (0.39” x 0.39”)
Input aperture:	∅ 9.5mm (0.374”)
Distance to ND filter:	2.6mm (0.10”)
Distance to detector:	5.6mm (0.22”)
Aperture thread	1.035-40 Outer Thread (SM1 compatible)
Optical power range:	35nW – 35mW (@ 1550nm)
Resolution:	100pW
Measurement Standard:	NIST traceable
Measurement uncertainty:	+/- 5%
Operating temperature:	5°C to 40°C
Weight:	0.07kg (0.155lbs)

Notes:

The sensor contains an IR viewing target with absorption bands from 400 to 640nm and 800 to 1700nm that can be removed by carefully levering in the side hole with a small screw driver.

The sensor can be equipped with fiber adapters from the S120 series.

(Order Codes: S120-FC, S120-SMA, S120-SC)

For use with metric posts insert the 8-32 to M4 adapter.

7.5.3 S130A / S132B Slim Sensor (PM130 / PM132)

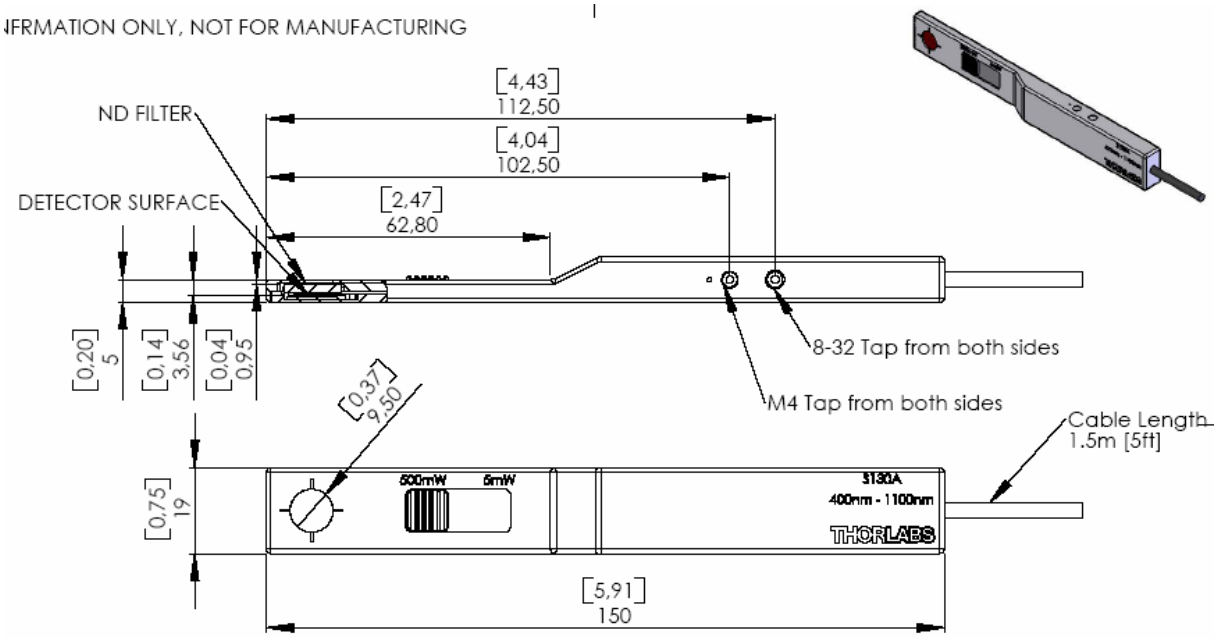

Figure 19 S130A / S132A Mechanical Drawing

Specifications:	**S130A**	**S132A**
Spectral range:	400 – 1100nm	700 – 1800nm
Sensor:	Silicon	Germanium
Sensor size:	10mm x 10mm sq. (0.39” x 0.39”)	
Input aperture:	∅ 9.5mm (0.374”)	
Distance to ND filter:	3.3mm (0.12”)	
Distance to detector:	5.8mm (0.23”)	
Optical power range (@980nm):	5nW – 5mW	
	5µW – 500mW	(100mW @1550nm)
Resolution:	100pW	
Optical Damage Threshold:	50W/cm²	
Measurement Standard:	NIST traceable	
Measurement uncertainty:	+/- 5%	
Operating temperature:	5°C to 40°C	
Weight:	0.125kg (0.155lbs)	

Notes:

The sensor contains one set of calibration data for each slider position. The console automatically uses the right calibration data a few seconds after the slider has been moved. Please care that the slider is always in a ‘snapped” position.

7.5.4 S140A / S144A Integrating Sphere Sensor (PM140 / PM144)

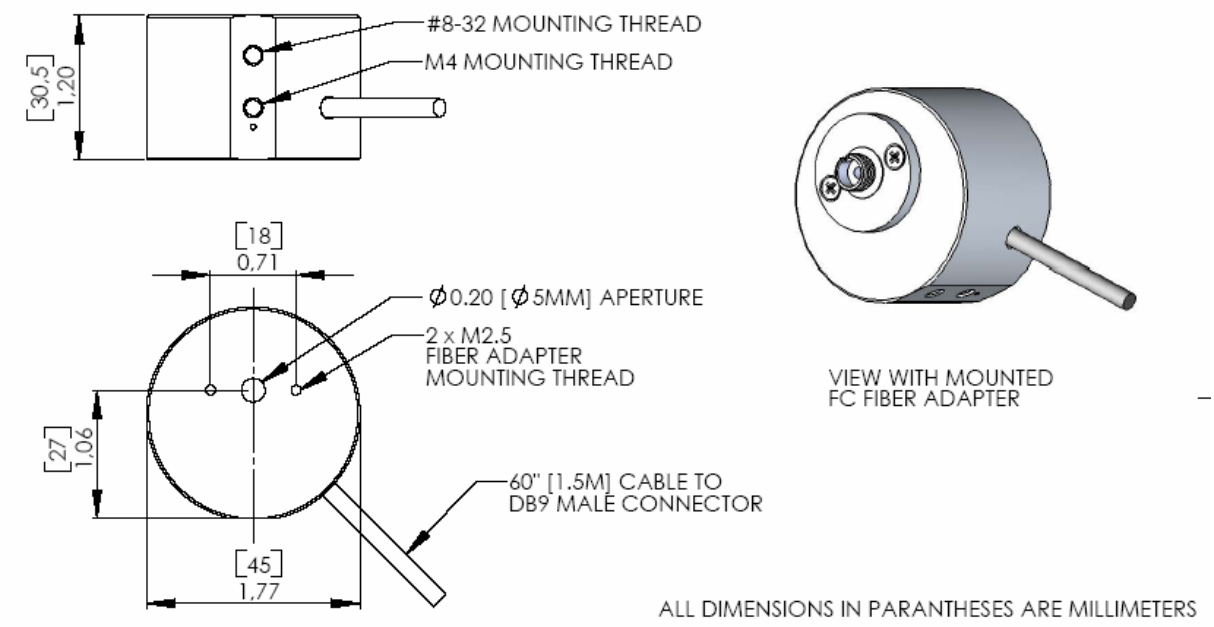

Figure 20 S140A / S144A Mechanical Drawing

Specifications:	**S140A**	**S144A**
Spectral range:	400 – 1100nm	800 – 1700nm
Sensor:	Silicon	InGaAs
Measurement Principle:	Integrating Sphere	
Sensor size:	∅ 1mm	
Input aperture:	∅ 5mm (0.20”)	
Optical power range	1µW – 1W	
Resolution:	10nW	
Optical Damage Threshold:	200W/cm²	
Measurement Standard:	NIST traceable	
Measurement uncertainty:	+/- 5%	
Operating temperature:	5°C to 40°C	
Weight:	0.125kg (0.155lbs)	

Notes:

To remove or change the fiber adapter, loosen the two M2.5x5 screws and lift-off the adapter. Fiber adapters are available for SMA connectors (S140-SMA) and SC connectors (S140-SC).

With removed fiber adapter the sensor can be used in free-space applications.

7.5.5 S210A 3W Thermal Sensor

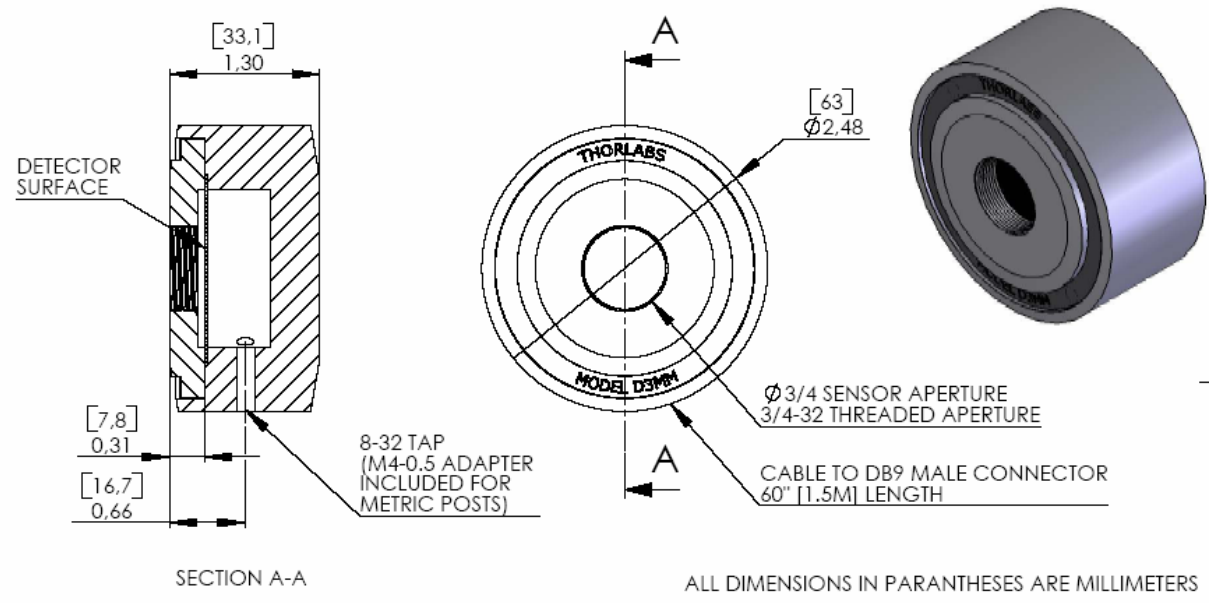

Figure 21 S210A Mechanical Drawing

Specifications:

Spectral range:	250nm – 10.6µm
Sensor:	Thermal Absorber
Input aperture:	∅ 19mm (3/4”)
Distance to detector:	8.0mm (0.315”)
Aperture thread:	3/4”-32
Optical power range:	20mW – 3W
Resolution:	1mW
Measurement Standard:	NIST traceable
Measurement uncertainty:	+/- 5%
Optical damage threshold:	200W/cm² CW
	3.3J/cm² (1ms pulse @ 1064nm)
	50mJ/cm² (20ns pulse @ 1064nm)
Size:	33.0mm x ∅63.5mm (1.3” x ∅2.5”)
Weight:	0.51kg (1.13lbs)

7.5.6 S212A 10W Thermal Sensor

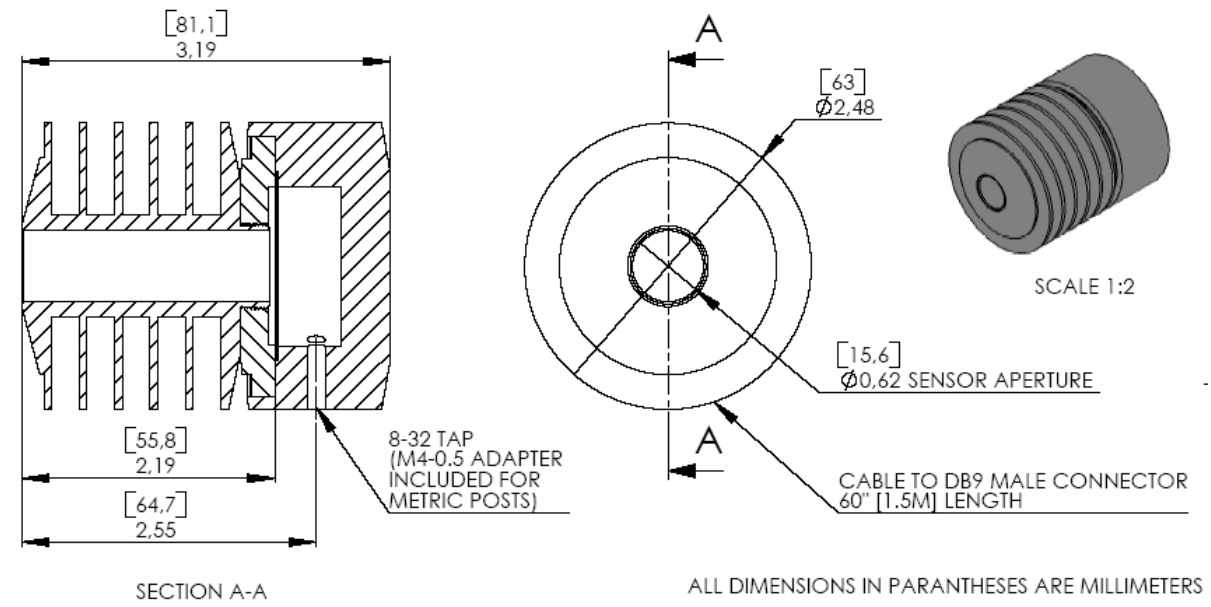

Figure 22 S212A Mechanical Drawing

Specifications:

Spectral range:	250nm – 10.6µm
Sensor:	Thermal
Input aperture:	∅ 12.7mm (1/2”)
Distance to detector:	55.9mm (2.20”)
Aperture thread:	none
Optical power range:	20mW – 10W
Resolution:	1mW
Measurement Standard:	NIST traceable
Measurement uncertainty:	+/- 5%
Optical damage threshold:	200W/cm² CW
	3.3J/cm² (1ms pulse @ 1064nm)
	50mJ/cm² (20ns pulse @ 1064nm)
Size:	81.3mm x ∅63.5mm (3.2” x ∅2.5”)
Weight:	0.51kg (1.13lbs)

7.5.7 S213A 30W Thermal Sensor

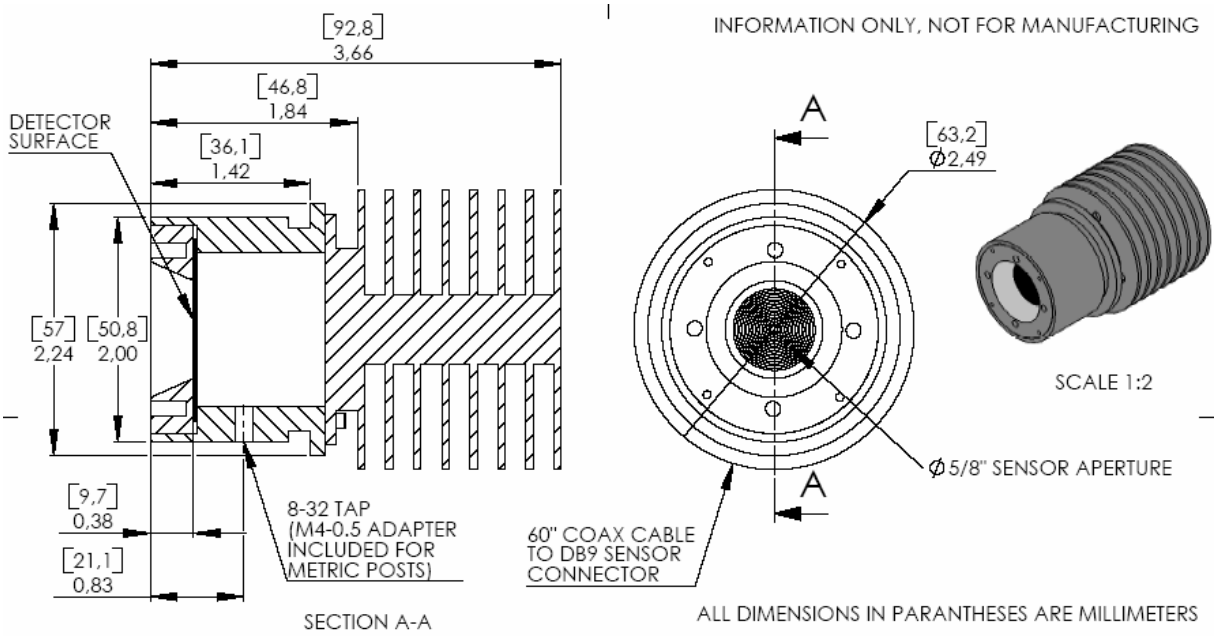

Figure 23 S213A Mechanical Drawing

Specifications:

Spectral range:	250nm – 10.6µm
Sensor:	Thermal
Input aperture:	∅ 15.8mm (5/8”)
Distance to detector:	9.7mm (0.38”)
Aperture thread:	none
Optical power range:	100mW – 30W
Resolution:	3mW
Measurement Standard:	NIST traceable
Measurement uncertainty:	+/- 5%
Optical damage threshold:	200W/cm² CW
	3.3J/cm² (1ms pulse @ 1064nm)
	50mJ/cm² (20ns pulse @ 1064nm)
Size:	92.5mm x ∅63.5mm (3.64” x ∅2.5”)
Weight:	0.51kg (1.13lbs)

7.6 Selection of Thorlabs Photo-Diodes

7.6.1 SM05PD Series

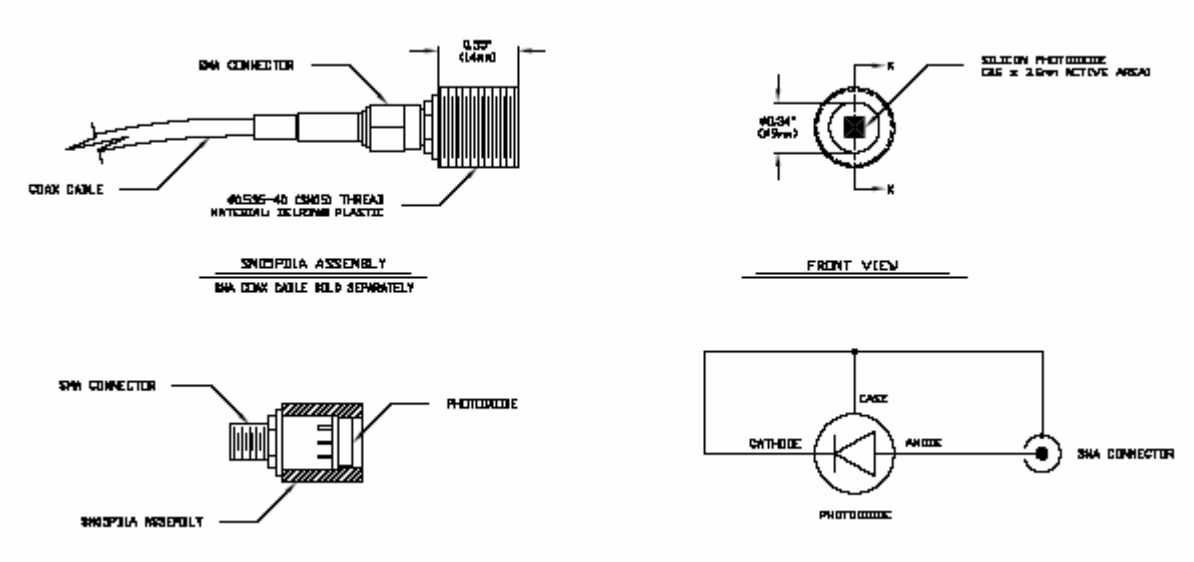

Figure 24 SM05PD1A cathode grounded silicon diode

7.6.2 SM1PD Series

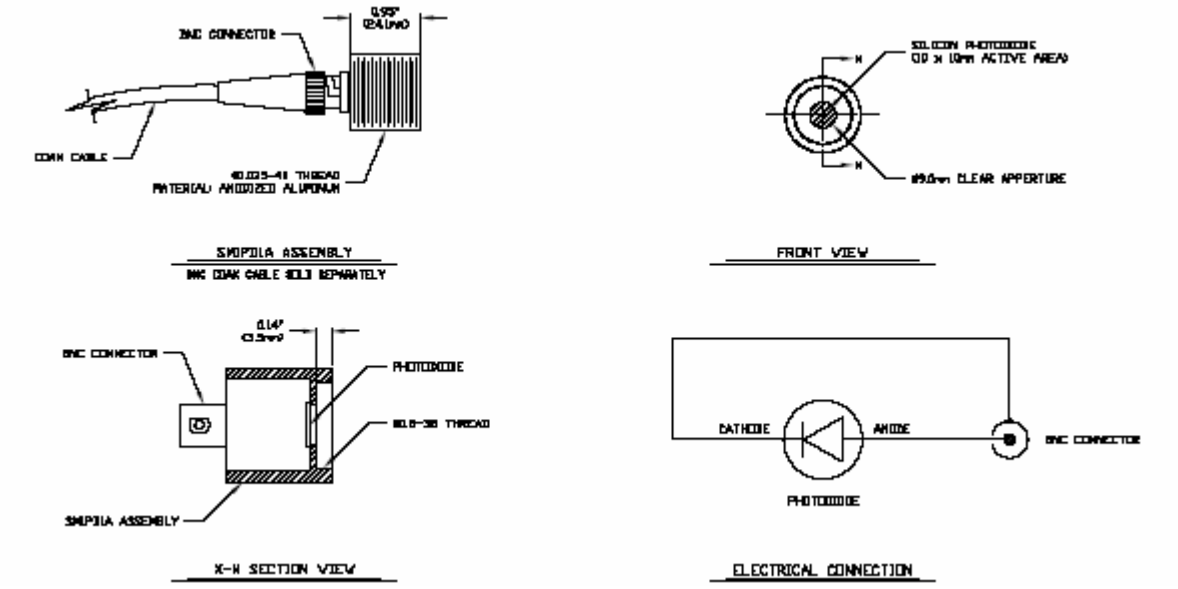

Figure 25 SM1PD1A cathode grounded silicon diode

7.6.3 IS200 Integrating Sphere Series

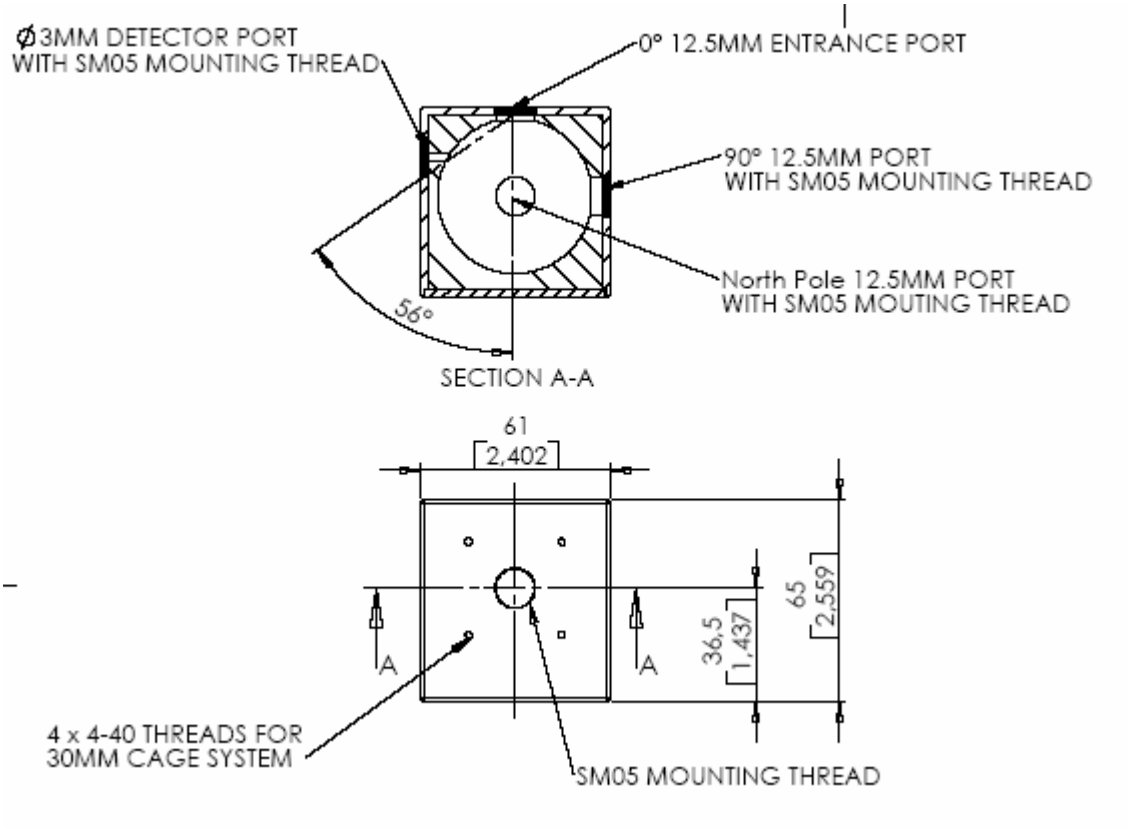

Figure 26 IS200 Mechanical Drawing

Technical Data:

Dimensions:	61 x 61 x 65 mm (2.4 x 2.4 x 2.56 Inch)
Inner Sphere Diameter:	2 Inch
Ports:	3 Ports with 0.5 Inch diameter @ 0°, 90°, North Pole SM05 threads and 4-40 threads for 30mm cage-system Detector Port: 3mm diameter port with SM05 thread Designed for the access of SM05PD detectors
Wavelength Range:	250 to 2500 nm
Reflectance:	>99% @ 350 to 1500nm; >95% @ 250 to 2500nm
Thermal Stability:	up to 250°C
Laser Damage Threshold:	7J/cm²
Weight:	0.5kg (0.77lb)
Post Mount:	M4 and 8-32 Threads at South Pole
Available Detectors:	Si, InGaAs, Ge, GaP mounted in SM05 package

7.6.4 Calibrated Photodiodes

Thorlabs offers calibration service on photodiodes, mounted photodiodes and integrating spheres. Please visit our website www.thorlabs.com or contact our sales office.

7.7 Thorlabs ‘End of Life” policy (WEEE)

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

This offer is valid for Thorlabs electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out ‘wheelie bin” logo (see Figure 27)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated

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

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB’s, housings etc.).

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

7.7.1 Waste treatment on your own responsibility

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

7.7.2 Ecological background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.
The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of live products will thereby avoid negative impacts on the environment.

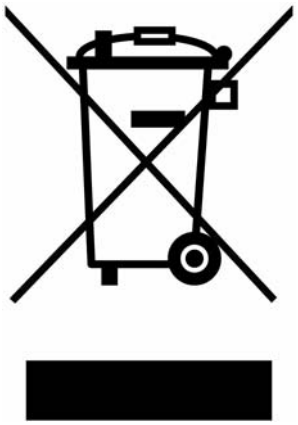

Figure 27 Crossed out ‘wheelie bin” symbol

7.8 List of figures

7.9 Addresses

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

USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
techsupport@thorlabs.com

UK and Ireland
Thorlabs Ltd.
sales.uk@thorlabs.com
techsupport.uk@thorlabs.com

Europe
Thorlabs GmbH
europe@thorlabs.com

Scandinavia
Thorlabs Sweden AB
scandinavia@thorlabs.com

France
Thorlabs SAS
sales.fr@thorlabs.com

Brazil
Thorlabs Vendas de Fotônicos Ltda.
brasil@thorlabs.com

Japan
Thorlabs Japan, Inc.
sales@thorlabs.jp

China
Thorlabs China
chinasales@thorlabs.com