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Operation Manual

Thorlabs Instrumentation

Optical Power Meter System

PM120, PM121, PM122,
PM130, PM132,
PM140, PM144
PM210, PM212, PM213

2006



THORLABS

Version: 1.22 M0009-510-401
Date: 12.05.2006

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We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to come 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 how to handle and use the PMxxx Optical Power Meter system. A general description is followed by explanations of how to operate the unit remotely via the serial RS232 connection.

☝Attention☝

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

Please read these advises carefully!

NOTE

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

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.

Use only the power cord specified for the unit.

Do not operate the power meter if its panels are removed or any of the interior circuitry is exposed

Do not operate the power meter in wet or damp conditions, or in an explosive atmosphere.

Operate the power meter only within the specified voltage range

Do not apply voltage outside the specified range of the input connections

Do not operate the power meter if there are suspected failures. Refer damaged units to qualified Thorlabs service personnel

☝ Attention ☝

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Standard shielding and filtering measures have to be undertaken to avoid interferences with other electronic equipment!

NOTE

Please check prior to operation, if the line voltage range, indicated on the power supply agrees with your local supply

2 Getting Started Quickly

This section is provided for those interested in getting the power meter up and running quickly. The more detailed description and advanced features are described in the following sections.

2.1 Setup

- Carefully unpack the console, optical head and accessories. If any of the items are damaged, do not use the meter. Call Thorlabs and arrange for replacement.
- Install the NiMH battery pack; therefore turn the unit, set the battery pack in its socket and push it slightly in top direction of the meter, until it snaps in.
- The battery pack should be fully charged before using the unit. Plug in the AC adapter into the jack on the bottom side of the console and allow the battery to charge for a minimum of 2 hours. The unit cannot switch off, when the charger is applied.
- Plug the DB9 connector of the optical head into the jack located on the top of the console and secure the two screws.
- Power on the unit by shortly pressing the on/off button.
- Conduct sensor zero calibration. The following procedure is required when attaching a new sensor
    - Press the Enter key and toggle down to the Dark Current Adj./Zeroing menu.
    - Cover the sensor and follow the wizard
    - The values will be stored for up to 5 different sensors

2.2 Keyboard Summary

ON/OFF



Shortly pressing this key will power up the unit. Pressing the key for longer than 2 seconds will power down the unit. Per factory default a changeable auto-shutdown time of 10 minutes is set.

Backlight



Pressing the backlight key will turn on or off the display backlight. To preserve the batteries, the backlight will turn off after the time that is set in the System\Backlight menu (factory default 5 seconds).

Wavelength Correction

λ

Short pressing of this button allows to toggle between 5 preset wavelengths (photodiode heads only). These are dependent from sensor type and serial number.

Pressing the button for longer than 2 seconds enters a screen where each of the 5 correction wavelengths can be individually changed by toggling the up, down, left and right buttons.

Display



This button enables to toggle between the different displays of visualization of the measured power. These displays are power reading in mW, analog needle, statistics screen, tuning graph and power reading in dBm.

Range Selection

RANGE

Pressing the range key shortly enables to change the display power range in decades for the digital displays and in 'half' decades (3, 10) for the quasi analog displays.

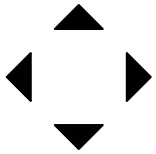
Pressing the range key shortly twice conducts one auto-ranging step to automatically jump to the optimal range.

Automatic Zeroing Mode

RELΔ

The RELΔ can be used to automatically zero the display by subtracting the current reading from the displayed value. The amount of offset is displayed additionally. Bar-graph and analog needle display go in a mid-position type of display. Pressing the key again turns off this mode.

Arrow Keys



The arrow keys are used to navigate through the menus as well as navigating and adjusting the display soft keys.

Enter Key



The enter key is used to get into child menus and confirm user settings

2.3 Display Arrangement

The display is divided into three horizontal sections that allow the user to view all relevant information on a single screen:

- The top section with sensor, wavelength correction, attenuation correction and battery info.
- The main display for measurement values, graphs and charts.
- The bottom section with soft buttons, operated by the arrow keys. Left/Right activates the soft buttons, Up/Down changes the values. The activated button is indicated in reverse style.

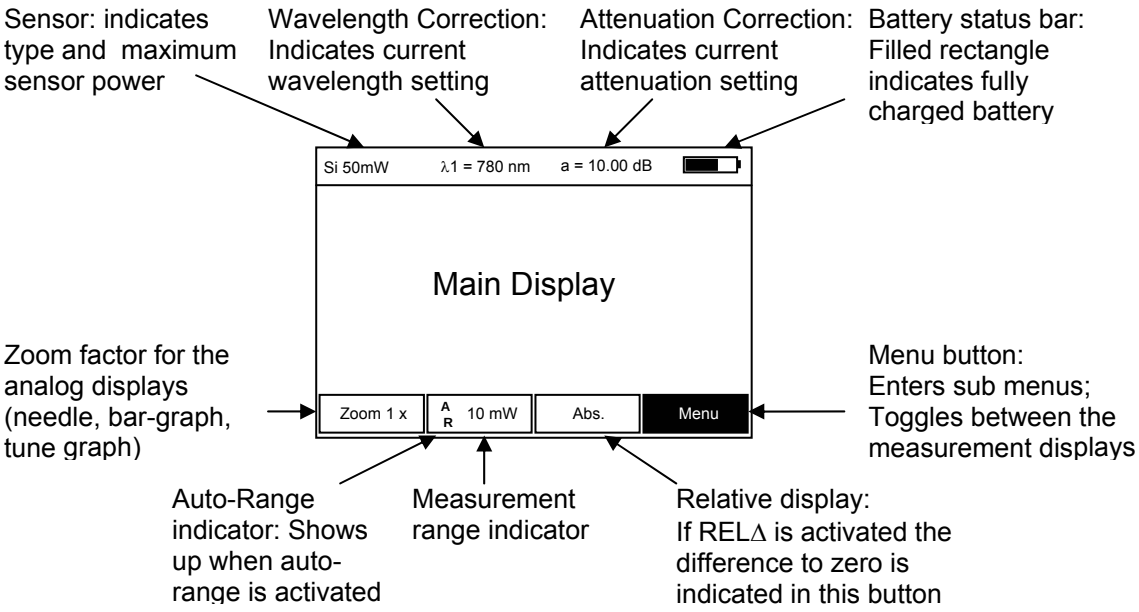


Figure 1 Display Arrangement

3 Description

The Thorlabs PMxxx Power Meter system is a flexible optical power measurement system that easily expands as your measurement needs grow. The system is based on a universal console which displays the measurement on a graphic LCD read-out and is controlled by an easy-to-use keypad.

Thorlabs offers a wide range of interchangeable sensor heads to use with the PM100 console. Large area silicon and germanium semiconductor heads cover the range from visible to mid IR with nW sensitivity. For higher power measurements, Thorlabs offers a line of thermal sensors that will measure up to 30W with sophisticated circuitry enabling fast measurement results.
Please refer to www.thorlabs.com for new sensors that will enhance the PM100 system.

Each sensor head includes a non-volatile memory chip, which stores the NIST-traceable calibration of the sensor along with other relevant data such as model number, serial number, wavelength range, etc. The console automatically recognizes the attached sensor head during the operation and adjusts the system accordingly to maintain NIST-traceable, reliable power measurements.

The LCD graphics screen displays the real time optical power in large, easy-to-read digits supported by a fine resolution bar graph. An x-y plot mode provides an oscilloscope-type display of the power reading. The analog needle display is ideal for tuning laser systems or aligning fiber launch systems. For process monitoring, real time statistics such as min/max/mean/std dev are accessible through the statistics mode. The display includes a backlight for easy viewing in dim lightning conditions.

The console includes an RS-232 serial port for remote access to the power meter, as well as a configurable analog output for externally monitoring the power reading.

The console is powered by a 3.6V, 1500mAh nickel-metal-hybrid (NiMH) battery pack for long life operation and fast recharging times. The included external power supply is provided to recharge the battery pack as well as to operate the unit independent from the battery pack.

3.1 Parts List – Accessories

The power meter system consists of the following items:

- **PM100** Universal power meter console with
  - **PMBAT** Rechargeable and replaceable
    3.6V 1500mAh NiMH battery pack
- **CABSER** Serial Interface cable; 9p Sub-D female on both ends
- Operation manual
- CD-ROM with all software included
- **PMPS9** Power supply (9V, 1.1A), 85 .. 264V line voltage,
  included line adaptors for US, EU, UK.

Depending on the order code the power meter system comes with one of the sensors given below:

PM120: S120B – Silicon Sensor Power Head; 50nW – 50mW; 400 – 1100nm
PM121: S121B – Silicon Sensor Power Head; 500nW – 500mW; 400 – 1100nm
PM122: S122B – Germanium Sensor Power Head; 35nW – 35mW;
700 – 1800nm

PM130: S130A – Slim, dual range Silicon Sensor Power Head;
5nW – 500mW; 400 – 1100nm
PM132: S130A – Slim, dual range Germanium Sensor Power Head;
5nW – 500mW; 400 – 1100nm

PM140: S140A – Integrating Sphere Silicon Sensor Power Head;
1µW – 1W; 400 – 1100nm

PM144: S144A – Integrating Sphere InGaAs Sensor Power Head;
1µW – 1W; 800 – 1700nm

PM210: S210A – Thermal Power Head; 20mW – 3W; 250nm – 10.6µm
PM212: S212A – Thermal Power Head; 20mW – 10W; 250nm – 10.6µm
PM213: S213A – Thermal Power Head; 100mW – 30W; 250nm – 10.6µm

3.2 Technical Data

(All technical data are valid at 23 ± 5°C and 45 ±15% humidity)

3.2.1 PM100 Display Unit

General Specifications:

Display:	240 x 160 pixel LCD with EL backlight
Display Format:	Digit, Analog needle, histogram, statistics and menu screens
PC Communication:	RS-232
Baud Rate:	2400 – 115200 bps

Data Acquisition:

Photo-diode current range:	0.1nA - 4mA
Thermal-sensor voltage range:	1µV - 10mV
Accuracy:	±1% (console)
Resolution:	16 to 24 bit (ΣΔA/D Converter)
Sample Rate:	6 Hz

Analog Output:

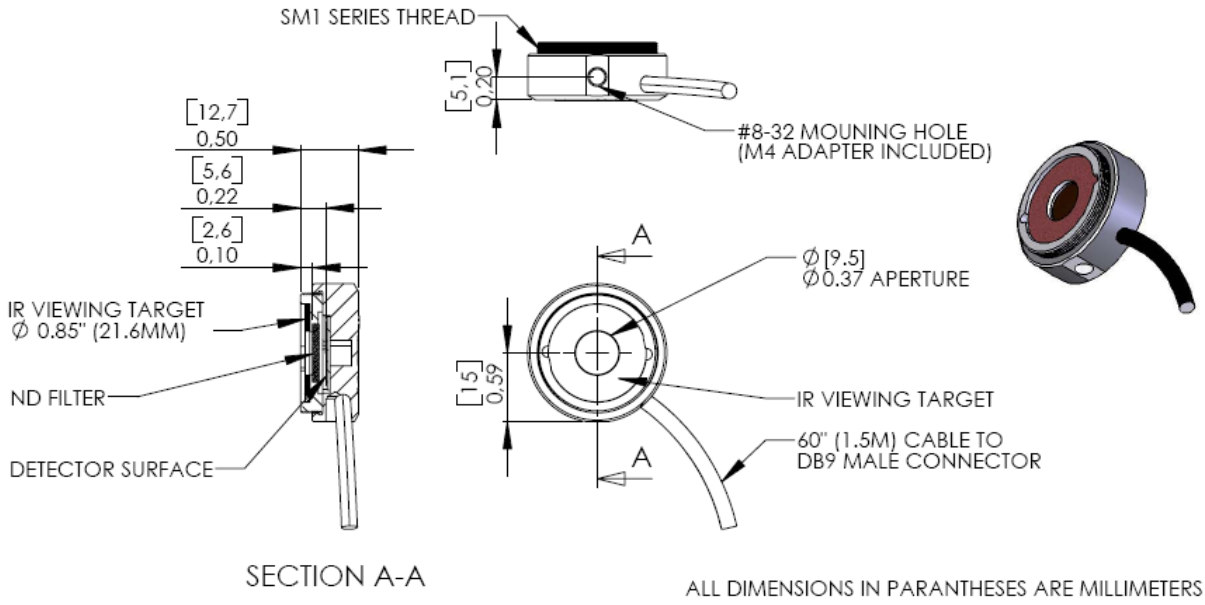
Voltage Range:	0 – 4.095V
Resolution:	12 bit (1mV)
Sample Rate:	6 Hz
Power Range:	0.001V/mW – 1000V/mW, Software Adjustable
Connector:	SMA

Power Management:

Battery Pack:	NiMH, 1500mAh, 3.6V
Battery Run Time:	> 12 hours (backlight off)
Charger:	built-in 2 hr. battery charger
Power Supply:	Plug-in power supply Input: 85 – 264 VAC, 50 – 60 Hz Output: 9VDC @ 1.1A

3.2.2 S120B / S121B Silicon Sensor (PM120 / PM121)

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.

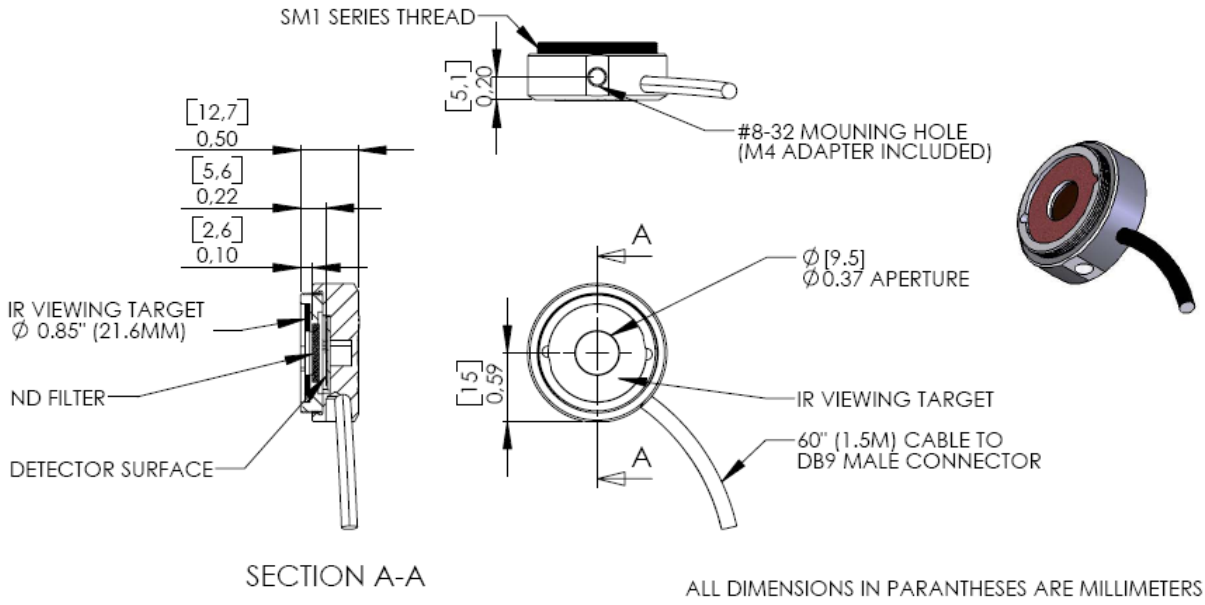
The sensors can be equipped with fiber adapters from the S120 series.

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

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

3.2.3 S122B Germanium Sensor (PM122)

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.

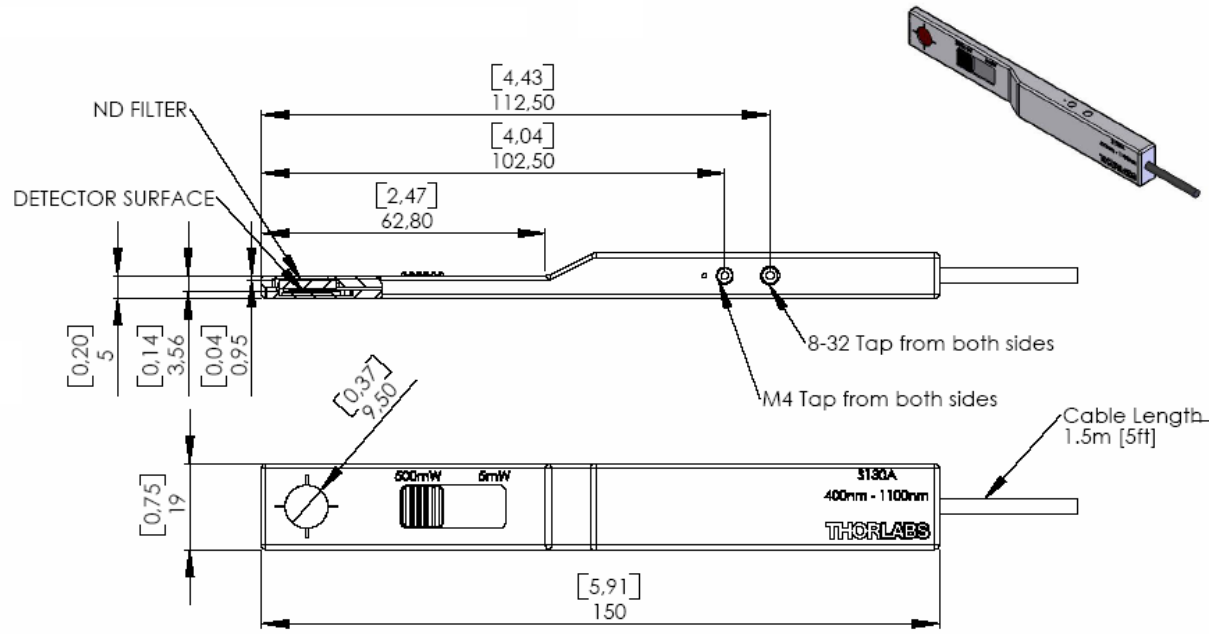
The sensor can be equipped with fiber adapters from the S120 series.

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

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

3.2.4 S130A / S132B Slim Sensor (PM130 / PM132)

Mechanical Drawing:



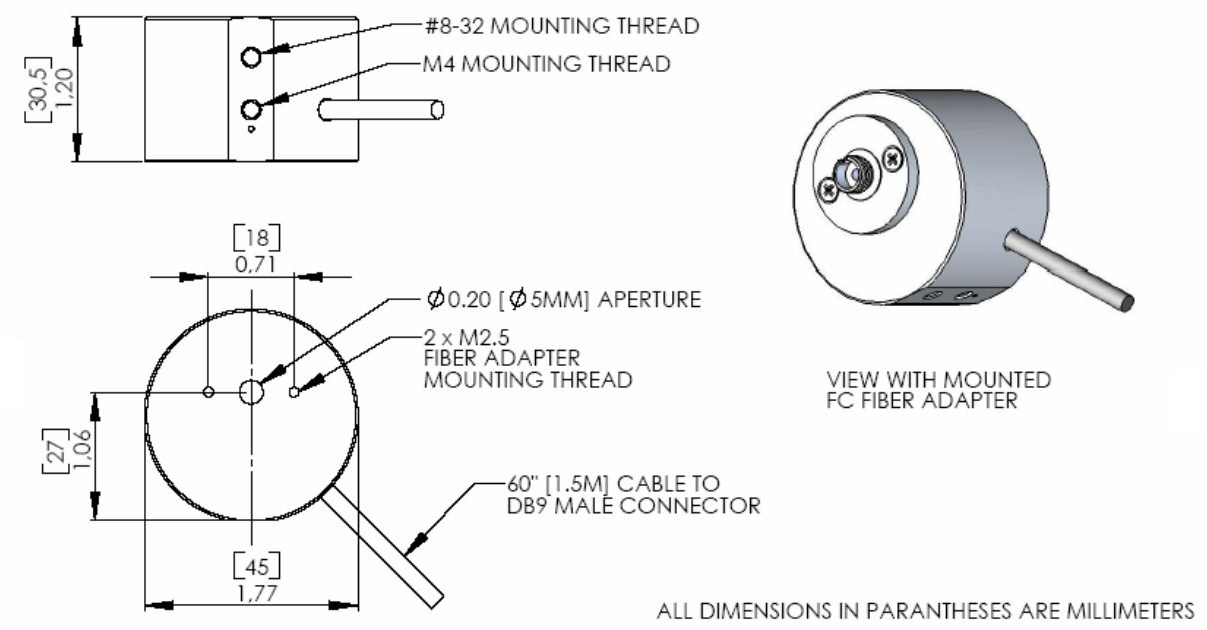
Specifications:	**S130A**	**S132A**
Spectral range:	400 – 1100nm	700 – 1800nm
Sensor:	Silicon	Germanium
Sensor size:	10mm x 10mm sq. (0.39” x 0.39”)	
Input aperture:	∅ 9.5mm (0.374”)	
Distance to ND filter:	3.3mm (0.12”)	
Distance to detector:	5.8mm (0.23”)	
Optical power range (@980nm):	5nW – 5mW	
	5µW – 500mW	(50mW @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 two sets of calibration data for both slider positions. 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.

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

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)	

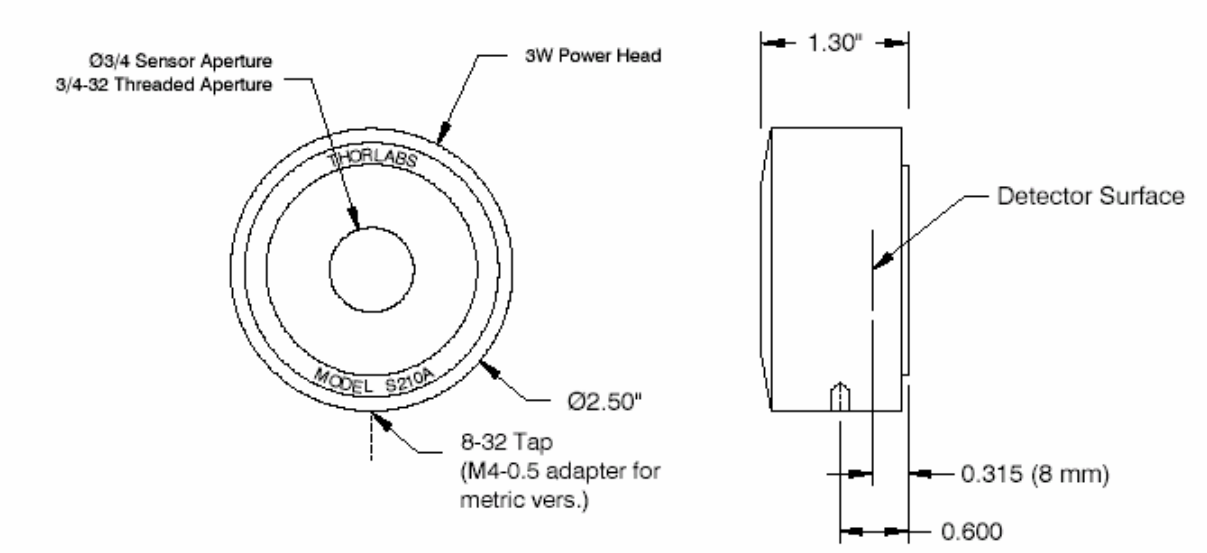
Notes:

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.

3.2.6 S210A 3W Thermal Sensor (PM210)

Mechanical Drawing:

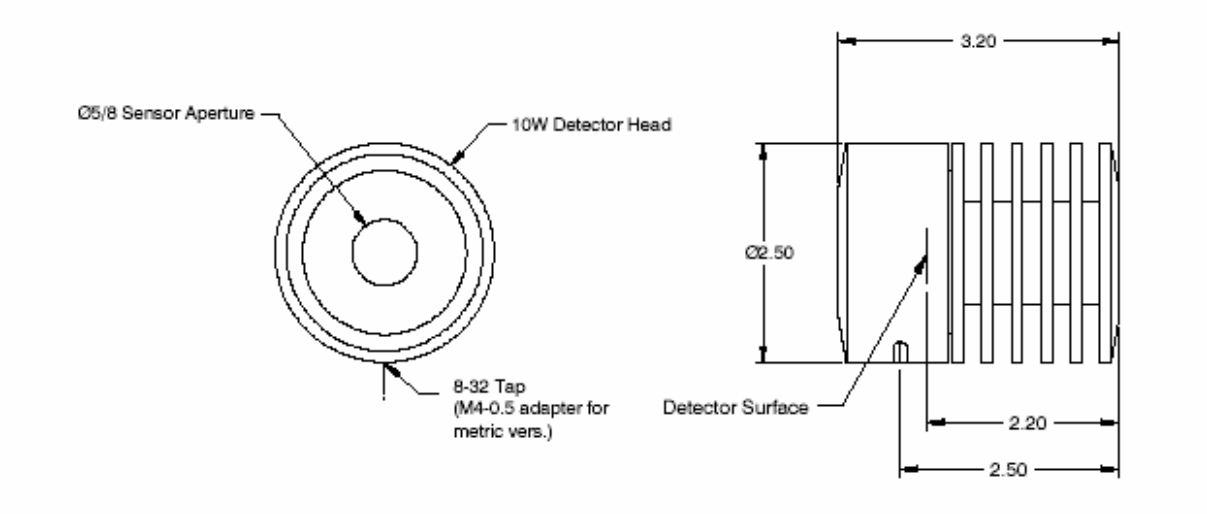


Specifications:

Spectra 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)

3.2.7 S212A 10W Thermal Sensor (PM212)

Mechanical Drawing:

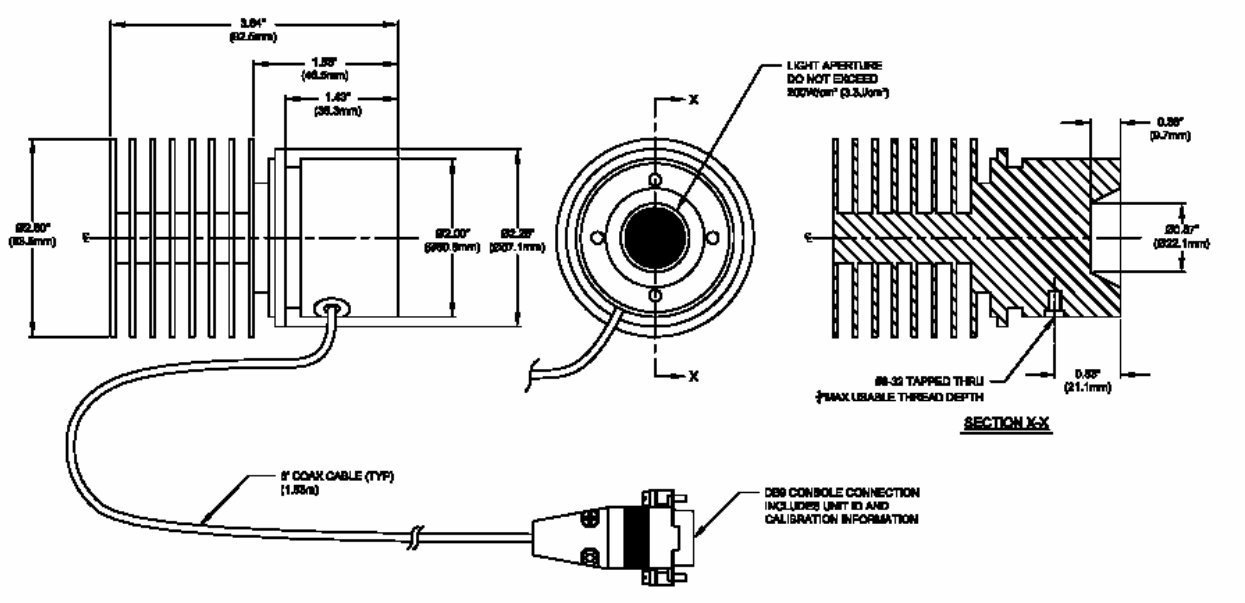


Specifications:

Spectra 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)

3.2.8 S213A 30W Thermal Sensor (PM213)

Mechanical Drawing:



Specifications:

Spectra 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)

3.3 Physical Overview



Figure 2 PM100 Operating Elements

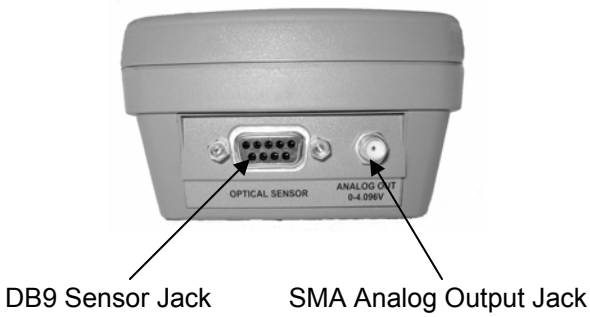


Figure 3 Top Plate Operating Elements

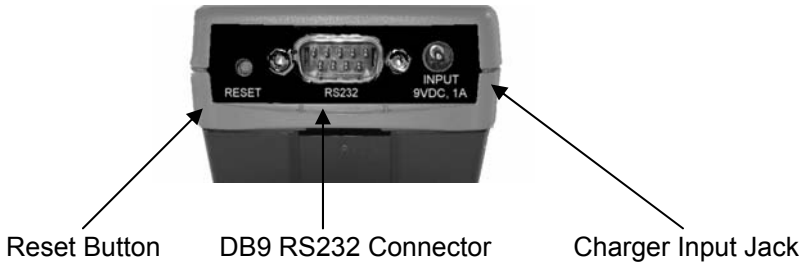


Figure 4 Bottom Plate Operating Elements

3.4 Operating Instruction

3.4.1 Inserting and Charging the Battery Pack

To install the battery turn the unit, set the battery pack in its socket and push it slightly in top direction of the meter, until it snaps in
To remove the battery pack press the release button and push the pack in bottom direction of the unit.

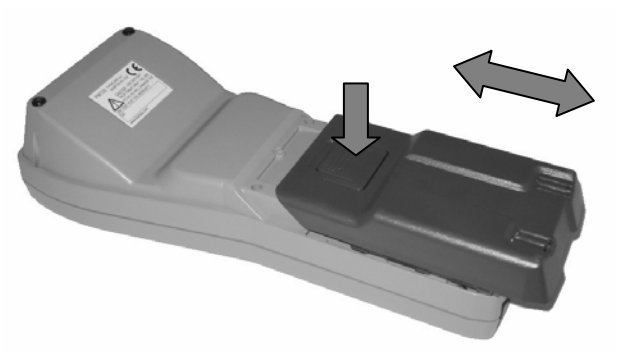


Figure 5 Inserting/Removing the Battery Pack

The batteries are not fully charged when shipping. A battery that is new or has not been used for a longer period does not develop its full capacity until after approximately 2 hours of charging.
Therefore plug the connector of the 9VDC power supply (supplied with the system) into the socket in the bottom plate of the unit and the power supply into a suitable AC outlet. Attach the right adapter depending on local power requirements to the power supply, adapters for US, Europe and UK are provided with the instrument. If the adapter is lost, contact Thorlabs for replacement.

The unit will turn on when the power supply is connected and cannot be turned off until the power supply is removed. The auto-shutdown function is detached while the power supply is connected.
The battery is equipped with an NTC temperature control which allows charging only within a temperature range of between 10°C and 40°C. Do not exceed the line voltage that is stated on the power supply. The power supply gets warm after longer time of use; this is normal and not dangerous.
The unit can be operated normally while the 9VDC adapter is plugged in.
When the power supply is not plugged, the battery charging state is indicated in the upper right corner of the graphics display. A filled rectangle indicates that the battery is fully charged.

3.4.2 Switching On and Off the Unit



Shortly pressing the on-key will power up the unit. The firmware version is displayed until the system initialization is complete. The unit will then start with the screen that was active prior to shutdown.

Pressing the key for longer than 2 seconds will power down the unit into standby.
Per factory default an auto-shutdown time of 10 minutes is set. Changing this auto-shutdown time can be accomplished in the menu under System\Shutdown.
When the 9VDC adaptor is applied a “loading battery symbol” remains in the display when the unit is switched off.

3.4.3 Principal of Operation and Menu Navigation

The PM100 uses the following types of operating elements:

- Navigating field with arrow and enter buttons
- Display soft keys
- Function buttons

The left/right arrow buttons:



- Toggle between the display soft keys
- Enter or leave child menus
- Select the decimal place of a numerical input.

The up/down arrow buttons:



- Toggle up and down in a display soft key (e.g. range setting)
- Toggle in up and down a menu or list field
- Increase/decrease a digit in a numerical input.

The enter button:



- Enters the main menu or selects sub menus
- Edits or confirms settings either from numerical input or list fields
- Operates display soft keys (where required)
- Is used in 'wizard' functions as 'next' button (e.g. dark current adjustment)

The display soft keys are flexibly used and can have the following two functions:

- The selected key can be switched with the Enter button.
- The key is used like a text ring, operated by the up and down arrow buttons. The current setting is indicated in the key.

Prior operation of a display soft key it must be selected either by navigating with the left/right arrow buttons or by pressing the appropriate function button.

The function buttons have a repeat function, with one exception the Lambda key. The Lambda key can be operated in two ways, by short pressing and by long pressing (2 seconds).

- Toggle the 5 preset correction wavelengths (short)
- Edit a preset correction wavelength (long)

3.4.4 Connecting a Photodiode Sensor (PM100 Series)

Plug the DB-9 connector of the optical head into the jack located on the top of the console and secure the two screws. This can be done while the power meter is switched on.
The display unit will automatically recognize the sensor, read out the head calibration data from its non-volatile memory and indicate after approximately 2 seconds the sensor type and operating wavelength. For up to 5 different sensors (photodiode and thermal in total) the system automatically sets the last valid data set for wavelength, dark current and user attenuation.

NOTE

Because the photodiode response is wavelength dependent, it is possible that the meter may reach a maximum limit on the measurable power before the full-scale value is reached. In this case the saturation level of the photodiode is reached. To avoid damaging the photodiode it will be necessary to attenuate the beam before a valid measurement can be made.

3.4.4.1 Dark current adjustment

Photodiode sensors have the characteristic to emit a small so called dark-current up to some nA for silicon and InGaAs, and up to some 200 nA for germanium, even if no photons meet the active area. To achieve accurate measurement results this dark current must be considered and subtracted from the power reading.
Even though the PM100 is capable to store and recall the dark currents from 5 different sensors it is recommended to conduct the following procedure from time to time to exclude failures caused by the temperature dependency of the dark current.

Procedure:

- Enter the Menu, toggle down to menu #4 'Dark Current Adj./Zeroing' and press Enter
- A wizard that leads through the next steps comes up
- Cover the sensor that no light meets the active area and press Enter
- The dark current will be measured and indicated in the display
- Press Enter to confirm and store the new dark current value
- The unit switches back to the measurement display and works with the new dark current value

3.4.4.2 Wavelength Correction

To take in account the wavelength dependency of a photodiode sensor, each Thorlabs sensor has a wavelength correction table with a 5nm grid over the wavelength range that is stored in a non-volatile memory in the sensor connecter.
To achieve accurate measurements it is necessary to adjust the PM100 to the wavelength of the light source whose power has to be measured.
The PM100 is capable to store 5 individual operating wavelengths for up to 5 different sensors.

λ Pressing the Wavelength correction button toggles between these 5 preset wavelengths. The chosen wavelength is indicated in the graphics display's top section right beneath the head identifier.

To change the preset values there are two possibilities (note, that a photodiode sensor must be connected):

- Press the wavelength correction button longer than 2 seconds. The unit switches to a numerical input screen, where the wavelength value can be changed by pressing the arrow keys. Up/down for increment and decrement; left/right to select the decimal place. The wavelength can be changed with a precision of 1nm. The upper and lower limit of the wavelength setting range is

given through the sensor type. Confirm the new wavelength setting with Enter, the unit will switch back to the measurement display. This method allows changing the wavelength quickly with very few clicks.

- The second way uses the menu structure. To get to the numerical input field enter the Menu, toggle down to menu #2 'Wavelength Correction'; confirm with Enter or right arrow. Chose the wavelength to be changed and confirm with Enter or right arrow. A numerical input screen comes up, press enter to enable editing the wavelength. Change the wavelength value by navigating with the arrow buttons and confirm with Enter. Leave the menu with the left arrow or any function button.

Whenever the PM100 is switched off (also by auto-shutdown) the last wavelength used will be stored. The next time the unit is powered up this wavelength will be in effect. When changing to a different sensor the last wavelength that was stored for this sensor will show up. This works for up to 5 different sensors.

3.4.4.3 Attenuation/Gain Correction

When an attenuator (e.g. a neutral density filter) is attached to the power meter system then the attenuation factor can be conveniently set as a ratio in dB that will automatically correct the measurement value. The value is linked to the connected sensor and stored with it's setup values. The attenuation correction will be effective when the unit is powered up again or the sensor is connected again. The attenuation value is displayed in the graphics display's top section.
Procedure:

- Enter the Menu, toggle down to menu #3 'User Calibration' and press Enter
- A numerical input screen comes up, press Enter to enable editing the attenuation value
- Set the calibration factor in logarithmic representation (dB) by using the arrow buttons. The system allows input values between -20dBm and +30dBm.
- Confirm the set value with the Enter button
- Toggle out of the menus with the left arrow button

3.4.5 Connecting a Thermal Sensor (PM200 series)

Plug the DB-9 connector of the optical head into the jack located on the top of the console and secure the two screws. This can be done while the power meter is switched on.

The display unit will automatically recognize the sensor, read out the head data from its non-volatile memory and indicate after approximately 2 seconds the sensor type. For up to 5 different sensors (photodiode and thermal in total) the system automatically sets the last valid data set for zero and user attenuation.

☝ Attention ☝

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

Exceeding these values will permanently destroy the sensor!

3.4.5.1 Zeroing the Sensor

Thermopile sensors need to be zeroed, when thermal differences between active area (thermal disk) and the sensor heat sink appear. An indicator that the sensor needs to be zeroed is when with switched off laser either a zero reading combined with the Lo indicator or a power reading greater zero is displayed.
To zero the sensor conduct the following procedure:

- Enter the Menu, toggle down to menu #4 'Dark Current Adj./Zeroing' and press Enter
- A wizard that leads through the next steps comes up
- Cover the sensor in a way that no light meets the active area and press Enter
- The thermocouple voltage will be measured and indicated in the display
- Press Enter to confirm and store the new zeroing value
- The unit switches back to the measurement display and works with the new zeroing value

3.4.5.2 Attenuation/Gain Correction

When an attenuator is attached in the beam between light source and sensor of the power meter system then the attenuation factor can be conveniently set as a ratio in dB that will automatically correct the measurement value. The value is linked to the connected sensor and stored with it's setup values. The attenuation correction will be effective when the unit is powered up again or the sensor is connected again.
Procedure:

- Enter the Menu, toggle down to menu #3 'User Calibration' and press Enter
- Set the calibration factor in logarithmic representation (dB) by using the arrow buttons. The system allows input values between -20dBm and +30dBm

- Confirm the set value with the Enter button
- The unit will switch back to the measurement display and keep the attenuation factor in it's memory

3.4.6 Range Setting

RANGE

The power measurement range is indicated in the second soft key from left. Access to this soft key is given by pressing shortly the RANGE function button or navigating to it by the left and right arrow buttons.

When the range soft key is selected another pressing the RANGE button proceeds one auto-range step to set the unit into the optimum measurement range.

An individual range setting can then proceeded by pressing the up and down arrow keys. The arrow keys will cycle the measurement range of the meter either in decade steps for the digital readings or for better visibility in 'half logarithmic' decades (.. 1, 3, 10 ..) for the analog representation of the measurement values (needle display and tune-graph display).

If the unit is in auto-range mode, pressing the up and down buttons deactivates the auto-range mode. To get back into the auto-range mode press the Enter button.

The auto-range function can be enabled/disabled by toggling the Enter button if the Range soft-key is activated or by entering the menu and choosing the submenus System\Auto-range.

3.4.7 Relative Measurements

RELΔ

The RELΔ function is either used to subtract background light levels or to exceed the sensitivity by 'zeroing' the display to enable a more sensitive range setting. The offset value is then displayed as a reference in the third soft key from left.

The RELΔ function button is used to toggle this zeroing function on and off. When the soft key is activated also the Enter and the up/down buttons toggle the relative measurement on and off.

When the RELΔ function is activated, the bar-graph and analog needle display go to a middle-positioned scale with an automatic zoom by a factor of 10.

3.4.8 Zoom Functions

The zoom function is very useful for beam alignment and laser tuning. The zoom function shows up as the left soft key when a quasi analog display is active (bar-graph, needle, tune-graph). Toggling the zoom button enables to spread the scales by a factor of 3 and 10, based on the current power reading.
Arrows on the edges of the scales show an over-range or an under-range reading.
The zoom mode can be exited by setting the zoom factor back to 1 or changing the measurement range.

3.4.9 Representation of the Optical Power Reading



The Display function button allows to toggle between different representations of the optical power reading. The PM100 enables numerical, quasi-analog and statistical display functions for the power read out. The different display are also accessible by pressing the up and down arrow buttons, when the Menu soft key is activated.

3.4.9.1 Power (Watts) and Bar-Graph Display

This display combines a clear numerical 4 digit reading of the optical power and a bar-graph function with zooming capabilities.

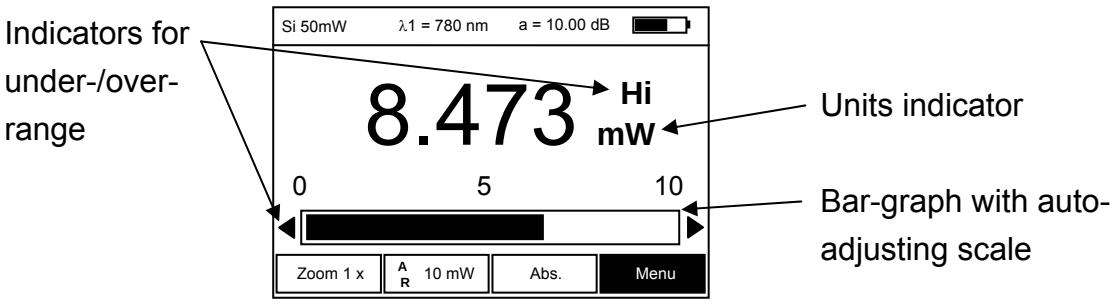


Figure 6 Power (Watts) and Bar-Graph Display

Special topics on the display soft keys:

- Zoom: Toggling zoom by the up and down buttons spreads the ar graph by a factor of 3 and 10.
  Zoom 1x indicates that the zoom function is switched off.
- Range: Ranges are set in decade cycles by pressing the up and down

arrow buttons. AR indicates the auto-range function enabled. Over or under-range is indicated by arrows on the left and right side of the bar-graph and by textual Lo and Hi annunciations above the units indicator.

- Rel∆: Pressing the REL∆ button zeros the display and indicates the offset value in the button. The bar graph will be zoomed by factor 10 and go into a middle scale position.
  Abs. indicates an absolute reading (REL∆ is deactivated)

3.4.9.2 Digital Needle Display

For laser tuning and beam alignment a digital representation an analog needle is very helpful to visualize changes and trends while the additional numerical 4 digit power read out shows the absolute value.

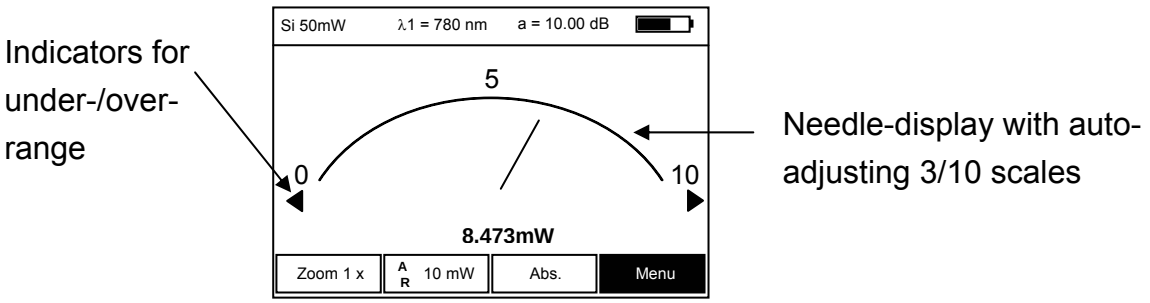


Figure 7 Digital Needle Display

Special topics on the display soft keys:

- Zoom: Toggling zoom by the up and down buttons spreads the needle scale by a factor of 3 and 10.
  Zoom 1x indicates that the zoom function is switched off.
- Range: Ranges are set in logarithmic half decade cycles (3, 10, ..) by pressing the up and down arrow buttons. AR indicates the auto-range function enabled. Over or under-range is indicated by arrows on the left and right side of the scale
- Rel∆: Pressing the REL∆ button zeros the display and indicates the offset value in the button. The needle scale will be zoomed by factor 10 and go into a middle scale position.
  Abs. indicates an absolute reading (REL∆ is deactivated)

3.4.9.3 Tune-Graph Display

The tune-graph display shows power readings over time in an oscilloscope like style. The time axis is adjustable by the 'Time-base' soft key that selects the number of readings per time, the power axis can be adjusted by the range and zoom settings. A cursor indicates the current reading.

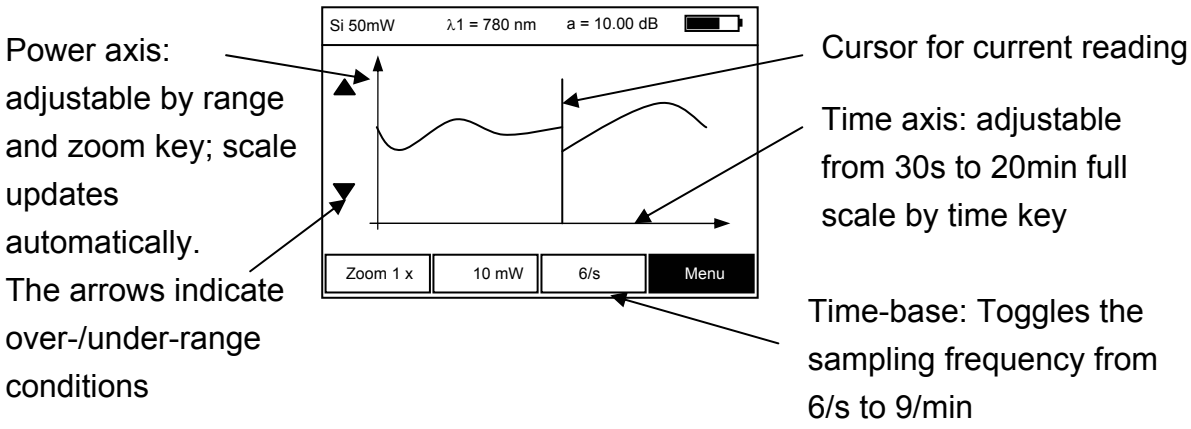


Figure 8 Tune-Graph Display

Special topics on the display soft keys:
The graph starts at zero after changing the range, zoom or time-base. The REL∆ zeroing function is not available in this display. The auto-range function will be disabled when entering this display.

- Zoom: Adjusting zoom spreads the needle scale by a factor of 3 and 10. Zoom 1x indicates that the zoom function is switched off.
- Range: Ranges are set in logarithmic half decade cycles (3, 10, ..) by pressing the up and down arrow buttons. Over or under-range is indicated by up and down arrows on the left side of the power axis.

3.4.9.4 Statistics Display

The statistics display shows simultaneously extreme, average and standard deviation measurement values over time to conduct for example pass/fail tests. The display is easy to operate by the three soft keys: Start, Stop and Reset. The meter switches automatically in auto-range. The Range and RELΔ will be set out of order.

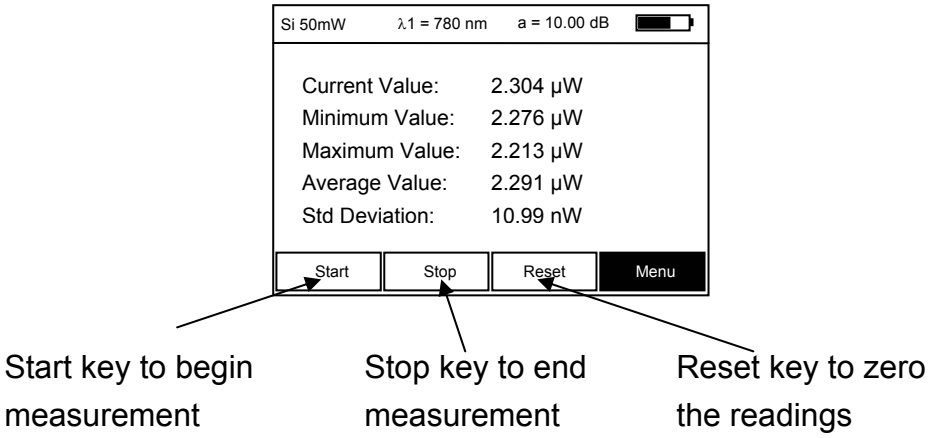


Figure 9 Statistics Display

3.4.9.5 Power dBm Display

The power dBm display features a big 4 digit numerical power reading in logarithmic representation combined with a smaller 4 digit numerical power reading in Watt. The display has the same Range and RELΔ functionality than the power Watt display but no zoom function. When RELΔ is activated the units change from dBm to dB, over or under-range conditions are displayed by Hi and Lo indicators above the units.

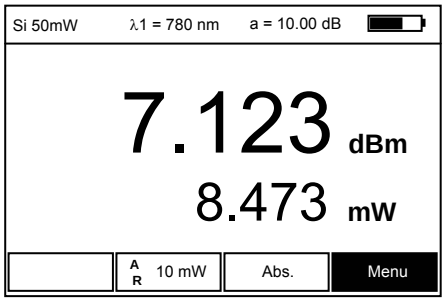


Figure 10 Power dBm Display

3.4.10 Menu Structure and Description of the Additional Functionality

When the Menu soft key is activated and confirmed with Enter, the unit enters a menu where all relevant system and operation settings can be accomplished. The menu will automatically be left, when no key press is made during 20 seconds. For manually leaving the menu press the left arrow button; or any of the function buttons. For convenient navigating the menu and submenu numbers are indicated instead of the battery symbol in the upper right corner of the graphics display. The list below shows the menu tree of the instrument and describes the functionality of each sub menu.

1 System

1-1 Autorange

Enables / Disables the auto-range

1-2 Analog Output

Sets the ratio of the voltage proportional to the power reading in mW for the analog output.

The numerical input field allows set values from 0.001V/mW up to 1000.000 V/mW

1-3 Display Refresh Rate

Sets the refresh rate for all numerical displays from 1 reading per second up to 6 readings per second.

The update rate for the bar-graph and needle display cannot be changed and runs always at its maximum rate of 6Hz.

1-4 Shutdown

Determines the time for the auto-shutdown function. The control allows the following settings: 1 minute, 10 minutes, 30 minutes, auto-shutdown off

1-5 Backlight

Determines how long the backlight will stay on after pressing the backlight button. Possible settings are: 5 seconds, 30 seconds, 1 minute, 5 minutes, always on.

To safe battery power set the time as short as possible.

1-6 Contrast

Adjusts the display contrast. The contrast can be set as a number of percentage. The result can be watched online while adjusting the contrast control.

1-7 Line Filter

To suppress interferences with line frequency adjust the control to the frequency of your local mains supply to 50Hz or 60Hz.

2 Wavelength Correction

Allows to set 5 preset wavelengths that can be toggled by the λ-button. Adjust the wavelengths to your needs by editing the numerical input fields. The wavelengths can be entered with 1nm precision. Note, that a semiconductor sensor with wavelength correction table has to be connected to the instrument. The PM100 will store and recall the preset wavelength settings for up to 5 different sensors.

3 User Calibration

Allows to set a ratio from -20.00dB up to 30.00dB that will be taken in account to all following power measurements. The ratio value is coupled to the connected power sensor. The device stores and recalls a calibration value for up to 5 different sensors.

4 Dark Current Adjustment / Zeroing

This menu comes as a wizard with 3 steps that allows the dark current adjustment of semiconductor sensors and zeroing thermal sensors. The value will be stored and recalled for up to 5 different sensors and considered in all power measurements.

5 Interface

5-1 Baudrate

Sets the interface baud rate. Possible settings are 2400, 4800, 9600, 19200, 28800, 38400, 57600 and 115200 baud.

3.4.11 Special Topics

3.4.11.1 Analog output

The SMA analog output connector provides a voltage proportional to the measured power. The voltage range goes from 0 up to 4.095V and has a resolution of 12 bits. 0V represent 0W. The ratio between Voltage and Power in mW can be set in the system menu.

3.4.11.2 Backlight



Pressing the backlight key will turn the display backlight on to allow easier viewing in dark environments. To conserve the batteries, the backlight will turn automatically off after the time that is set in the System\Backlight menu (factory default 5 seconds).

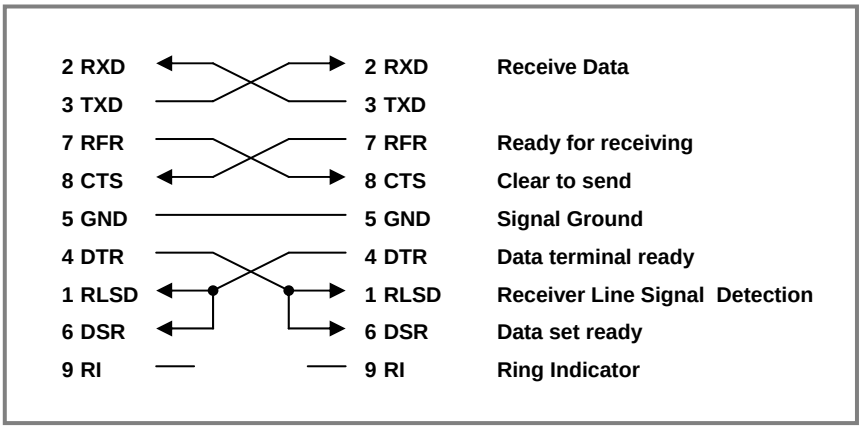
3.4.11.3 Processor Reset

The PM100 uses a sophisticated microprocessor with non-volatile memory to store system values when the unit is powered off. Under normal conditions, it should not be necessary to reset the system. However, if the system locks up and does not respond to any key presses, it may be necessary to reset the unit by pressing the reset key in the bottom plate of the console. The same result can be achieved by removing and reinserting the battery pack (when charger is not connected).

4 Computer Interface

4.1 Connecting a Computer

This device provides an interface which is similar to the IEEE1174 “Serial Interface for Programmable Instrumentation” standard which provides a way to emulate the common IEEE488 interface over a serial link using SCPI-style commands. Refer to the SCPI specification for further information.
The device is considered to be a Data Terminal Equipment (DTE). To connect it with a control PC use the 9-pole null-modem cable that is provided with the optical power meter system. Plug one end to the DB9 socket in the bottom plate of the PM100, the other end to a free COM port of the PC.
The serial null mode cable wiring is shown in the following table; the numbers indicate the pins of the DB9 connectors.



Set up your control PC to meet the following communication setup:

Line setup:	**2400 .. 115200-8N1-RFR/CTS**
	(8 data bits, 1 stop bit, no parity)
Program message end character:	**<LF>**
	(Line Feed, $0A_{hex}$)
Response message end characters:	**<CR><LF>**
	(Carriage Return, $0D_{hex;}$ Line Feed, $0A_{hex}$)

The CD Rom delivered with the instrument contains drivers and applications for the PM100. Please refer also to our website www.thorlabs.com for the latest software version.

4.2 Data Format

4.2.1 Program Data Elements

The controlling PC uses Program Data Elements to send information to the device. Program Data Elements are defined by IEEE488.2-1992. The device accepts the following elements:

<CHARACTER PROGRAM DATA>
A <CHARACTER PROGRAM DATA> element is used to convey parameter information best expressed mnemonically as a short alpha or alphanumeric string. Characters used within this element are not case sensitive.
Examples: `ON` , `Off` , `ENABLE` , `Disable`

<DECIMAL NUMERIC PROGRAM DATA>
A <DECIMAL NUMERIC PROGRAM DATA> element is used to send numeric values to the device. Characters used within this element are not case sensitive.
Examples: `5` , `-23.5` , `123E-3` , `+0.123`

<NONDECIMAL NUMERIC PROGRAM DATA>
A <NONDECIMAL NUMERIC PROGRAM DATA> element is used to send numeric integer values to the device. Characters used within this element are not case sensitive.
Examples: `#H1E` , #036 , `#B11110` (hexadecimal, octal, binary representation of 30)

<STRING PROGRAM DATA>
A <STRING PROGRAM DATA> element allows any character in the ASCII code to be transmitted as a message.
Examples: `Hello` , `"Good luck"` , `'How are you?'`

4.2.2 Response Data Elements

The device responds with Response Data Elements. These elements typically contain measurement results, settings, or status information. Response Data Elements are defined by IEEE488.2-1992. The device uses the following elements:

<CHARACTER RESPONSE DATA>

The <CHARACTER RESPONSE DATA> element is used to convey parameter information best expressed mnemonically as a short alpha or alphanumeric string.
Examples: ON , OFF , ENABLE , DISABLE

<NR1 NUMERIC RESPONSE DATA>

A <NR1 NUMERIC RESPONSE DATA> element is used to transmit whole-numbered value.
Examples: 5 , -23

<NR2 NUMERIC RESPONSE DATA>

A <NR2 NUMERIC RESPONSE DATA> element is the representation of an explicit point numeric value.
Examples: 5.0 , -23.1

<NR3 NUMERIC RESPONSE DATA>

A <NR3 NUMERIC RESPONSE DATA> element is the representation of a scaled radix point numeric value together with an exponent notation.
Examples: 5.0E+03 , -23.1E-06

<HEXADECIMAL NUMERIC PROGRAM DATA>

A <HEXADECIMAL NUMERIC PROGRAM DATA> element is used to represent implicit radix, base 16 numeric information.
Examples: #H1E

<STRING PROGRAM DATA>

A <STRING PROGRAM DATA> element allows any character in the ASCII code to be transmitted as a message.
Examples: Hello , ”Good luck” , ’How are you?’

4.3 IEEE Emulation Codes

The following list shows all emulation codes supported by the device. Other emulation codes defined by IEEE1174 are not supported.

Emulation code	Direction	Description
&SRQ<CR><LF>	Device ► Controller	Informs the controller that the device requires service.
&POL	Controller ► Device	Polls the device's Status Byte.
&ddd<CR><LF>	Device ► Controller	Response to '&POL'. 'ddd' is the 3 digit decimal value of the device's Status Byte.

The Service Request (SRQ) function is used by the device to alert the controller that it requires service. The SRQ function uses the following sequence:

1. The device sends **'&SRQ<CR><LF>'** to the controller showing that it requires service.
2. The controller has to respond with **'&POL'** to query the device's Status Byte.
3. The device then responds by sending **'&ddd<CR><LF>'** where 'ddd' is the 3 digit decimal value of the Status Byte.

4.4 Commands

The device supports the IEEE488.2 Message Exchange Control (MEC) protocol. It does not send data until it is asked for (this does not apply to the emulation codes). White-space characters (ASCII codes 0 – 9, $0B_{hex}$ – 20_{hex}) are ignored on reception. To terminate a program message (Controller ► Device) the '<LF>' character (Line Feed, $0A_{hex}$) is used. It is possible to put more than one command into a program message using the ';' character (semicolon, $3B_{hex}$) as a separator. The character sequence '<CR><LF>' (Carriage Return, $0D_{hex}$ Line Feed, $0A_{hex}$) is used as the response message (Device ► Controller) terminator.

4.4.1 Common IEEE488.2 Commands

4.4.1.1 Common Command Overview

Command	Description
***IDN?**	Identification query. (IEEE488.2-1992-§10.14)
***TST?**	Self test 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 Common Command Description

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)

Selftest Query

Command syntax:	***TST?**
Response syntax:	**<NR1 NUMERIC RESPONSE DATA>**
Description:	Self test query (see also IEEE488.2-1992-§10.38). There is no self test functionality implemented in this device. Therefore this query always returns `'0'` which means success.

Operation Complete Command

Command syntax:	***OPC**
Response syntax:	None
Description:	Sets the `'OPC'` bit in the 'Standard Event Status Register' (see also IEEE488.2-1992-§10.18).

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).

Wait Command

Command syntax:	***WAI**
Response syntax:	None
Description:	This command is required for IEEE488 compatibility and has no effect. (see also IEEE488.2-1992-§10.39).

Reset Command

Command syntax: ***RST**

Response syntax: None

Description: This command resets the device into a known state. It recalls values from memory location #1 and enables the scrambler unit. This is similar to the local operation mode (see also IEEE488.2-1992-§10.32).

Service Request Enable Command

Command syntax: ***SRE <NR1>**

Response syntax: None

Description: Sets the device's Service Request Enable Register (see also IEEE488.2-1992-§10.34 and Chapter 'Status Reporting').

Service Request Enable Query

Command syntax: ***SRE?**

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').

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').

Standard Event Status Enable Command

Command syntax: ***ESE <NR1>**

Response syntax: None

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

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').

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').

Clear Status Command

Command syntax: ***CLS**

Response syntax: None

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

- Standard Event Status Register
- Device Error Event Register and Device Error Event Enable Register
- Device State Event Register and Device State Event Enable Register

4.4.2 Device Specific Commands

4.4.2.1 Device Specific Command Overview

Command	Description
:POWER?	Query the last measured power value [Watt].
:HEAD:INFO?	Query information from the currently used optical head. (S/N, ID-Text, short description, Maximum Power)
:WAVELENGTH?	Query the currently used correction wavelength [meter].
:WAVELENGTH	Set the wavelength [meter] to use for calculating the sensitivity
:WAVELENGTH:RANGE?	Query the minimum and the maximum settable wavelength [meter] for the currently used optical head.
:FILTER?	Query the current setting for the instruments power supply rejection
:FILTER	Set the instruments power supply rejection (50Hz or 60Hz)
:PHOTOCURRENT?	Query the last measured value of the photo diode head current; works only with photodiode sensors
:PHOTOVOLTAGE?	Query the last measured value of the thermal power head voltage; works only with thermal sensors
:DARKCURRENT?	Query the currently set dark current (photodiode sensors only)
:DARKCURRENT	Set the dark current (photodiode sensors only)
:DARKVOLTAGE?	Query the currently set dark voltage (thermal sensors only)
:DARKVOLTAGE	Set the dark voltage (thermal sensors only)
:ATTENUATION?	Query the currently set attenuation correction (this is an additional attenuation set by the user to e.g. compensate for additional filters)
:ATTENUATION	Set the attenuation correction (this is an additional attenuation the user can set to compensate for e.g. additional filters)

4.4.2.2 Device Specific Command Description

Power Query

Command syntax:	**:POWER?**
Response syntax:	last measured power **<NR3 NUMERIC RESPONSE DATA>**
Description:	Queries the last measured power value [Watt].

Optical Head Information Query

Command syntax:	**:HEAD:INFO?**
Response syntax:	head's serial number **<ARBITRARY ASCII RESPONSE DATA>** head name **<ARBITRARY ASCII RESPONSE DATA>,** head description **<ARBITRARY ASCII RESPONSE DATA>,** maximum power **<NR3 NUMERIC RESPONSE DATA>**
Description:	Queries information from the connected optical head. This information is stored in the head's EEPROM.

Set Wavelength Command

Command syntax:	**:WAVELENGTH?**
Response syntax:	currently used wavelength **<NR3 NUMERIC RESPONSE DATA>**
Description:	Queries the currently used wavelength [meter]. The wavelength used for calculating the photodiode sensor's sensitivity.

Wavelength Query

Command syntax:	**:WAVELENGTH <DECIMAL NUMERIC PROGRAM DATA>**
Response syntax:	None
Description:	Set the wavelength [meter] to use for calculating the sensitivity

Wavelength Range Query

Command syntax:	**:WAVELENGTH:RANGE?**
Response syntax:	minimum settable wavelength **<NR3 NUMERIC RESPONSE DATA>** maximum settable wavelength **<NR3 NUMERIC RESPONSE**

DATA>

Description: Queries the minimum and the maximum settable wavelength [meter] for the currently used optical head

Line Frequency Rejection Filter Query

Command syntax: **:FILTER?**

Response syntax: **50HZ|60HZ**

Description: Queries the current setting for the instrument's power supply rejection frequency

Set Line Frequency Rejection Filter Command

Command syntax: **:FILTER 50HZ|60HZ**

Response syntax: None

Description: Sets the instrument's power supply rejection frequency (50Hz or 60Hz)

Photo Current Query

Command syntax: **:PHOTOCURRENT?**

Response syntax: photo diode current **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the last measured value for the photo diode current [amperes]; works with photodiode sensors only

Photo Voltage Query

Command syntax: **:PHOTOVOLTAGE?**

Response syntax: thermal sensor voltage **<NR3 NUMERIC RESPONSE DATA>**

Description: Queries the last measured value for the thermal head sensor voltage [volts]
works with thermal head sensors only

Dark Current Query

Command syntax: **:DARKCURRENT?**

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

Description: Queries the set value for the photo diode dark current value [amperes]; works with Si/Ge sensors only

Set the Dark Current

Command syntax:	**:DARKCURRENT <DECIMAL NUMERIC PROGRAM DATA>**
Response syntax:	None
Description:	Sets the value for the photo diode dark current value. This current is substracted from the sensors measured current before any further calculations (of power) will be performed works with photodiode sensors only

Dark Voltage Query

Command syntax:	**:DARKVOLTAGE?**
Response syntax:	dark voltage **<NR3 NUMERIC RESPONSE DATA>**
Description:	Queries the set value for the thermal head sensor dark voltage value works with thermal head sensors only

Set the Dark Voltage

Command syntax:	**:DARKVOLTAGE <DECIMAL NUMERIC PROGRAM DATA>**
Response syntax:	None
Description:	Sets the value for the thermal head sensor dark voltage value. This current is subtracted from the sensors measured voltage before any further calculations (of power) will be performed works with thermal head sensors only

Attenuation Correction Query

Command syntax:	**:ATTENUATION?**
Response syntax:	attenuation **<NR3 NUMERIC RESPONSE DATA>**
Description:	Queries the set (by the user) value for attenuation.[dB] This is to compensate for additional attenuation caused by e.g. filter glass.

Set Attenuation Correction

Command syntax:	**:ATTENUATION <DECIMAL NUMERIC PROGRAM DATA>**
Response syntax:	None
Description:	Sets the value for the attenuation [dB] a user can set to

compensate for additional attenuation caused by e.g. filter glass

4.4.3 Status Reporting

The device uses a status reporting structure like it is defined in IEEE488.2-1992-§11. The Status Byte Register gives a summary of all underlying status structures. See also IEEE488.2-1992-§11.2.

Bit #	Mnemonic	Description
7		Reserved
6	**RQS/MSS**	Request Service / Master Summary Status
5	**ESB**	Standard Event Status Bit
4	**MAV**	Message Available. Since IEEE1174 is a full duplex interface this bit is always 0.
3	**OSM**	Optical Sensor Missing
2	**EAV**	Error Available. There is at least one error in the error queue.
1		Reserved
0	**CHC**	Charger Connected

4.4.4 Error Reporting

The device stores errors in a queue containing up to 30 entries. The error queue may be read out by the `':SYST:ERR?'` command. The following table lists all error numbers and the according descriptive messages.

Error	Description	Category
0	No error	-
1	General fault	Device Dependent Error
2	Value out of range	Execution Error
20	Wrong command for used head	Execution Error
100	Input buffer overflow	Command Error
101	Unknown IEEE488 emulation command	Command Error

102	Unknown command	Command Error
110	Wrong number of command parameters	Command Error
111	Erroneous character/string program data	Command Error
112	Unknown character program data	Command Error
113	String program data too long	Command Error
114	Erroneous non-decimal program data	Command Error
115	Erroneous decimal program data	Command Error
200	Authentication required for operation	Execution Error
201	Authentication failed	Execution Error
255	Error queue overflow	-

5 Calibration and Warranty

5.1 Calibration

Thorlabs optical power meters and sensors are precise instruments that are designed to deliver very accurate measurements and provide useful service over a long period of time. For maintaining this high level of performance, *Thorlabs* recommends to have the measurement system serviced and recalibrated once a year.
Thorlabs will service and recalibrate the power meter and sensor head for a nominal fee. Please contact Thorlabs customer service to make the appropriate arrangements.

5.2 Warranty

Thorlabs warrants material and production of the PM1xx power meter system 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* 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 faulty 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 conditions 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 at any time.

6 Service and maintenance

☝ Attention ☝

Do not try to open the power supply! Dangerous or even lethal voltages inside.

6.1 General Care

Protect the PM100 from adverse weather conditions. The PM100 is not water resistant.

☝ Attention ☝

To avoid damage to the PM100, do not expose it to spray, liquids or solvents!

6.2 Cleaning

To clean the console, use a mild detergent and damp cloth. Do not soak the unit in water or use solvent base cleaners.

When cleaning the aperture filter on the semiconductor sensor heads, treat it as any other fine optic. Gently blow off any debris using compressed air and wipe gently with an optic tissue wetted with propanol.

The sensors on the thermal heads cannot be cleaned. Gently blow off any debris using compressed air. If any scratches or other signs of damage remain on the sensor area, contact Thorlabs service department for repair or replacement.

6.3 Line Voltage

The power supply of the PM100 operates at line voltages of 100 V … 240 V ± 10% and line frequencies of 50 and 60Hz. Prior to starting operation check that your local supply agrees with this line voltage range.

6.4 Repair

The power meter system does not contain any components to be repaired by the user. If any disturbances in function should occur, please contact *Thorlabs* prior to sending the respective unit to *Thorlabs* for repair.

7 Listings

7.1 Default Settings

The PM100 measurement system comes with the following factory settings:

Setting	**Default**
Autorange	Enabled
Analog Output	0.1V/mW
Display Refresh Rate	3/s
Shutdown	10 minutes
Backlight	5 seconds
Contrast	72%
Line Filter	50Hz
Wavelength Correction	Silicon Sensors: 1: 635nm; 2: 670nm; 3: 780nm; 4: 830nm; 5: 980nm Germanium Sensors: 1: 780nm; 2: 830nm; 3; 980nm; 4: 1310nm; 5: 1550nm
User Calibration	0.00 dB
Dark Current Adj. / Zeroing	0 A; 0 V
Baudrate	115200 Baud

7.2 List of figures

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7.3 Certifications and Compliances

Category	Standards or description	
EC Declaration of Conformity - EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance to the following specifications as listed in the Official Journal of the European Communities is given:	
	EN 61326	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A Radiated and Conducted Emissions and Immunity.[1,2]
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion C) [1]
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance criterion A) [1]
	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity (Performance criterion C) [1]
		[1] For full compliance with these standards this unit must be operated in a grounded and shielded housing. The power supply must be propperly filtered!
		[2] Emissions which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

7.4 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 fig. 1)
- 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.

7.4.1 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.

7.4.2 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.

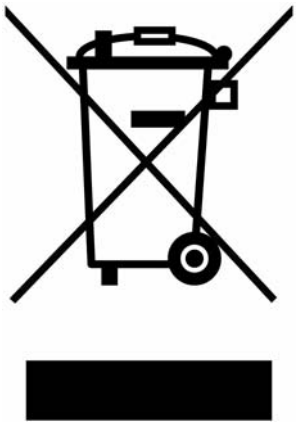


Figure 11 Crossed out “wheelie bin” symbol

7.5 Addresses

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



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