THORLABS

Optical Power and Energy Meter

PM200
Operation Manual

2018

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Contents

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 improve 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 GmbH

WARNING

Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully, before performing the indicated procedure.

ATTENTION

Paragraphs preceeded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.

NOTE

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

Please read these advices carefully!

1 General Information

The PM200 Handheld Optical Power and Energy Meter is designed to measure the optical power of laser light or other monochromatic or near monochromatic light sources and the energy of pulsed light sources.

The space-saving, battery powered design and compatibility to all Thorlabs "C-Series" Photodiode, Thermal, Pyroelectric sensors, and custom Photodiode, Thermal and Pyroelectric detectors, combined with a fast USB device interface open a wide range of applications in Manufacturing, Quality Control, Quality Assurance, and R&D for stationary and field use.

The provided software, including drivers and applications for LabVIEW and C makes it easy to integrate the instrument in test and measurement systems.

The PM200 can be operated through its auto-detecting position sensor and the rotatable kick-stand in both a bench-top style landscape view and a hand-held style portrait view.

Please refer to the user manual on the data carrier supplied with the unit for detailed function description.

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 as it was designed for.
The power meter PM200 must not be operated in explosion endangered environments!

All modules, sensors and externally connected devices must only be operated with properly 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 remove covers!

This precision device is only serviceable if properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for a replacement package.

1.2   Ordering Codes and Accessories

Order Code	Description
PM200	Handheld Power/Energy Meter Console

Photodiode Power Sensors:

Order Code	Type	Detector	Aperture mm	Wavelength nm	Power W
S120C	Compact Sensor	Si	⌀ 9.5	400 - 1100	50n - 50m
S120VC	Compact Sensor	UV-Si	⌀ 9.5	200 - 1100	50n - 50m
S121C	Compact Sensor	Si	⌀ 9.5	400 - 1100	500n - 500m
S122C	Compact Sensor	Ge	⌀ 9.5	700 - 1800	50n - 40m
S130C	Slim Sensor Dual Range	Si	⌀ 9.5	400 - 1100	5n - 5m 500n - 500m
S130VC	Slim Sensor Dual Range	UV-Si	⌀ 9.5	200 - 1100	5n - 5m 50n - 50m
S132C	Slim Sensor Dual Range	Ge	⌀ 9.5	700 - 1800 1200 - 1800	5n - 5m 500n - 500m
S140C	Integr. Sphere (1")	Si	⌀ 5.0	350 - 1100	1μ - 500m
S144C	Integr. Sphere (1")	InGaAs	⌀ 5.0	800 - 1700	1μ - 500m
S142C	Integr. Sphere (2")	Si	⌀ 12	350 - 1100	10μ - 20
S145C	Integr. Sphere (2")	InGaAs	⌀ 12	800 - 1700	1μ - 3
S145C	Integr. Sphere (2")	InGaAs	⌀ 12	800 - 1700	10μ - 20
S150C	Fiber Head	Si	3.6 x 3.6	350 - 1100	100p - 5m
S151C	Fiber Head	Si	3.6 x 3.6	400 - 1100	1n - 20m
S154C	Fiber Head	InGaAs	⌀ 2.0	700 - 1700	100p - 5m
S155C	Fiber Head	InGaAs	⌀ 2.0	700 - 1700	1n – 20m

Thermal Power Sensors:

Order Code	Type	Aperture mm	Wavelength nm	Power W
S302C	Thermally Stabilized Thermal Absorber	⌀ 12	190 - 25000	100μ - 2
S310C	Thermal Surface Absorber	⌀ 20	190 - 25000	10m - 10
S314C	Thermal Surface Absorber	⌀ 25	190 - 10600	10m - 60
S322C	Thermal Surface Absorber	⌀ 25	190 - 10600	100m - 250
S350C	Thermal Surface Absorber Excimer Coating	⌀ 40	190 - 1100 and 10600	10m - 60
S370C	Thermal Volume Absorber for high peak power lasers	⌀ 25	400 - 5200	10m - 15

Pyroelectric Energy Sensors:

Order Code	Type	Aperture mm	Wavelength nm	Energy J
ES111C	Pyroelectric Sensor with broadband coating	⌀ 11	185 - 25000	10μ - 150m
ES120C	Pyroelectric Sensor with broadband coating	⌀ 20	185 - 25000	100μ - 500m
ES145C	Pyroelectric Sensor with broadband coating	⌀ 45	185 - 25000	500μ - 2
ES220C	Pyroelectric Sensor with ceramic coating	⌀ 20	185 - 25000	500μ - 3
ES245C	Pyroelectric Sensor with ceramic coating	⌀ 45	185 - 25000	1m -15

Please visit our homepage http://www.thorlabs.com for various accessories like fiber adapters, posts and post holders, data sheets and further information.

1.3   Requirements

1.3.1 Hardware Requirements

- CPU: 1 GHz or higher

- RAM: 256 MB

- Graphic card with at least 32 MB memory

- Hard disc with at least 100 MB free storage space
- free USB2.0 port

- USB cable according the USB 2.0 specification

1.3.2 Software Requirements

Operating System:

- Windows ® XP (32-bit) SP3

- Windows ® Vista (32-bit, 64-bit)

- Windows ® 7 (32-bit, 64-bit)

- VISA runtime (version 5.0.3 or higher)

1.3.3 Interface Requirements

A free USB2.0 port is required.

2 Installation

2.1 Parts List

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 PM200 mechanically and electrically.

Verify that you have received the following items within the package:

1. PM200 power/energy meter console
2. Desktop power supply (5 VDC / 2.4 A)
3. Power cord according to local power supply
4. USB cable (USB Type A Connector to Mini USB Connector)
5. Cable 3.5 mm Audio Connector to Flying Leads for analog output
6. Adapter for the auxiliary connector in the top panel
7. USB memory stick (Flash Drive 1 GB) with instrument drivers, user application and operation manual
8. Quick Reference
9. Certificate of Calibration

Optional Accessories

- Environmental Measurement Module (Displays Temperature and Relative Humidity)

- Fiber Inspection Camera Module (Monochrome Fiber Inspection Camera with Power Measurement Capability)

2.2   Operating Elements

Front Panel

1.   LED indicators for „Standby" mode and „Charging"
2.   Touch-pen
3.   Touch-screen display
4.   Removable protective silicone rubber boot
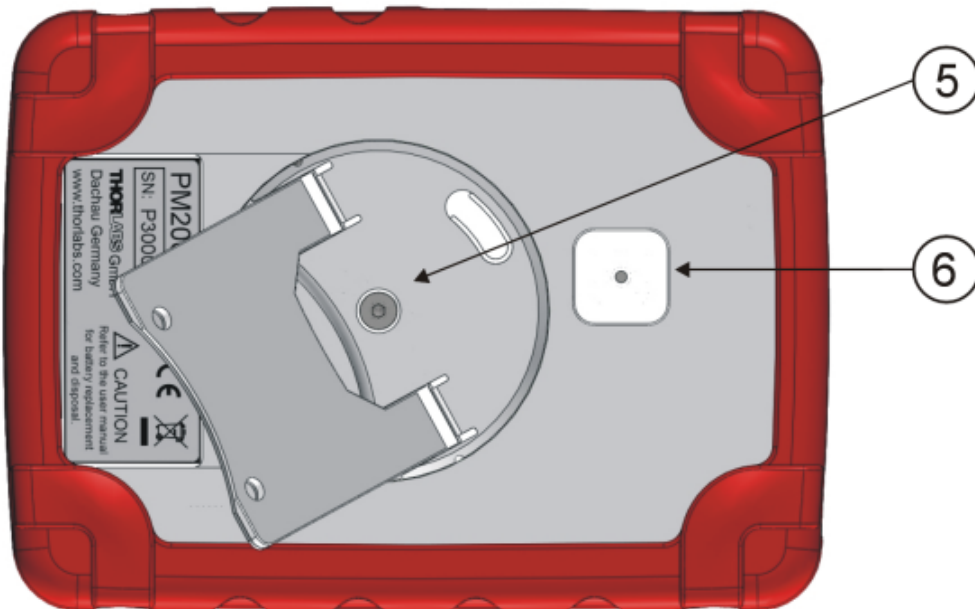
Rear Panel

5.   Four position rotatable and two flap position adjustable stand
6.   Adaptor for optional fiber inspection camera

Side View

7. ON/OFF button
8. DC Input (DC 5V/2A)
9. USB host (for flash drive and fiber inspection camera)
10. Analog Output (0...2V DC)
11. Optical head input

Top View

12. Auxiliary In/Output (ext. Trigger, 4 x GPIO, 2 x ADC)
13. USB Device (PC remote operation)
14. Ambient Light Sensor

2.3 Getting Started

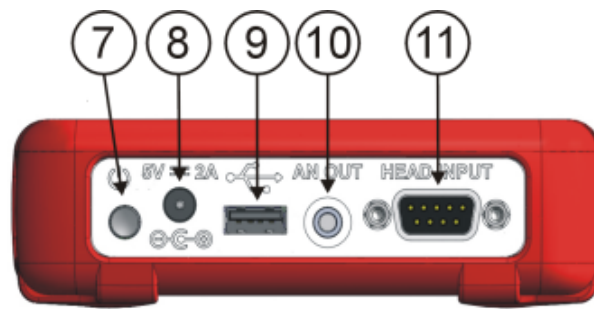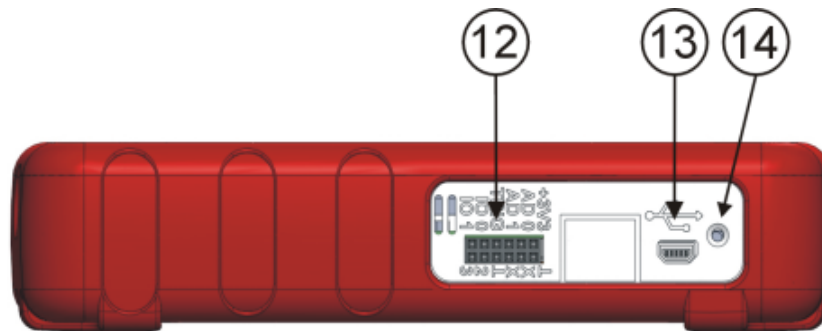For first use, plug in the power supply and allow 4 hours charging the battery. During the charging process the right LED indicator lights up, even when the unit is turned off.

Connect a suitable Thorlabs "C-series" power or energy sensor. The sensors have a self-fixing mechanism. To plug or unplug a sensor slightly press from both sides on the pins in the connector housing. Sensors can be 'hot-swapped' to the console, after recognizing a new valid sensor the type and calibration data will be downloaded to the console in a few seconds and the unit is ready to operate with the new sensor.

Turn on the unit by pressing the power button in the side panel.

After switching on the unit, the touch screen display will come up with a boot screen for about 30 seconds and then jump to the last measurement screen before power down.

3   Operating Instruction

The PM200 supports all Thorlabs 'C-Series' photodiode, thermal and pyroelectric sensors. These can easily identified against older versions of Thorlabs power or energy sensors by their red connector housing. The console will not recognize sensors from the 'A' and 'B' series. Please contact Thorlabs for upgrading of old sensors with 'C-Series' connectors.

To plug or remove a sensor slightly press the two bolts in the connector housing. Sensors can be 'hot-swapped' to the console, after recognizing a new valid sensor the type and download of the calibration data, the console is ready to operate with the new sensor.

The PM200 also supports custom detectors, please refer to chapter Photodiode Sensors[28], Thermal Sensors[31] or Pyroelectric Sensors[33] and to the connector pin-out[68].

From the main menu all functions can be reached by clicking to the appropriate icon:
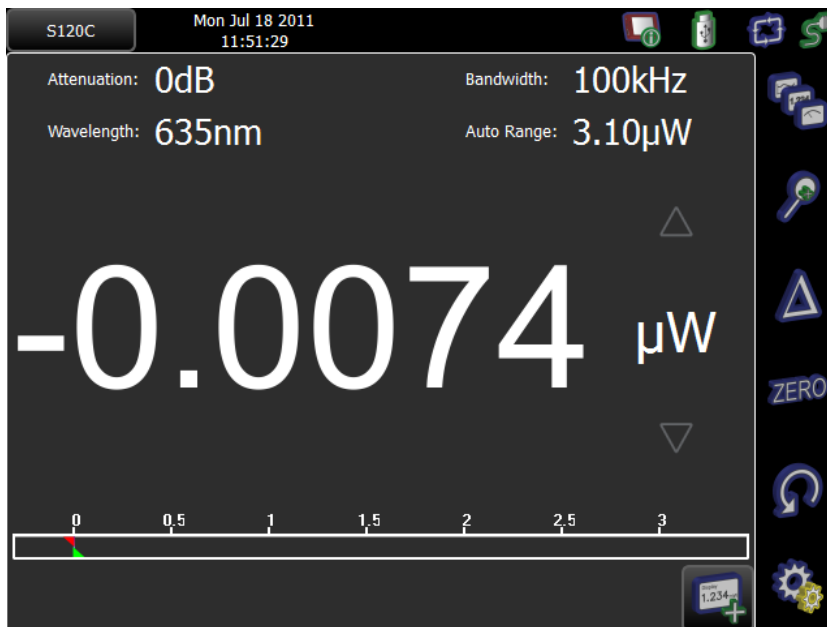
Icon	Description
	Console Info (Type and serial number)
	Opens external USB memory (File manager[23])
	Battery status[27]
	Measurement Views[16]
	Zooms In the actual display
	Delta[24] measurement mode
	Zeroing[24] the sensor
	Resets min / max[25] labels
	Settings[26] panel

3.1 Attenuation Correction

The attenuation menu can be used to apply an additional, external related correction factor to the power or energy reading (e.g. filter). The handling is similar to the wavelength correction, it is possible to create a list with dedicated attenuation items in dB or loading complete spectral transmission curves in comma separated format.

Note

Attenuation must be entered always as a positive value, e.g., (+)10dB. The software allows to enter negative values as well,but this would be equivalent to an amplification.

Note

If the attenuation curve e.g. of a filter is loaded and selected, it can be easily displayed in the 'Sensor' panel. Comparing the graphics in tab 'curve' with the tab 'eff. curve', the superposition of the sensor's response curve and the filter curve can be seen.

3.2 Wavelength Correction

The PM200 allows the creating and administering of a nearly unlimited number of user wavelengths and spectral curves of light sources that will be used for calculating the spectrally corrected power or energy value.

By clicking to the wavelength value, a drop down list appears with saved wavelength value. The menu item ("**Edit...**") opens the editor panel. The editor panel instantly appears when clicking to the **Wavelength** button:
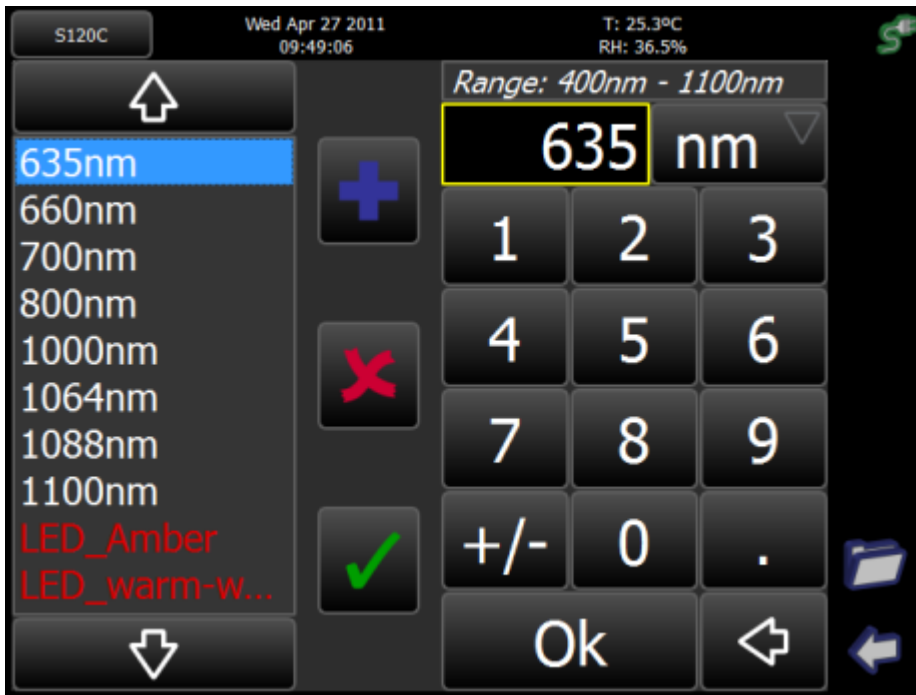
Wavelength Editor Panel

Left side of the panel

User created wavelength list with scroll arrows. Depending on the connected sensor the list items appear in standard color for a valid value or in red for a value that is out of the sensor wavelength range. The selected wavelength will show in the "edit window".

Right side of the panel

- Wavelength range of the connected sensor.
- Edit Window with selectable units
- Numeric input field.

Icons

✚	Add item to the list
✖	Delete item from the list
✓	Overwrite item in the list with new value
🗁	Load spectral curve
⬅	Quit editor

A specialty of the PM200 is the possibility to load spectral curves of broadband light sources. These files must be in comma separated format (.csv), can be loaded from the USB drive and will be stored in the user space of the local drive.

3.3 Bandwidth

Depending on the sensor type, the measurement bandwidth can be selected. This can be useful to lower the impact of sensor noise to the measurement result, particularly at low power levels.

3.4 Range Control

Up to 6 current measurement ranges (corresponding to power measurement using photo diode sensors) and 4 voltage measurement ranges (for power measurement using thermal sensors or energy measurement using pyroelectric sensors) can be chosen manually with the △ or ▽ buttons near the measurement unit

or by opening a list box when clicking on the measurement range value.

For power measurements an auto-ranging function is available that can be activated by clicking on the **Range** label (toggle function) or via the list box, which appears when clicking on measurement range value.

3.5   Measurement Views

This menu can be reached via the 📇 button.

The different measurement views can be easily selected after pressing the "views" 📇 button. For most applications the "numeric[16]" and the "needle[20]" view will be the best choice for an excellent visible and quickly configurable power or energy readout. The interactive touch areas allow fast access to all settings and the drag and drop box gives up to 6 useful, free configurable extra displays.

From this panel, also graph and statistics measurement panels[20] can be selected. Additionally, the File Manager[23] and the Calculator[22] can be started.

3.5.1 Numeric View
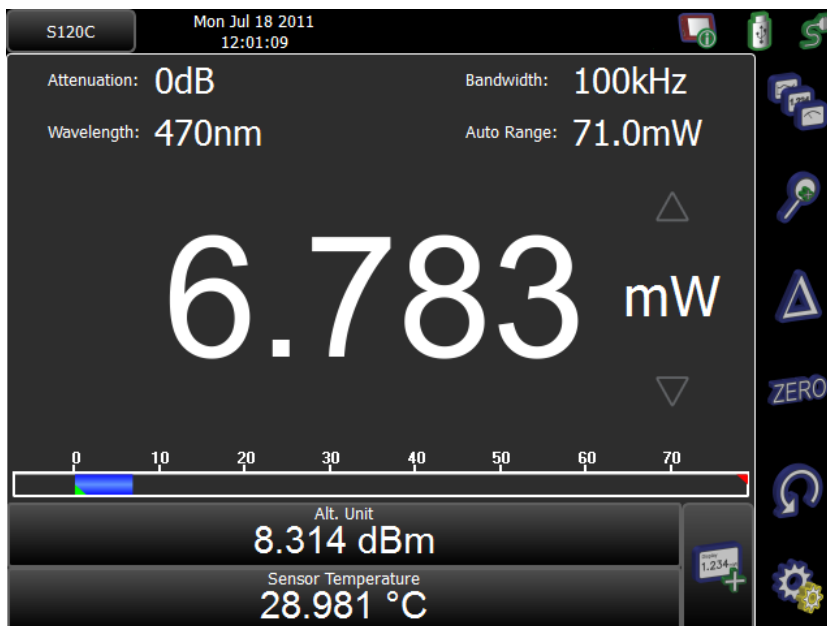
The upper part of the display important measurement settings are displayed. These settings can be changed either in the Measurement settings menu 26 or directly by clicking to the appropriate item.

In the bottom of the display, additional parameters can be displayed (see Subpanels 17)

Precision of the Readout Value
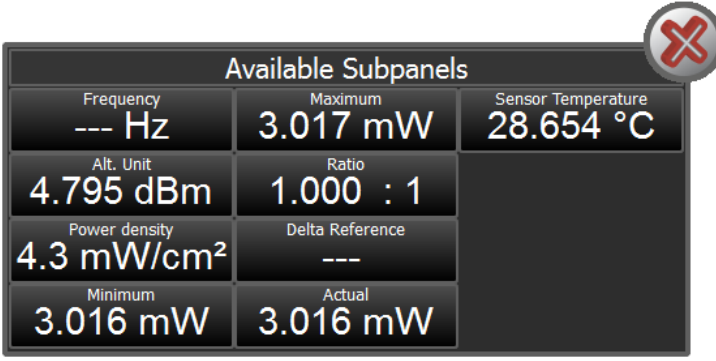
The precision of the power or energy readout can simply be changed by clicking on the power or energy value in the numeric or needle screen. The reading will toggle between 3, 4 or 5 significant digits.

Units of Measure

The units of measure can be selected by clicking on the measurement unit in the numeric or needle display. A list box will open and offer sensor depending choices of the selectable measurement unit in W, dBm, J, A or V.

3.5.1.1 Subpanels

In the numeric display it is possible to configure supplementary displays. Click to the [icon] , a choice of available, depending on the connected sensor, subpanels will appear (below shown for a S120C sensor):

Up to 6 subpanels can be enabled by drag and drop to the measurement screen. To remove items, the container needs not to be opened, just pick the item and drag it back to the container.

Frequency

The PM200 can measure and display frequencies of pulsed, modulated or chopped light sources up to 100kHz. The maximum measurable frequency is depending on the sensor type and instrument settings. The measured frequency is displayed in a subpanel.

Alternative Unit

Depending on the sensor type, alternative measurement units are available and can be selected in both the numeric and needle view panels by clicking to the appropriate unit.

Photodiode sensors - they deliver a current, proportional to the incident power, but also wavelength dependent:

- W (nW, µW, mW)
- A (nA, µA, mA)
- dBm (1mW = 0 dBm)

Thermal sensors - they deliver a voltage proportional to the incident power:

- W (nW, µW, mW)
- V (mV)
- dBm (1mW = 0 dBm)

Pyroelectric sensors - they deliver a voltage peak, proportional to the incident pulse energy:

- J (mJ)
- V (mV)

Power / Energy Density

The calculation is based on the beam parameters, entered in Measurement Settings panel (and in the next panel):
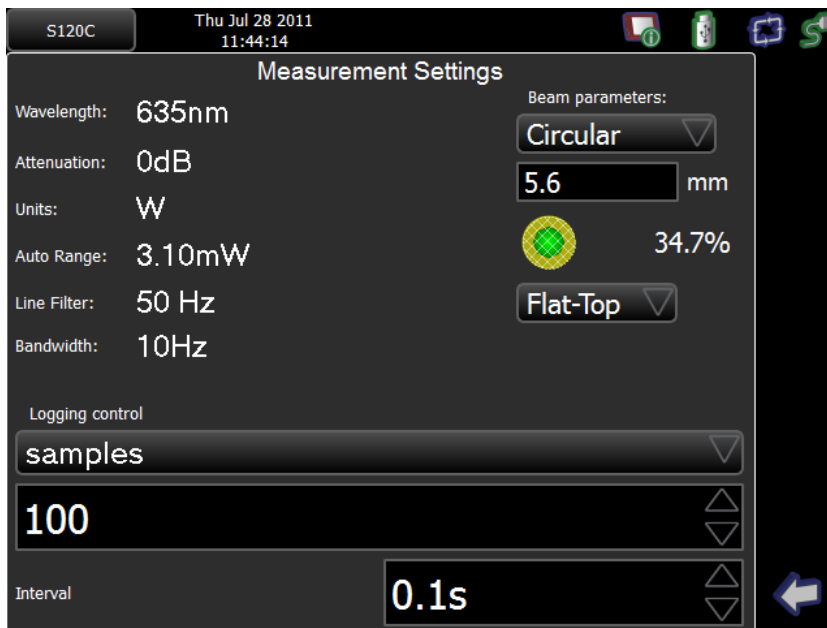
Beam shapes can be selected from a drop-down menu:
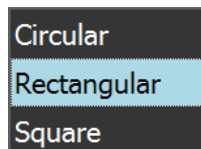
To change the beam dimension, click into the numeric field - an editor comes up:
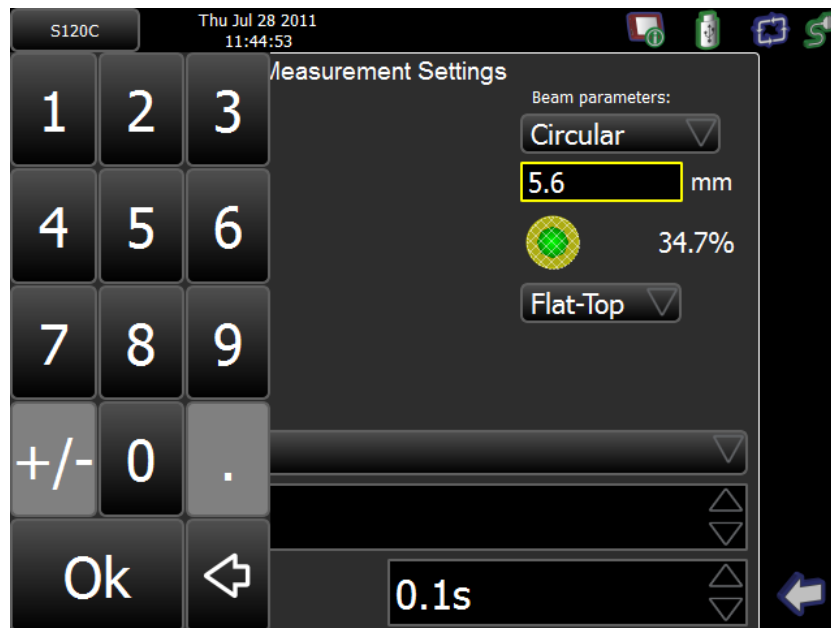
Also, beside the default flat top beam profile, where the power is distributed evenly over the beam area, 2 more typical cases are also considered:

Gaussian: In case, the beam shape has one significant peak, the power density around the peak is much higher than on the periphery. In order to consider that, the calculated average power density value is doubled.

Hotspot: Some lasers have a beam profile shaped like a donut, or 2 or more significant peaks appear in the profile. The power density in these hot spots is much higher than the average across the entire beam diameter. The calculated average power density value is tripled.

Note

Power density is always displayed in W/cm², energy density in J/cm². Density is measured correctly only if the connected sensor is calibrated. In case a customer made sensor is used, please make sure that the correct calibration coefficient is entered.

Min, Max and Ratio

These subpanels show the minimum, maximum value, and the ratio out of both numerically, in addition to the green and red markers on the power bar:
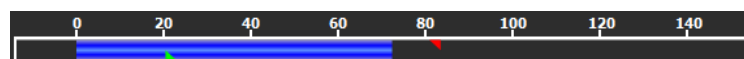
These values will update permanently. The "Reset Min / Max" 🔄 button will reset the displays to zero and restart the measurement sampling.

The ratio value will show "nan" ("No A Number") when a negative reading occurs.

Delta Reference is the reference power value, when the console measures the deviation (Delta measurement)

Actual is the measured value. This display is useful when performing Delta measurements - in this mode the main display shows the deviation from the delta reference value, so in a subpanel the actual power can be displayed.

Sensor temperature: Most of Thorlabs photodiode and thermal sensors are equipped with a NTC Thermistor to control the temperature of the sensor head. To show the sensor temperature, pick the "Sensor Temperature" subpanel and drop it to the main view.

3.5.2 Needle View
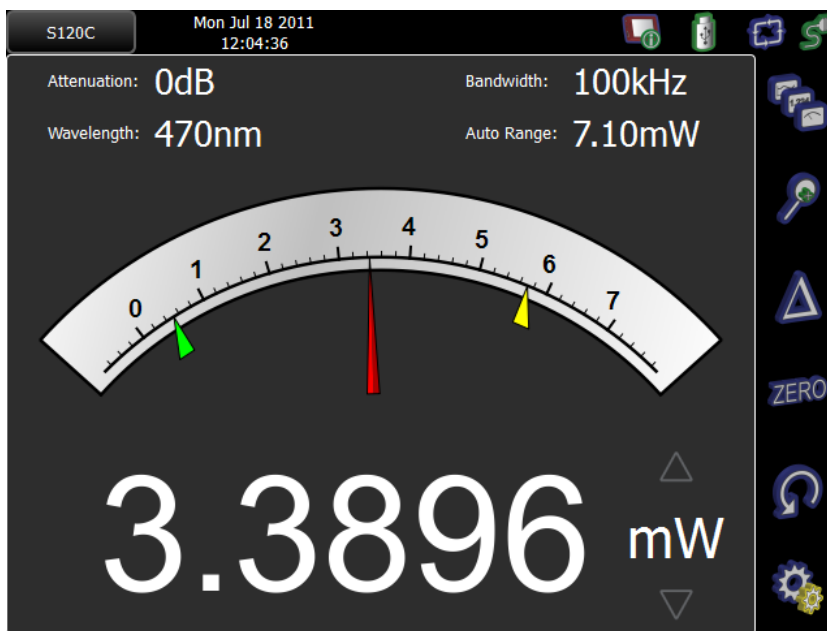
In contrast to the numeric view, the needle view offers additionally a needle gauge with min and max indicators. Subpanels are not available.

3.5.3 Graph and Statistics Display

For recording, visualizing and analyzing the measurement data in Watts or Joules over time, the PM200 features a scope view and a statistics analysis with a histogram view. During the record, the data will be stored to an internal temporary file. After the record is finished or has been stopped, the measurement data can be permanently stored to the internal logging drive or the USB drive. The data format is comma separated (.csv) and contains

- measurement value
- time stamp
- additional settings
- sensor information.

The record stopping criteria can be selected to manually, elapsed time or number ofdetected samples in the measurement settings page, as well as the interval between two records.

Note

Please note that the temporary file will be overwritten after pressing the start button or when pressing the reset button during record. Some buttons and functions will not be accessible during the record is running. During the record it is possible to quickly swap between the Graph and the Statistic View as in the following screen shots.
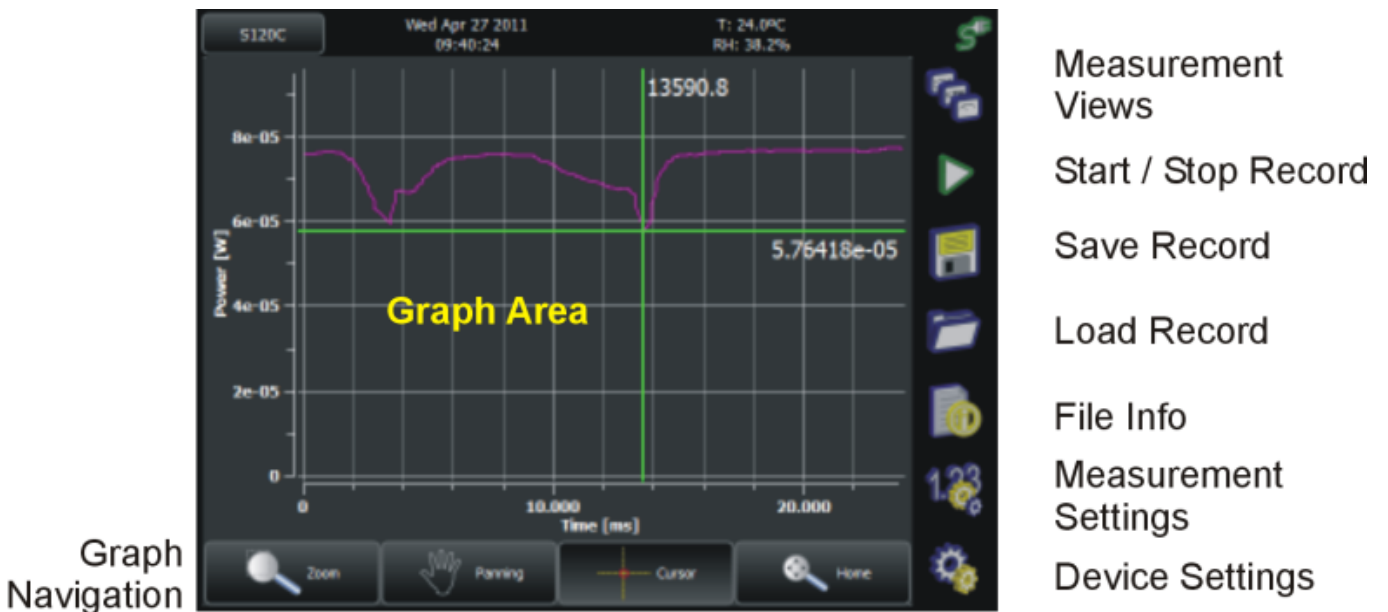
Graph View
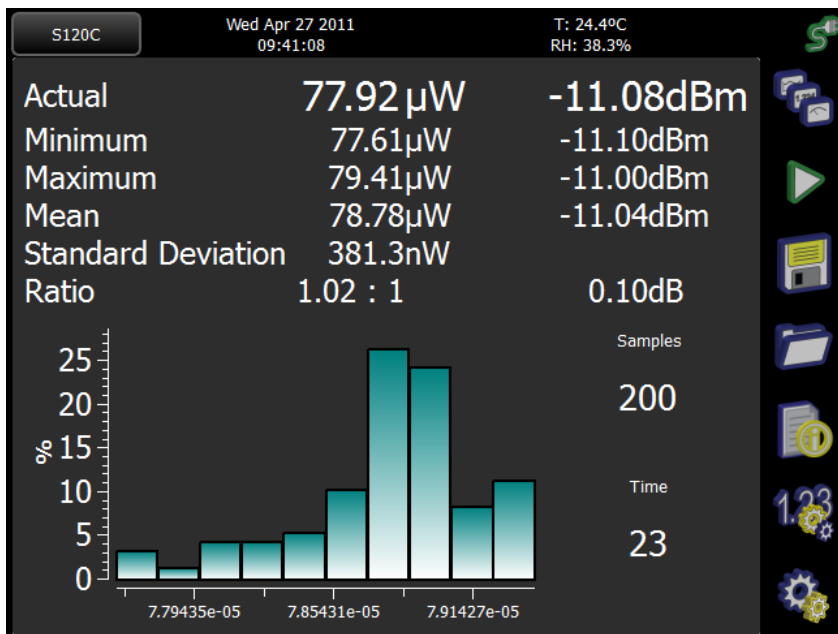
Statictics View

By clicking to the histogram area, the histogram will be displayed in the entire display area.

3.5.4 Calculator

The calculator can be reached via the Measurement views [16] panel. This tool helps to choose a suitable sensor. Enter the laser type, beam shape and dimensions and laser parameters - the calculator derives beam parameters essential for sensor choice and outputs a list of suitable sensor heads. Below are two examples - for CW and pulsed lasers.
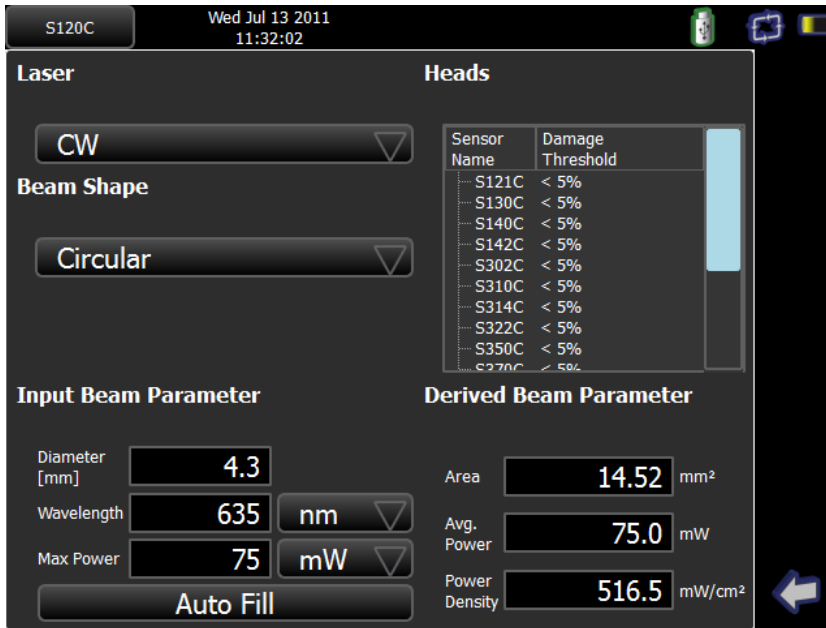
Beam Parameter Calculator for CW Lasers
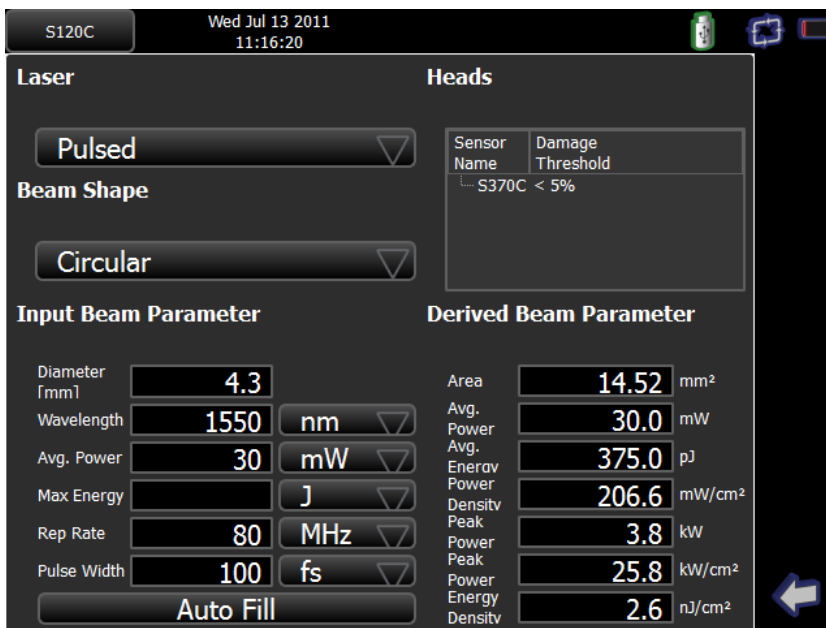
Beam Parameter Calculator for Pulsed Lasers

3.5.5 File Manager

The file manager gives access to the LOCAL system drive, the user space and - if connected - to an external USB flash drive.

The following folders in the local drive are pre-configured and cannot be changed:

- **light-sources**: Tables of spectral curves of broadband light sources that can be loaded to the wavelength list and selected for the wavelength correction of the power or energy readout.

- **logging**: Administer data records.

- **response-curves**: Tables of spectral response curves for custom detectors.

- **temp**: Temporary file for data logging. This folder contains the latest record file.

- **transmissions**: Tables of transmission curves that can be loaded to the atten-uation menu to use for the spectral correction of the power or energy readout.

All files can be copied to and from the USB drive. To remove a custom folder, the folder must be selected (opened). The rename, copy and paste function is only available for files, not for directories.

| Note |

Above default folders cannot be deleted nor renamed.
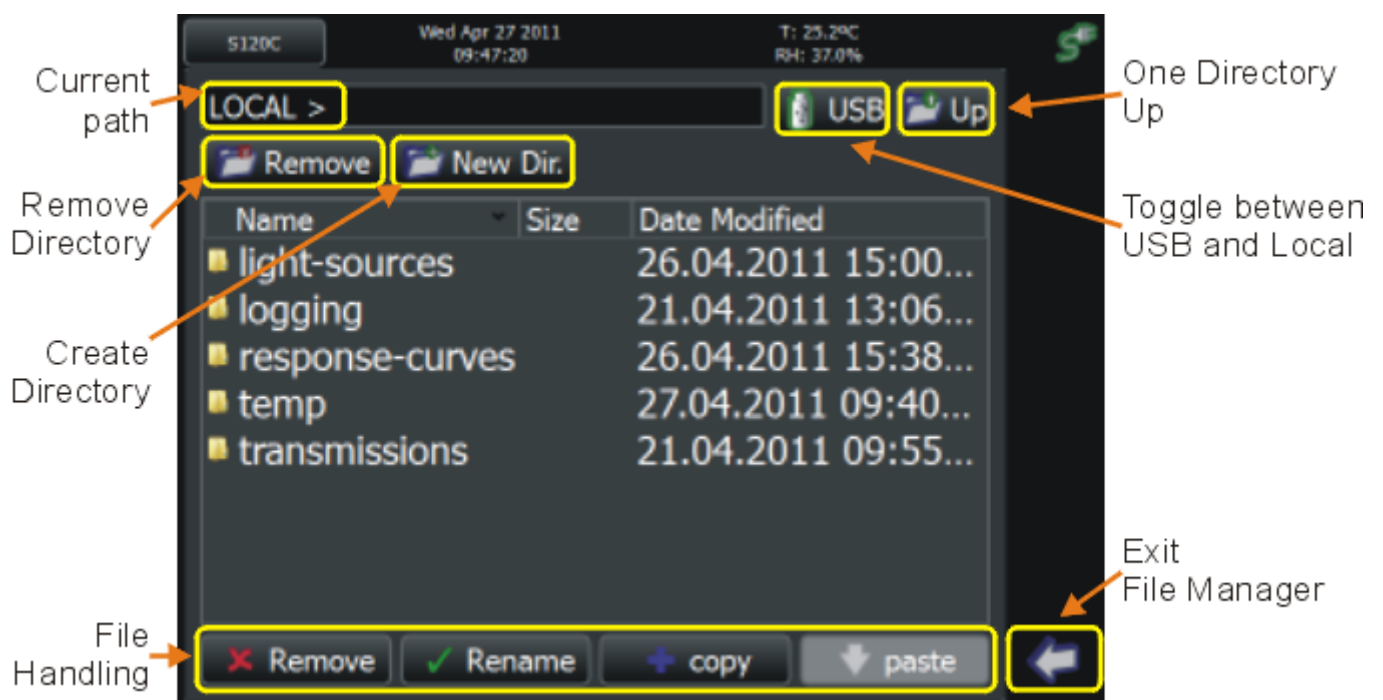
File manager

3.6 Zoom

Zoom: The 🔍 icon enlarges the main screen (if subpanels are active, they are closed), the 🔍 icon returns to the standard view.

3.7 Delta

This feature can be used to observe power drifts, adjust power to a certain level, or quickly subtract ambient light. By pressing the Delta ⚠ button the main readout value will show the difference between the reference value (that is the value in the moment of pressing the delta button) and the actual reading.

In needle view, both the needle scale and the additional numeric readout show the difference.

In numeric view, 2 additional subpanels appear: "Delta Reference" shows the reading in the moment of pressing the Delta button, while in the panel "Actual" the actual absolute reading is displayed. the difference of both is displayed as main readout value.

In case if logarithmic display, the difference will be displayed in dB.

Negative values indicate, that the actual value is less than the reference.

3.8 Zeroing

The zeroing function can be accessed in the numeric or needle view panel. To perform a zero adjustment it is important to properly cover the power sensor with a light-tight shield and after then pressing the "**ZERO**" button. The zero adjustment will fail and show a warning, when the detected zero value is too large for the connected sensor; e.g. when accidentally hitting the zero button under light exposure to the sensor.

Note

Do not hold a sensor in the hand, especially a thermal sensor, when performing a zero adjustment. Temperature effects will influence the quality of the zeroing result!

When measuring very small power levels, the dark current of photodiode sensors or the zero voltage of thermal sensors will have an influence on the measurement result and must be compensated by the zero adjustment. An indicator that a sensor needs to be zeroed is when with covered sensor either a negative power reading or a reading much greater than zero is displayed.

After performing a zero adjustment, the detected zero value will be included in all power readings in Watts or dBm. The basic units (A, V) will still measure the absolute values without zero correction. The detected zero value may influence the wavelength corrected calculated full scale power range values in the lower power ranges; also there might be a zero shift in the bar graph representation.

In logarithmic (dBm) representation the unit cannot display negative values. In this case the display will show 'nan' (Not A Number).

Photodiode sensors emit small current levels, even 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.

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. 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 a zero voltage of some µV is normal.

3.9   Min/Max Marker Reset

In the main display, two markers (green and red in numeric view, green and yellow in needle view) display the minimum and maximum measured power values.

The 🔄 icon resets these two markers.

3.10   Additional Measurement Settings

The measurement settings page can beached via the settings page [26] (⚙️), then press 🔢.

There are listed various sensor dependent configuration items:

Common for **all sensors**:
- wave length correction
- attenuation
- measurement units
- ranging
- line filter for anti-aliasing

Photo diode sensors: bandwidth

Pyroelectric sensors: trigger level

Thermal Sensors: accelerator (speed-up circuitry) settings

Also, in this panel the following settings can be made:
- Beam characteristic parameters for calculating the power or energy density
- Configuration of the PM200 for customer built sensors
- Long-term logging control

3.11 Settings

To access the settings page press the cog-wheel button 🎛 in the operating bar. The Settings panel comes up:

Settings page

Measurement[25]	Gives an overview about all relevant measurement parameters and beam settings, the logging control parameters and the remote state.
Application[16]	Opens the Measurement Settings and Tools panel
File Manager[23]	Gives access to the user space on the local drive for administering logging files and user defined correction curves.
Display Settings	Controls display brightness, display orientation and operation, and display color schemes.
Language	Sets the dialog language between English, French, German, Spanish, Italian and simplified Chinese.
Date/Time	Sets the time and date.
Power Options:	Configures power saving schemes for both battery and mains operation.
System Info:	Shows system relevant data and triggers the software update[43] via USB stick.
Sensor Info:	Shows sensor relevant data and the spectral response curve

To return to the measurement view, press the arrow button ⬅ in the operating bar.

3.12 Analog Output

The analog output provides the amplified photo-diode current or the amplified thermal or pyroelectric sensor voltage.

The signals from the analog output are not wavelength and zero corrected. The analog output voltage can range from -0.3V to +2.3V. It is is measurement range dependent and can be calculated to:

$$U_{out} = 2V \times \frac{measured\ value}{full\ scale\ value}$$

3.13 Auxiliary Input and Output

This 12 pin connector in the top panel gives access to an external trigger input, 4 configurable general purpose input/output (GPIO) pins and two 10bit ADC inputs.

With the optional available environmental module that can be plugged into this connector it is possible to monitor the room temperature and the relative humidity in the status bar.

3.14 Charging the Battery

The PM200 is powered by a 2 cell LiPo+ battery that needs to be recharged intermittently by plugging the AC adapter. To fully charge the battery it takes approximately 4 hours. A built in charging circuit automatically regulates and terminates the charging.

Note

Charging via the USB cable to a computer might not sufficiently compensate the power consumption of the PM200.

Following battery icons in the display header show the charging state from empty to full battery and line operation

The empty battery symbol starts blinking one minute prior to the automatic shutdown of the PM200..

When an external power supply is connected, the symbols above change sequentially until the battery is fully charged; after then the power cord icon will appear.

3.15 Sensor Dependent Functions

3.15.1 Photodiode Sensors

The PM200 works with all Thorlabs S1xxC series photodiode power sensors. The sensor is ready to operate few seconds after plugging to the DB9 connector.

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 power levels from nano-watts up to 20 W Thorlabs offers photodiode sensors that show big advantages in sensitivity, stability and drift compared to 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 very good sensitivity at smallest power levels down to the pW range. Handling fairly small power levels the sensor size can be held small, further the response time of such sensors is very fast down to the sub-microsecond range.

Photodiodes, neutral density filters and also integrating sphere materials show a wavelength dependent behaviour and therefore each sensor is individually calibrated over the whole spectral working range in 5 or 10nm steps. The sensors spectral response data ("calibration data") get stored in a non-volatile memory inside the DB-9 sensor connector and downloaded to the PM200 when plugged to the unit. To perform an accurate measurement it is necessary to enter the operating wavelength of the incident light. The PM200 then calculates the light power from the measured photo current, using the correct responsivity value from the wavelength calibration table.

Bandwidth Setting (Signal Filtering)

The analogue bandwidth setting influences the power reading and the analog output. The bandwidth can be selected in the measurement settings panel or directly in numeric / needle view panels as to 10Hz, 1kHz or 100kHz.

For measuring CW or average power from pulsed sources the bandwidth should be set to 10Hz. When using the analog output to control external equipment or measuring peak power levels the 100kHz setting is recommended so that the meter can follow the signal.

Power Measurements using Photo Diodes

Common photo diodes can be used for power measurements with the PM200. Therefore to the sensor input (see Sensor Connector Pinning 68) the photodiode (cathode to pin 4) and an interlock (1..10 kΩ between pin 7 and pin 3) must be connected. In order to measure the power, a response curve of the used photo di-

ode must be loaded. If no responsivity curve is available, the PM200 uses a default responsivity of 1A/W, and only photo current measurement is possible.

Note

Please take care for the correct polarity of the photo diode - the anode needs to be connected to analog ground (pin 3)!

Set the Sensor Type to 'Photodiode Detector' in the 'Measurement Settings' panel. For correct power measurement, the response curve (*.csv file) of the used photo diode must be loaded.

Note

It's important that the response curve file is a true comma separated values file - the separator must be a comma (,) not a semicolon (;)! Less important is the file extension - it can be a *.txt file as well. The response curve file must not contain a header!

- Copy the appropriate *.csv file from an external flash memory (e.g., USB stick) to the folder LOCAL > response-curves, using the File Manager
- Click to the 'PD Adapter' tab in the upper left corner of the display, click to the 'select curve' button on the screen bottom.
- Select from the 'LOCAL > response-curves' folder the desired file and hit the select ✔ button.

The responsivity curve now will be displayed and used for calculations. If no responsivity curve is available, the PM200 uses a default responsivity of 1A/W, and only photo current measurement is possible.

Example

- A Thorlabs FDS100-CAL calibrated photo diode, s/n 10112420, is used with PM200.
- The calibration data can be downloaded from Thorlabs' website - search for the item FDS100-CAL, on the product site a table can be found.
- Select the tab "Calibration Data", enter the serial number and download the provided calibration data file FDS100-CAL 2010112420_103280830.txt to a USB memory stick.
- Edit the file and remove the header lines.
- Connect the USB memory stick to the PM200
- Copy the file to the folder LOCAL > response-curves, using the File Manager
- Click to the 'PD Adapter' tab in the right upper corner of the display, click to the 'select curve' button on the screen bottom.
- Select from the 'LOCAL > response-curves' folder the desired file and hit the select ✔ button.

Now, the response curve is displayed and used for calculation. The last step is to enter the correct wavelength.

3.15.2 Thermal Sensors

The PM200 is compatible to the Thorlabs S3xxC series thermal power sensors. The sensor will be ready to operate few seconds after plugging to the DB9 connector.

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 and convert the developing heat into a small voltage caused by heat flow through thermocouple elements between absorbing area and sensor heat sink. Thorlabs S3xxC series thermal sensors cover a wide range of applications. The sensors are available with different coatings. Black broad band coating as absorber does not need a wavelength correction because the response is nearly flat from UV to mid-IR wavelengths. Special hard coatings can withstand high power levels and show also a good spectral flatness. Further Thorlabs offers special heads with coatings for very high peak power levels for Excimer lasers with large beam diameters and short pulse lasers .

The output voltage of a thermal sensor is linear to the incident laser power, as long the thermal system is properly zeroed. The main application for thermal sensors is the measurement of high power levels from 100mW up. Thorlabs offers also a special thermally isolated thermal head with flat response for measurement of a power level starting in the µW range.

Readout acceleration

Thermal sensors show a fairly slow response. When laser power hits the active area, it takes some time to reach the correct power indication. This settling time may take, depending on the sensor type, from a few up to 20 seconds. As the settling time (time constant) is well known for each sensor type, a special electronic circuitry can shorten this time to approximately 1-3 seconds by 'predicting' the final power value.

The PM200 automatically uses the right adjustment of the electronics to the time constant of the recognized thermal sensor. Nevertheless this circuitry has the disadvantage of inducing some noise to the measurement value. Therefore the acceleration circuit can be disabled / enabled in the 'Measurement Settings' panel (Accelerator 'on / off / auto').

In 'auto' mode the accelerator will switch on when a power change larger than 5% of the measurement range is detected and switch off after 5 times of the time con-

stant of the sensor. This feature provides a fast response and keeps the noise level to a minimum on constant power levels.

Custom Thermal Elements

Custom thermal elements can be used for power measurements with the PM200. Therefore to the sensor input (see Sensor Connector Pinning 68⃞) the thermal element ('+' to pin 8) and an interlock (1..10 kΩ between pin 7 and pin 3) must be connected. In order to measure the power, a response curve of the used thermal element must be loaded. If no responsivity curve is available, the PM200 uses a default responsivity of 1V/W, and only voltage measurement is possible.

Note

Please take care for the correct polarity of the thermal element - the negative contact needs to be connected to analog ground (pin 3)!

Note

It's important that the response curve file is a true comma separated values file - the separator must be a comma (,) not a semicolon (;)! Less important is the file extension - it can be a *.txt file as well. The response curve file must not contain a header!

Set the Sensor Type to 'Thermal Detector' in the 'Measurement Settings' panel. For correct power measurement, the response curve (*.csv file) of the used thermal element must be loaded:

- Copy the appropriate *.csv file from an external flash memory (e.g., USB stick) to the folder LOCAL > response-curves, using the File Manager
- Click to the 'Thermo Adapter' tab in the upper left corner of the display, click to the 'select curve' button on the screen bottom.
- Select from the 'LOCAL > response-curves' folder the desired file and hit the select ✔ button.

The responsivity curve now will be displayed and used for calculations.

If no responsivity curve is available, the PM200 uses a default responsivity of 1V/W, and only voltage measurement is possible.

Accelerator settings

Different from S3xxC series, for a custom thermal element the time constant 'Tau' can be entered in the Measurement Settings panel. Accelerator modes are the same, as for S3xxC sensors.

3.15.3 Pyroelectric Sensors

Pyroelectric sensors allow the energy measurement of short light pulses. The PM200 works with Thorlabs ES1xxC and ES2xxC series pyroelectric power sensors. The sensor will be ready to operate few seconds after plugging to the DB9 connector.

Attention

Refer to the sensor data sheet and pay attention to the optical damage threshold! Exceeding these values will permanently destroy the sensor!

A pyroelectric sensor converts the incident energy pulse into a voltage pulse, largely independent of the incident radiation wavelength. The amplitude of this voltage pulse is proportional to the laser pulse energy and is measured by a peak detector circuit. The voltage peak decays in time, so the max. repetition rate is limited.

When a pyroelectric sensor is connected the PM200 cannot be switched to auto-range mode. The measurement value will be updated with each incoming pulse. When no pulses appear the measurement display will be held on the last measured value until the "Reset Min / Max" 🔄 button will be pressed.

Trigger Level

The trigger level can be set either directly by clicking to the value in the measurement panel or from the 'Measurement Settings' panel.

When an incoming pulse exceeds the set trigger level, the peak detector circuit gets armed and is waiting until the pulse peak is reached. After finding the maximum voltage the level is kept and the microprocessor reads the AD converted voltage for displaying the pulse energy. Finally the peak detector circuit gets a reset and is ready for the next pulse.

The trigger level can be adjusted between 0% and 99% of each selected energy range. Only pulses that are higher than the adjusted trigger level are recognized by the PM200. The trigger level should be set between the noise level and the expected pulse height.

Average Power Measurement

With continuously repeating pulses the PM200 calculates the average power from the pulse energy and the repetition rate. For displaying the average power drag and drop the appropriate subpanel to the numeric view panel.

Repetition Rate

The pulse repetition rate in Hz can be displayed in the 'Frequency' subpanel.

Power / Energy density

The precondition to measure the correct power and/or energy density is a well known beam area. Therefore, select in 'Measurement Settings' panel the applicable beam shape (square, rectangular or circular) and enter the beam size. Average power density (in W/cm²) and energy density (in J/cm²) are then displayed in the appropriate subpanels.

Custom Pyroelectric Sensors

Custom pyroelectric detectors can be used for energy measurements with the PM200. Therefore to the sensor input (see Sensor Connector Pinning⌐68⌐) the pyroelectric sensor ('+' to pin 5) and an interlock (1..10 kΩ between pin 7 and pin 3) must be connected. In order to measure the energy, a response curve of the used pyroelectric sensor must be loaded. If no responsivity curve is available, the PM200 uses a default responsivity of 1J/V, and only peak voltage measurement is possible.

Note

Please take care for the correct polarity of the thermal element - the negative contact needs to be connected to analog ground (pin 3)!

Note

It's important that the response curve file is a true comma separated values file - the separator must be a comma (,) not a semicolon (;)! Less important is the file extension - it can be a *.txt file as well. The response curve file must not contain a header!

Set the Sensor Type to 'Pyroelectric Detector' in the 'Measurement Settings' panel. For correct energy measurement, the response curve (*.csv file) of the used thermal element must be loaded:

- Copy the appropriate *.csv file from an external flash memory (e.g., USB stick) to the folder LOCAL > response-curves, using the File Manager
- Click to the 'Pyro Adapter' tab in the upper left corner of the display, click to the 'select curve' button on the screen bottom.
- Select from the 'LOCAL > response-curves' folder the desired file and hit the select ✔ button.

The responsivity curve now will be displayed and used for calculations. If no responsivity curve is available, the PM200 uses a default responsivity of 1V/J, and only peak voltage measurement is possible.

3.16 Application Note

Choosing the right sensor

The question of the right sensor depends on many factors starting with the light source to measure and the application. No sensor can cover all applications; the following table shows the main pros and contras of the different power sensor types. Of course this can only be a rough guide because within each sensor group there are special models, that are best suitable for specific applications.

Power Sensors:

Sensor Type → Light Source ↓	Photodiode			Thermal		
	Si	Ge	InGaAs	BB	HTC	Volume
Laser Diode UV - NIR	+++	+	-	++	-	-
Laser Diode NIR	-	+	+++	++	-	-
High Power Fiber Lasers	-	-	++	++	++	-
ASE sources	-	-	++	++	-	-
fs Laser	-	+	++	++	+	-
Gas Laser	++	-	-	++	+	-
Excimer	-	-	-	-	+++	+
YAG	-	-	-	-	+	+++
LED	+	-	-	+++	+	-

+++   Preferred
++   Useable
+   Useable with some restrictions
-      Not useable

Reducing Noise for High Accuracy Measurements

Main disturbing influence on each measurement is induced by grounding noise, the cable capacitance, temperature effects, stray and ambient light and detector noise.

- The housing of power sensors is connected to the digital ground of the meter and should be linked to earth ground (e.g. via a post); energy sensors should be mounted isolated, because the housing is connected to the console's analog ground.

- The sensor cable conducts very small current or voltage signals. Moving the cable will induce disturbances given through the cable capacitance. For measuring low power or energy levels the cable should be fixed in position.

- With photodiode sensors the bandwidth should be set to 'LOW' setting; with thermal sensors the acceleration circuit should be shut off or set to 'AUTO'.

- The detector noise is lowest with Silicon and InGaAs sensors.

- For long term measurements in free space applications it is necessary to provide constant ambient light conditions, or shielding the beam.

- The temperature should be stable over the time of the measurement.

Power Measurement of Pulsed Signals

The PM200 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 to 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. Further it is important to use a power range in manual mode that can measure the peak value, therefore the Min-Max function is very helpful. Depending on the pulse length and repetition rate the bandwidth setting will influence the power reading. It is recommended to use the low bandwidth (10Hz) setting for a stable display; when the pulse should be monitored via the analog output, the bandwidth should be set to '100kHz'.

Line width of Light Sources

The line width of light sources can be neglected only when using a broadband thermal or pyroelectric sensor. Photodiode sensors show a strong dependency of the responsivity vs. 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 PM200 will nearly show the right optical power for a symmetrical spectral response shape.

Note

PM200 allows to load a spectral curve of a light source, having a broad line width. If select such a spectral curve instead of a center wavelength from the 'Wavelength' drop down menu, the PM200 will calculate the optical power correctly.

Spectral intensity curves for Thorlabs LED are available as EXCEL™files from our web site.

Temperature Effects with 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 term 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).

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 zero adjustment. More complicated is varying ambient light like daylight or turning on/off room light. In such cases the only solution is a proper light shielding of the sensor.

Back Reflection

Photodiodes, ND filters and even black coatings of thermal sensors show a certain kind of back reflection of the incoming light. For example, the back reflection to a diode or HeNe laser can distort the power stability of the laser, therefore it is recommended to slightly tilt the power meter sensor in the laser beam.

When back reflection must be avoided it is advised to use an integrating sphere based S14xC series sensor where the incoming light gets nearly completely absorbed in the sensor.

Beam Diameter vs. Active Sensor Area

Most sensors, except integrating spheres, are not completely uniform in their response over the active area. To overcome uniformity issues the incident beam should have a diameter larger than 10% of the active sensor area diameter.

Another important parameters are the maximum allowed power and energy densities of the sensor. The maximum ratings are given in the sensor spec sheet. The PM200 can display the actual power or energy density for a known beam diameter. For high power or high energy beams a good efficiency can be reached to chose a detector that has a active area diameter about 20% - 30% larger than the beam diameter.

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.

For typical single mode fiber connectorized with a PC ferrule, 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. On the other hand for measurements with high power fiber lasers a certain gap between fiber tip and detector surface has to be kept to decrease the power density.

Thorlabs offers fiber adapters with the most common connectors that are verified with the S12xC series optical sensors and with most thermal sensors.

For large divergence angles or fiber measurements that are critical to back-reflections it is recommended to use an integrating sphere based sensor from the S14xC series.

Another good choice for fiber based measurements are the S15xC series 'Fiber-Heads'. They plug directly to the meter and go without a disturbing cable between sensor and console.

Energy Measurement with Pyroelectric Sensors

To select the best suitable pyroelectric energy sensor, the following parameters must be considered:

− Energy to Measure: The maximum energy is determined by the absorption layer (too high pulse energy causes mechanical damages on the layer) and by the sensor material, that must remain in a certain temperature level. It is important to pay attention to the maximum power density during a pulse, the maximum energy density and the average power.

− The lower detection limit depends of the resolution and the minimum settable trigger level of the display unit, as well as on the noise level. To minimize the noise level and ground loops it is advisable to mount the detectors isolated with the supplied isolation adapters.

− Beam Diameter: The active area of the detector should be chosen slightly larger than the beam diameter. It is not a must that the beam should cover most of the sensor area, but maximum allowed energy density has to be considered.

− Repetition Rate: The maximum pulse repetition rate depends on the combination of the internal capacitance of the detector and the load resistor. The display unit has an input resistor of 1MΩ (like the typical input resistor of an Oscilloscope).

− Pulse Length: Thorlabs energy sensors detect and measure pulses from sub nano-seconds duration up to approximately 2 ms. Generally, the pyroelectric effect allows just the measurement of a temperature change caused by radiation pulses or modulated radiation. For shorter impulses there are no restrictions, as the energy of the shortest impulse is converted into heat flow in the absorption layer. The maximum impulse duration depends on several factors: One is the electrical time constant, given by the detector capacity and the load

resistance, the other is the thermal time constant of the detector, which must not influence the measurement result.

− Wavelength: The sensors are calibrated at one wavelength, for the entire wavelengths a sensor specific correction curve is stored in the memory in the sensor connector. The black coating is nearly linear flat over a wavelength range from 185nm to > 25µm; the ceramic coating is also suitable for this wavelength range, but is not linear.

4 Computer Interface

The PM200 optical power meter contains a USB 2.0 interface for remote controlling the unit with an external PC. Connect the unit via the Mini-USB connector in the top panel to a free USB port of your PC. When connecting the PM200 first time, a new hardware will be found. For proper installing the PM200 it requires a NI-VISA runtime version on the PC (available on the National Instruments website www.ni.com) or from the data carrier that comes with the instrument. Allow installing and follow the dialog instructions.

The PM200 comes with an utility software that easily enables remote operation of the PM200 (and also PM100D, PM100A and PM100USB) and visualizing and logging measurement data. Perform the setup.exe and follow the installing instructions.

The LabVIEW source code of this application is included on the data carrier as well and can be used to build own applications or to modify the utility program to specific requirements (LabVIEW 8.5.1 or higher required).

4.1 PM200 Utility Software

The PM200 comes with an utility software that easily enables remote operation of the PM200 - as well as PM100D, PM100A and PM100USB - along with visualizing and logging of measurement data. The software is written in LabVIEW 8.5.1 and can either be installed from the data carrier as executable where LabVIEW isn't required on the PC; or can be run with LabVIEW 8.5.1 or higher.

The source code of the application is included on the data carrier and can be used to build own applications or to modify the utility program to specific requirements.

The PM200 utility software does not require the installation of the instrument drivers as described in section Using the Instrument Drivers 44.

After launching the PM200 utility program it will automatically screen for connected console devices. Select the desired device and press o.k. In case that the connected console is not yet recognized, press Rescan to perform a new search for connected devices.
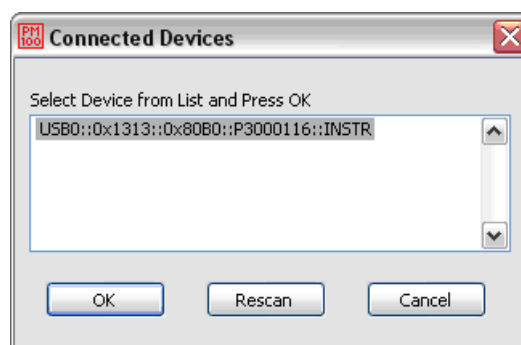
The identification string contains the following items:

USB0   USB Port number
0x1313   Thorlabs Vendor ID
0x80B0   Product ID = PM200
P3000116   Instrument serial number
INSTR   Measurement instrument device

Front Panel
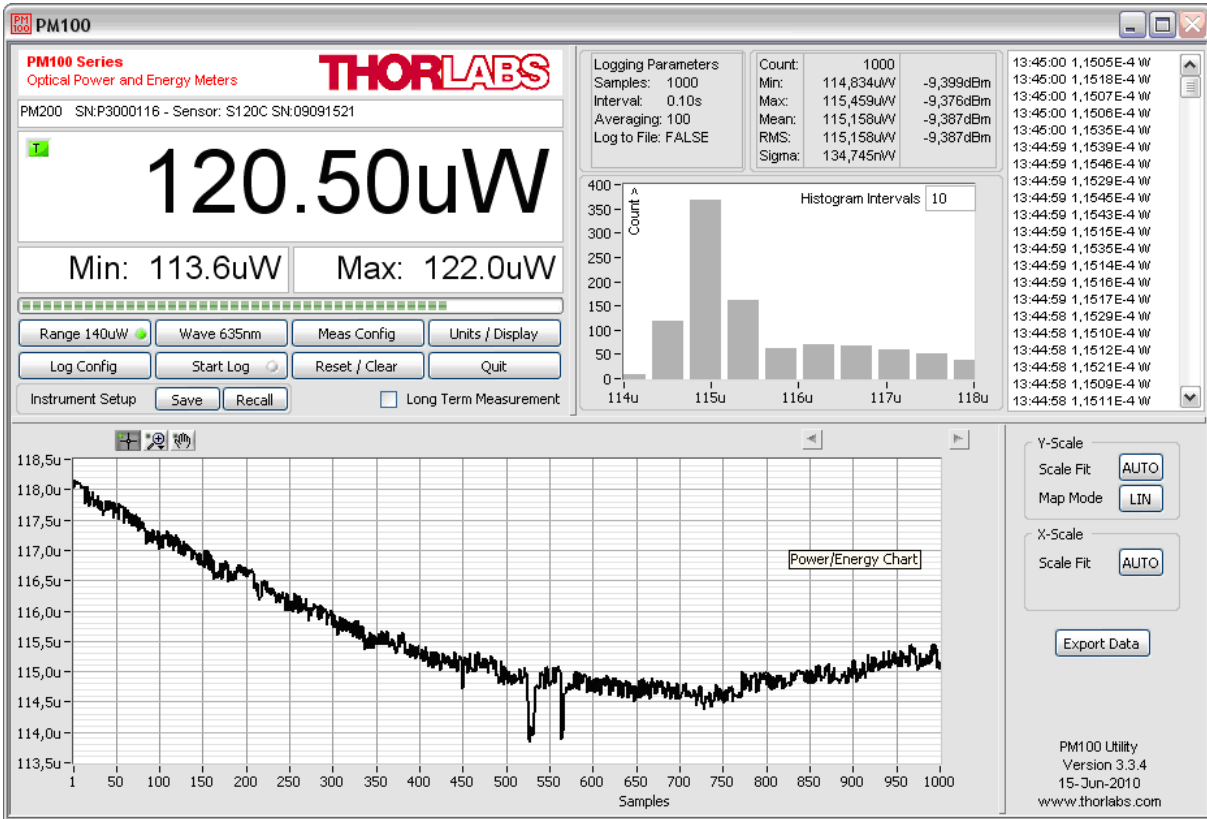
Description of the Front Panel Elements:

Header	This indicator shows the device setup: - console type (PM200) - serial number of the console - sensor type - sensor serial number
Main Display	The display has a configurable display resolution. Independent from the measurement range the display always has the full number of the selected digits. To achieve best AD converter resolution it is necessary to set the measurement range according to the signal to measure. A trigger indicator shows whether the unit is sampling data 'A' indicator or a new measurement value gets displayed 'T' indicator and green light.
Left Sub Display	The display has the following configurable items: - no display

- maximum value - sampling until reset
- ratio max/min value - sampling until reset
- power or energy density
- alternate unit depending on connected sensor
Available choices depend on the connected sensor

Right Sub Display	The display has the following configurable items, the possible choices depend on the connected sensor: - no display - minimum value - sampling until reset - frequency or repetition rate - temperature - resistance of temperature sensor
Bargraph indicator	The bargraph indicator shows the incidence or the used measurement range.
Statistics screen	Statistical values in linear and logarithmic representation
Data logging screen	Shows the logging history data
Histogram Power / Energy histogram	- displays histogram data
Chart display	Power/Energy Chart
Range button	Press to open a dialog box for setting the measurement range. The indicator in the button shows the currently used measurement range in the chosen unit. A green light indicates 'auto-ranging' Shortcut: [Shift + F1]
Wavelength / Response button	Press this button to open a dialog box for setting the correction wavelength, or in adapter mode to enter the responsivity value in A/W or V/W. The currently used parameter is indicated in the button label. Shortcut: [Shift + F2]

Measurement configuration button

Depending on the connected sensor the following parameters can be set in the dialog box:

− display resolution - set number of digits

− averaging rate, a rate of 3000 averages the incoming measurement values for approx. 1 second

− photodiode bandwidth HI and LO

− acceleration circuit for thermal sensors ON, AUTO and OFF

	– trigger level for pyroelectric sensors – Zeroing for photodiode and thermal sensors Shortcut: [Shift + F3]
Units / Display button	A dialog box with the following items appears: - configure unit of measure, depending on the connected sensor [W, J, dBm, V and A] - configure the left sub display - configure the right sub display Shortcut: [Shift + F4]

Logging configuration button - Opens a dialog box to:

- set averaging rate for logging
- set interval between samples
- set number of samples
- configure logging into data file

Shortcut: Shift + F5

Start/Stop log button	- start and stop data logging Shortcut: [Shift + F6]

Reset / Clear button	- reset min/max monitor - clear power / energy graph - clear power / energy histogram - clear power / energy statistics - clear log screen Shortcut: [Shift + F7]

Quit button	- stops the PM200 application - to restart press the white arrow in the tool bar Shortcut: [Shift + F8]

Instrument Setup Save / Recall

- save / recall remote control specific parameters

Shortcut: [Shift + F9]

Long Term Measurement

- sets the device to local mode between the measurement intervals

Shortcut: [Shift + F10]

4.2   PM200 Software Update

Download the PM200 Update Package from Thorlabs' web site and copy it to the root directory of a USB flash drive. Connect Open 'Measurement Settings' panel and call 'System Info' - the following screen appears:
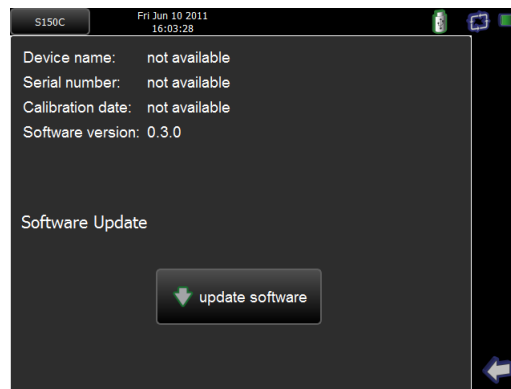
Click to 'update software', make sure the power supply is connected.
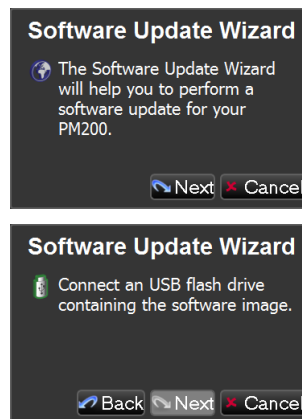
Connect the USB flash drive, then click 'next'. In the next screen, click 'Finish' to start the update.

Warning

- Do not turn off the console during update!
- Do not remove the USB flash drive during update!
- Wait until update has completed!

Upon completing the update, on the screen appears the message

```
Please remove update jumper an reboot
```

Now, remove the USB flash drive and press and hold the power button, until the PM200 switches off. To reboot, switch on again.

4.3 Using the Instrument Drivers

Instrument Driver Installation

The PM200 software package contains a set of instrument drivers that allows conveniently remote controlling the instrument in most common programming languages. The instrument drivers must be installed, please follow the setup dialog instructions.

Note

To successfully complete the install of the PM200 USB driver you must have Administrator privileges on the PC which you are performing the install.

Prior to connecting the PM200 with a PC, please check if NI-VISA is installed on the PC, otherwise install NI-VISA that is available for free from the National Instruments website www.ni.com or from the data carrier that came with the instrument.

After successfully installing the drivers connect the PM200 to a USB port of your PC. The PC will find a PM200 test and measurement device. Please follow the instructions of the dialog screens and allow the installing.

Instrument Driver Example

The following LabVIEW example demonstrates how to use the instrument drivers for measurement tasks. The example is included on the data carrier that came with the instrument.
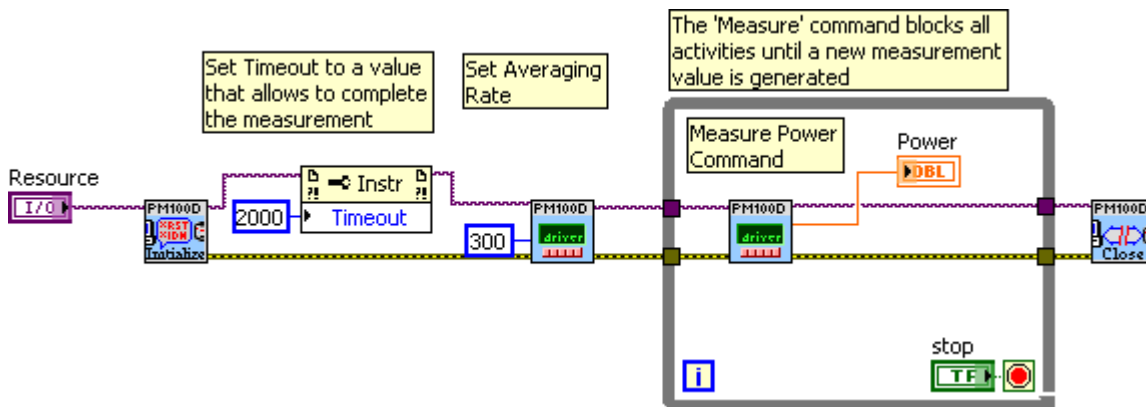
5   Write Your Own Application

In order to write your own application, you need a specific instrument driver and some tools for use in different programming environments. The driver and tools are included in the installer package and cannot be found as separate files on the installation CD.

In this section the location of drivers and files, required for programming in different environments, are given for installation under Windows XP (32 bit) and Windows 7 (32 and 64 bit)

Note

PM200 software and drivers contains 32 bit and 64 bit applications.

In 32 bit systems, only the 32 bit components are installed to

```
C:\Program Files\...
```

In 64 bit systems the 64 bit components are being installed to

```
C:\Program Files\...
```

while 32 bit components can be found at

```
C:\Program Files (x86)\...
```

In the table below you will find a summary of what files you need for particular programming environments.

Programming environment	Necessary files
C, C++, CVI	*.fp (function panel file; CVI IDE only) *.h (header file) *.lib (static library) *.dll (dynamic linked library)
C#	.net wrapper dll
Visual Studio	*.h (header file) *.lib (static library) or .net wrapper dll
LabView	*.fp (function panel) and NI VISA instrument driver Beside that, LabVIEW driver vi's are provided with the *.llb container file

Note

All above environments require also the NI VISA instrument driver dll !

During NI-VISA Runtime installation, a system environment variable `VXIPNPPATH` for including files is created. It contains the information where the drivers are installed to, usually to `C:\Program Files\IVI Foundation\VISA\WinNT\`.

This is the reason, why after installation of a NI-VISA Runtime a system reboot is required: This environment variable is necessary for installation of the instrument driver software components.

In the next sections the location of above files is described in detail.

5.1   Windows XP 32bit

NI VISA Instrument Driver 32bit

```
C:\Program Files\IVI Foundation\VISA\WinNT\Bin\PM100D_32.dll
```

Online Help for NI VISA Instrument Driver

```
C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\Manual\PM100D.html
```

NI LabVIEW Driver

The LabVIEW version of this driver was generated with the "NI LabVIEW Instrument Driver Import Wizard 2.0" in conjunction with LabVIEW 2011.

```
C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\LabVIEW\PM100D.llb
```

Header File

```
C:\Program Files\IVI Foundation\VISA\WinNT\include\PM100D.h
```

Static Library

```
C:\Program Files\IVI Foundation\VISA\WinNT\lib\msc\PM100D_32.lib
```

Function Panel

```
C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\PM100D.fp
```

.net wrapper dll

```
C:\Program Files\IVI Foundation\VISA\VisaCom\...
...Primary Interop Assemblies\Thorlabs.PM100D.dll
```
```
C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\DotNet\...
...Thorlabs.PM100D.dll
```
```
C:\Program Files\Microsoft.NET\Primary Interop Assemblies\...
...Thorlabs.PM100D.dll
```

Examples

ANSI-C

```
C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\Samples\C\sample.c
```

Thorlabs PM100x/PM160/PM200 Instrument Driver Sample Application with console interface. Read the comment text in the sample.c file for more information.

C# Visual Studio 2010

```
C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\Samples\...
...DotNet\DotNetSample.csproj
```

Very basic C# sample project. The application opens a session to a device takes one measurement and closes the device again.

5.2   Windows Vista / 7 / 8 - 32bit

NI VISA Instrument Driver

`C:\Program Files\IVI Foundation\VISA\WinNT\Bin\PM100D_32.dll`

Online Help for NI VISA Instrument Driver:

`C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\Manual\PM100D.html`

NI LabVIEW Driver

The LabVIEW version of this driver was generated with the "NI LabVIEW Instrument Driver Import Wizard 2.0" in conjunction with LabVIEW 2011.

`C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\LabVIEW\PM100D.llb`

Header File

`C:\Program Files\IVI Foundation\VISA\WinNT\include\PM100D.h`

Static Library

`C:\Program Files\IVI Foundation\VISA\WinNT\lib\msc\PM100D_32.lib`

Function Panel

`C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\PM100D.fp`

.net wrapper dll

`C:\Program Files\IVI Foundation\VISA\VisaCom\...`
`...Primary Interop Assemblies\Thorlabs.PM100D.dll`

`C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\DotNet\...`
`...Thorlabs.PM100D.dll`

`C:\Program Files\Microsoft.NET\Primary Interop Assemblies\...`
`...Thorlabs.PM100D.dll`

Examples:

ANSI-C

`C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\Samples\C\sample.c`

Thorlabs PM100x/PM160/PM200 Driver Sample Application with console interface. Read the comment text in the sample.c file for more information.

C# Visual Studio 2010

`C:\Program Files\IVI Foundation\VISA\WinNT\PM100D\Samples\...`
`...DotNet\DotNetSample.csproj`

Very basic C# sample project. The application opens a session to a device takes one measurement and closes the device again.

5.3   Windows Vista / 7 / 8 - 64bit

NI VISA Instrument Driver 32bit

`C:\Program Files (x86)\IVI Foundation\VISA\WinNT\Bin\PM100D_32.dll`

NI VISA Instrument Driver 64bit

`C:\Program Files\IVI Foundation\VISA\Win64\Bin\PM100D_64.dll`

Online Help for NI VISA Instrument Driver

`C:\Program Files\IVI Foundation\VISA\Win64\PM100D\Manual\PM100D.html`

NI LabVIEW Driver 32bit

`C:\Program Files (x86)\IVI Foundation\VISA\WinNT\PM100D\...`
`...LabVIEW\PM100D.llb`

NI LabVIEW Driver 64bit

`C:\Program Files\IVI Foundation\VISA\Win64\PM100D\LabVIEW\PM100D.llb`

Header File 32bit

`C:\Program Files (x86)\IVI Foundation\VISA\WinNT\include\PM100D.h`

Header File 64bit

`C:\Program Files\IVI Foundation\VISA\Win64\include\PM100D.h`

Static Library 32bit

`C:\Program Files (x86)\IVI Foundation\VISA\WinNT\lib\msc\PM100D_32.lib`

Static Library 64bit

`C:\Program Files\IVI Foundation\VISA\Win64\Lib_x64\msc\PM100D_64.lib`

Function Panel 32bit

`C:\Program Files (x86)\IVI Foundation\VISA\WinNT\PM100D\PM100D.fp`

Function Panel 64bit

`C:\Program Files\IVI Foundation\VISA\Win64\PM100D\PM100D.fp`

.net wrapper dll 32bit

```
C:\Program Files (x86)\IVI Foundation\VISA\VisaCom\...
...Primary Interop Assemblies\Thorlabs.PM100D.dll
```

```
C:\Program Files (x86)\Microsoft.NET\Primary Interop Assemblies\...
...Thorlabs.PM100D.dll
```

.net wrapper dll 64bit

```
C:\Program Files\IVI Foundation\VISA\VisaCom64\...
...Primary Interop Assemblies\Thorlabs.PM100D.dll
```

Examples:

ANSI-C

```
C:\Program Files\IVI Foundation\VISA\Win64\PM100D\Samples\C\sample.c
```

Thorlabs PM100x/PM160/PM200 Driver Sample Application with console interface. Read the comment text in the sample.c file for more information.

C# Visual Studio 2010

```
C:\Program Files\IVI Foundation\VISA\Win64\PM100D\Samples\DotNet\...
...DotNetSample_64.csproj
```

Very basic C# sample project. The application opens a session to a device takes one measurement and closes the device again.

5.4   Simple LabVIEW Example using SCPI commands

The PM200 Instrument driver is not required for this LabVIEW example.

PM100D Simple Example.vi

This VI shows how to communicate with a PM200 optical power/energy meter with SCPI commands. The following steps are demonstrated within this application:

- Initializing the instrument
- Getting system info
- Setting parameters
- Measurement configuration
- Measuring queue
- Fetching and displaying a measurement value
- Closing the application
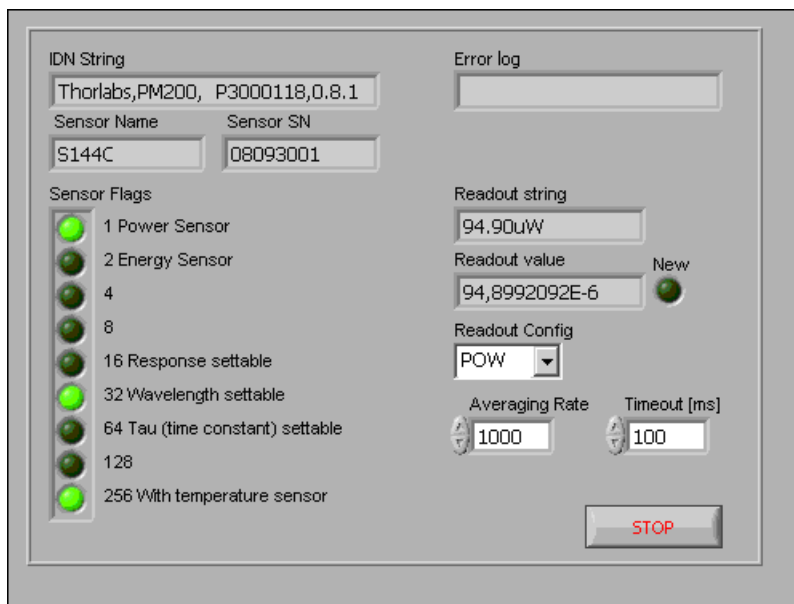
Block diagram
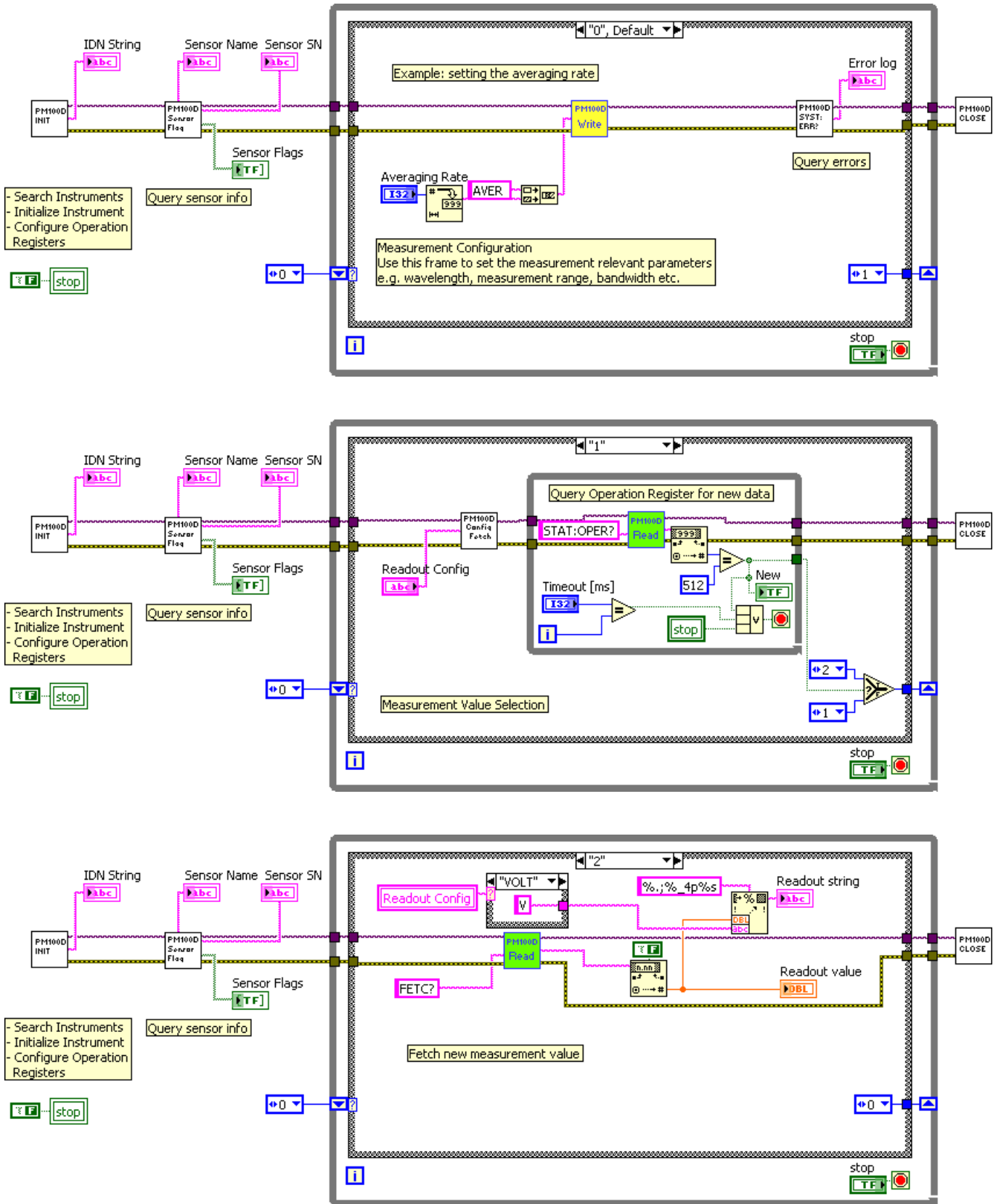
I32 **Averaging Rate**
Sets the averaging rate - 3000 averages take approximately 1s for performing a new measurement value

abc **Readout Config**
Selects the measurement parameter

- POW power measurement in W
- CURR current measurement in A
- VOLT voltage measurement in V
- ENER energy measurement in J
- FREQ frequency / repetition rate measurement in Hz
- PDEN power density measurement in W/cm²
- EDEN energy density measurement in J/cm²
- RES thermistor resistance measurement in Ohm
- TEMP temperature measurement in °C

TF **Stop**
Stops application

I32 **Timeout [ms]**
Sets a timeout value in ms that allows the instrument to sample.

The timeout must be longer than it takes to perform a new measurement. This has especially to be considered when performing single shot energy measurements.

abc **Error log**
Error indicator, 'no error' is suppressed

abc **Readout string**
Formatted measurement value

- limitation to 4 significant digits
- SI notation
- '.' decimal separator
- appended unit according readout configuration

TF **New**
Indicator lights up, when a new measurement value is processed

TF **Sensor Flags**

    TF Sensor flag bitmap:
        1 Is power sensor
        2 Is energy sensor
        16 Response settable
        32 Wavelength settable
        64 Tau settable
        256 Has temperature sensor

abc **Sensor Name**
Name of connected power/energy sensor

abc **Sensor SN**
Serial number of connected power/energy sensor

abc **IDN String**
Answer from instrument on *idn? command:

- manufacturer

- model number
- serial number
- firmware version

DBL ▶ Readout value
Plain readout value in full resolution

PM100D_Initialize.vi
This VI scans for connected devices, that can be selected in a dialog box. Next steps

- setting timeout
- performing identification query
- configuring the operation register to '512'; flag gets to HI when a new measurement value is ready to fetch
- clear operation register

PM100D_Write.vi
Writes a SCPI command to the connected instrument

PM100D_Read.vi
Reads data from the connected instrument. All query commands according the SCPI command table are terminated by a question mark (?)

PM100D_SensorFlag.vi
This VI queries all relevant sensor info with SYST:SENS:IDN?

- sensor name
- sensor serial number
- calibration message
- sensor type
- sensor sub-type
- sensor flags

PM100D_ConfMeas.vi
- CONFigure measurement; CONF:<parameter> (POW, ENER, etc.)
- ABORt measurement
- Clear operation register with STAT:OPER?
- INITiate measurement

PM100D_SYST-ERR.vi
This VI lists all errors coming from the instrument with the command SYST:ERR?

'no error' is suppressed

PM100D_Close.vi
Closes the VISA session

Sets the connected instrument in local mode (default option)

6 SCPI Commands

This section describes in detail the SCPI command set with respect to PM200 power meter console. However, these commands are compatible with PM100A, PM100D and PM100USB consoles as well as with the PM160 Hand-held Power Meter, except some console and sensor related functions.

6.1 An Introduction to the SCPI language

The PM200 interface commands use the SCPI (Standard Commands for Programmable Instruments), an ASCII-based command language that was designed for test and measurement instruments.

SCPI commands are based on a hierarchical structure, also known as a tree system. In this system, associated commands are grouped together under a common node or root, thus forming subsystems. A portion of the SENSE subsystem is shown below to illustrate the tree system.

```
SENSe:
  CORRection
      :COLLect
        :ZERO
            [:INITiate]
            :ABORt
            :STATe?
            :MAGNitude?
      :BEAMdiameter {MINimum|MAXimum|DEFault|<numeric_value>[mm]}
      :BEAMdiameter? [{MINimum|MAXimum|DEFault}]
      :WAVelength {MINimum|MAXimum|<numeric_value>[nm]}
      :WAVelength? [{MINimum|MAXimum}]
      :POWer
        [:PDIode]
            [:RESPonse] MINimum|MAXimum|DEFault|<numeric_value>[A]}
            [:RESPonse]? [{MINimum|MAXimum|DEFault}]
        :THERmopile
            [:RESPonse] {MINimum|MAXimum|DEFault|<numeric_value>[V]}
            [:RESPonse]? [{MINimum|MAXimum|DEFault}]
```

SENSe is the root keyword of the command, CORRection is the second-level keyword, and COLLect and BEAMdiameter are third-level keywords, and so on.
A colon (:) separates a command keyword from a lower-level keyword.

Command Format

The format used to show commands in this manual is shown below:

```
CURRent[:DC]:RANGe {MINimum|MAXimum|<numeric_value>[A]}
CORRection:BEAMdiameter {MINimum|MAXimum|DEFault|<numeric_value>[mm]}
```

The command syntax shows most commands (and some parameters) as a mixture of upper- and lower-case letters. The upper-case letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, send the long form.

For example, in the above syntax statement, `CURR` and `CURRENT` are both acceptable forms. You can use upper- or lower-case letters. Therefore, `CURRENT,` `current` and `Current` are all acceptable. Other forms, such as `CUR` and `CURREN`, will generate an error.

Braces (**{ }**) enclose the parameter choices for a given command string. The braces are not sent with the command string. A *vertical bar* (**|**) separates multiple parameter choices for a given command string.

Triangle brackets (**< >**) indicate that you must specify a value for the enclosed parameter. For example, the above syntax statement shows the *range* parameter enclosed in triangle brackets. The brackets are not sent with the command string. You must specify a value for the parameter (such as `"CURR:DC:RANG 50E-6"`).

Some parameters are enclosed in *square brackets* (**[ ]**). The brackets indicate that the parameter is optional and can be omitted. The brackets are not sent with the command string. In this example `[:DC]` can be omitted, so the command string can be shortened to "`CURR:RANG 50E-6`". If you do not specify a value for an optional parameter, the power/energy meter chooses a default value.

Command Separators
A *colon* (**:**) is used to separate a command keyword from a lower-level keyword. You must insert a *blank space* to separate a parameter from a command keyword. If a command requires more than one parameter, you must separate adjacent parameters using a *comma* as shown below:

`"SYST:TIME 10, 34, 48"`

A *semicolon* (**;**) is used to separate commands within the *same* subsystem, and can also minimize typing. For example, sending the following command string:

`"CORR:BEAM 1; WAV 1310"`

... is the same as sending the following two commands:

`"CORR:BEAM 1"`
`"CORR:WAV 1310"`

Use a colon and a semicolon to link commands from different subsystems. For example, in the following command string, an error is generated if you do not use both the colon and semicolon:

`"CORR:BEAM 1;:AVER 300"`

Using the *MIN* and *MAX* Parameters
You can substitute `MINimum` or `MAXimum` in place of a parameter for many commands. For example, consider the following command:

`CURRent[:DC]:RANGe {MINimum|MAXimum|<numeric_value>[A]}`

Instead of selecting a specific current range, you can substitute MIN to set the range to its minimum value or MAX to set the range to its maximum value.

Querying Parameter Settings
You can query the current value of most parameters by adding a question mark (`?`) to the command. For example, the following command sets the operating wavelength to 1550 nm:
`"CORR:WAV 1550"`
You can query the operating wavelength by executing: `"CORR:WAV?"`
You can also query the minimum or maximum operating wavelength allowed as follows:

`"CORR:WAV? MIN"`

```
"CORR:WAV? MAX"
```

Caution

If you send two query commands without reading the response from the first, and then attempt to read the second response, you may receive some data from the first response followed by the complete second response. To avoid this, do not send a query command without reading the response. When you cannot avoid this situation, send a device clear before sending the second query command.

SCPI Command Terminators

A command string sent to the power/energy meter must terminate with a <new line> character. The IEEE-488 EOI (end-or-identify) message is interpreted as a <new line> character and can be used to terminate a command string in place of a <new line> character. A <carriage return> followed by a <new line> is also accepted. Command string termination will always reset the current SCPI command path to the root level.

IEEE488.2 Common Commands

The IEEE-488.2 standard defines a set of common commands that perform functions like reset, self-test, and status operations. Common commands always begin with an asterisk (*), are four to five characters in length, and may include one or more parameters. The command keyword is separated from the first parameter by a blank space. Use a semicolon (;) to separate multiple commands as shown below:

```
"*RST; *CLS; *ESE 32; *OPC?"
```

SCPI Parameter Types

The SCPI language defines several different data formats to be used in program messages and response messages.

Numeric Parameters Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation.
Special values for numeric parameters like MINimum, MAXimum and DEFault are also accepted. You can also send engineering unit suffixes with numeric parameters (e.g., M, K, or u). If only specific numeric values are accepted, the power/energy meter will automatically round the input numeric parameters. The following command uses a numeric parameter:

```
POWer:REFerence {MINimum|MAXimum|DEFault|<numeric_value>[W]}
```

Discrete Parameters Discrete parameters are used to program settings that have a limited number of values (like W, DBM). They can have a short form and a long form just like command keywords. You can mix upper- and lower-case letters. Query responses will *always* return the short form in all upper-case letters. The following command uses discrete parameters:

```
POW:UNIT {W|DBM}
```

Boolean Parameters Boolean parameters represent a single binary condition that is either true or false. For a false condition, the power/energy meter will accept "OFF" or "0". For a true condition, the meter will accept "ON" or "1". When you query a boolean setting, the instrument will *always* return "0" or "1". The following command uses a boolean parameter:

```
CURRent:RANGe:AUTO {OFF|0|ON|1}
```

String Parameters String parameters can contain virtually any set of ASCII characters. A string *must* begin and end with matching quotes; either with a single quote or with a double quote. You can include the quote delimiter as part of the string by typing it twice without any characters in between. The following command uses a string parameter:

`DIAG:CALString` *`<quoted string>`*

6.2 IEEE488.2 Common Commands

Common commands are device commands that are common to all devices according to the IEEE488.2 standard. These commands are designed and defined by this standard. Most of the commands are described in detail in this section. The following common commands associated with the status structure are covered in the "Status Structure" section: *CLS, *ESE, *ESE?, *ESR?, *SRE, *SRE?, *STB?

6.2.1 Command Summary

Mnemonic	Name	Description
`*CLS`	Clear status	Clears all event registers and Error Queue
`*ESE <NRf>`	Event enable command	Program the Standard Event Enable Register
`*ESE?`	Event enable query	Read the Standard Event Enable Register
`*ESR?`	Event status register query	Read and clear the Standard Event Register
`*IDN?`	Identification query	Read the unit's identification string
`*OPC`	Operation complete command	Set the Operation Complete bit in the Standard Event Register
`*OPC?`	Operation complete query	Places a "1" into the output queue when all device operations have been completed
`*RST`	Reset command	Returns the unit to the *RST default condition
`*SRE <NRf>`	Service request enable command	Programs the Service Request Enable Register
`*SRE?`	Service request enable query	Reads the Service Request Enable Register
`*STB?`	Status byte query	Reads the Status Byte Register
`*TST?`	Self-test query	Performs the unit's self-test and returns the result.
`*WAI`	Wait-to-continue command	Wait until all previous commands are executed

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6.2.2 Command Reference

*IDN? – identification query - read identification code
The identification code includes the manufacturer, model code, serial number, and firmware revision levels and is sent in the following format: THORLABS,MMM,SSS,X.X.X

Where: MMM is the model code
           SSS   is the serial number
           X.X.X is the instrument firmware revision level

*OPC – operation complete - set OPC bit
*OPC? – operation complete query – places a "1" in output queue
When *OPC is sent, the OPC bit in the Standard Event Register will set after all pending command operations are complete. When *OPC? is sent, an ASCII "1" is placed in the Output Queue after all pending command operations are complete.

Typically, either one of these commands is sent after the INITiate command. The INITiate command is used to take the instrument out of idle in order to perform measurements. While operating within the trigger model layers, many sent commands will not execute. After all programmed operations are completed, the instrument returns to the idle state at which time all pending commands (including *OPC and/or *OPC?) are executed. After the last pending command is executed, the OPC bit and/or an ASCII "1" is placed in the Output Queue.

When *OPC is sent, the OPC bit in the Standard Event Register will set after all pending command operations are complete. When *OPC? is sent, an ASCII "1" is placed in the Output Queue after all pending command operations are complete.

*RST – reset – return instrument to defaults
When the *RST command is sent, the instrument performs the following operations:
- Returns the instrument to the default conditions
- Cancels all pending commands.
- Cancels response to any previously received *OPC and *OPC? commands.

*TST? – self-test query – run self test and read result
Use this query command to perform the instrument self-test routine. The command places the coded result in the Output Queue. A returned value of zero (0) indicates that the test passed, other values indicate that the test failed.

*WAI – wait-to-continue – wait until previous commands are completed
The *WAI command is a no operation command for the instrument and thus, does not need to be used. It is there for conformance to IEEE488.2.

6.2.3 PM200 specific SCPI Command Reference

See also SCPI Specification, Version 1999.0, May, 1999, http://www.scpiconsortium.org . All commands with a 'SCPI' checkmark are described in the SCPI specification.

All described commands work also with the PM100D, PM100A, PM100USB and PM160 instruments (with some limitations due to the hardware capabilities).

6.2.3.1 SYSTem subsystem commands

Command	Description
`SYSTem`	Path to SYSTem subsystem. (SCPI Vol.2 §21)
`:BEEPer`	
`[:IMMediate]`	Issue an audible signal. (SCPI Vol.2 §21.2.2)
`:STATe {ON|1|OFF|0}`	Activate/deactivate the beeper. (SCPI Vol.2 §21.2.3)
`:STATe?`	Return the state of the the beeper (SCPI Vol.2 §21.2.3)
`:ERRor`	
`[:NEXT]?`	Returns the latest <error code, "message">. (SCPI Vol.2 §21.8.8)
`:VERSion?`	Query level of SCPI standard (1999.0) . (SCPI Vol.2 §21.21)
`:DATE <year>,<month>,<day>`	Sets the instrument's calendar. (SCPI Vol.2 §21.7)
`:DATE?`	Query the instrument's calendar. (SCPI Vol.2 §21.7)
`:TIME <hour>,<min>,<sec>`	Sets the instrument's clock. (SCPI Vol.2 §21.19)
`:TIME?`	Query the instrument's clock. (SCPI Vol.2 §21.19)
`:LFRequency <numeric value>`	Sets the instrument's line frequency setting to 50 or 60Hz. (SCPI Vol.2 §21.13)
`:LFRequency?`	Query the instrument's line frequency setting. (SCPI Vol.2 §21.13)
`:SENSor`	
`:IDN?`	Query information about the connected sensor. This is a query only command. The response consists of the following fields: `<name>`, `<sn>`,`<cal_msg>`,`<type>`,`<subtype>`,`<flags>` `<name>` Sensor name in string response format `<sn>` Sensor serial number in string response format `<cal_msg>` calibration message in string response format `<type>` Sensor type in NR1 format `<subtype>` Sensor subtype in NR1 format `<flags>` Sensor flags as bitmap in NR1 format. Flag: Dec.value: Is power sensor 1 Is energy sensor 2 Response settable 16 Wavelength settable 32 Tau settable 64 Has temperature sensor 256

6.2.3.2 STATus subsystem commands

Command	Description
`STATus`	Path to STATus subsystem. (SCPI Vol.2 §20)
`  :MEASurement`	Path to control measurement event registers
`    [:EVENt]?`	Read the event register
`    :CONDition?`	Read the condition register
`    :PTRansition <value>`	Program the positive transition filter
`    :PTRansition?`	Read the positive transition filter
`    :NTRansition <value>`	Program the negative transition filter
`    :NTRansition?`	Read the negative transition filter
`    :ENABle <value>`	Program the enable register
`    :ENABle?`	Read the enable register
`  :AUXillary`	Path to control measurement event registers
`    [:EVENt]?`	Read the event register
`    :CONDition?`	Read the condition register
`    :PTRansition <value>`	Program the positive transition filter
`    :PTRansition?`	Read the positive transition filter
`    :NTRansition <value>`	Program the negative transition filter
`    :NTRansition?`	Read the negative transition filter
`    :ENABle <value>`	Program the enable register
`    :ENABle?`	Read the enable register
`  :OPERation`	Path to control operation event registers
`    [:EVENt]?`	Read the event register
`    :CONDition?`	Read the condition register
`    :PTRansition <value>`	Program the positive transition filter
`    :PTRansition?`	Read the positive transition filter
`    :NTRansition <value>`	Program the negative transition filter
`    :NTRansition?`	Read the negative transition filter
`    :ENABle <value>`	Program the enable register
`    :ENABle?`	Read the enable register
` :QUEStionable`	Path to control questionable event registers
`    [:EVENt]?`	Read the event register
`    :CONDition?`	Read the condition register
`    :PTRansition <value>`	Program the positive transition filter
`    :PTRansition?`	Read the positive transition filter
`    :NTRansition <value>`	Program the negative transition filter
`    :NTRansition?`	Read the negative transition filter
`    :ENABle <value>`	Program the enable register
`    :ENABle?`	Read the enable register
`  :PRESet`	Return status registers to default states.

6.2.3.3 DISPlay subsystem commands

Command	Description
`DISPlay`	Path to DISPlay subsystem. (SCPI Vol.2 §8)
`:BRIGhtness <value>`	Set the display birghtness. (SCPI Vol.2 §8.2)
`:BRIGhtness?`	Return the display birghtness value. (SCPI Vol.2 §8.2)
`:CONTrast <value>`	Set the display contrast. (SCPI Vol.2 §8.4)
`:CONTrast?`	Return the display conrast value. (SCPI Vol.2 §8.4)

6.2.3.4 CALibration subsystem commands

Command	Description
`CALibration`	Path to CALibration subsystem. (SCPI Vol.2 §5)
`:STRing?`	Returns a human readable calibration string. This is a query only command. The response is formatted as string response data.

6.2.3.5 SENSe subsystem commands

Command	Description
`SENSe`	Path to SENSe subsystem. (SCPI Vol.2 §18)
`AVERage`	
`[:COUNt] <value`	Sets the averaging rate (1 sample takes approx. 3ms)
`[:COUNt]?`	Queries the averaging rate
`CORRection`	
`[:LOSS[:INPut[:MAGNitude]]] {MINimum|MAXimum|DEFault| <numeric_value>}`	Sets a user attenuation factor in dB
`[:LOSS[:INPut[:MAGNitude]]]? [{MINimum|MAXimum|DEFault}]`	Queries the user attenuation factor
`COLLect`	
`ZERO`	
`[:INITiate]`	Performs zero adjustment routine
`ABORt`	Aborts zero adjustment routine
`STATe?`	Queries the zero adjustment routine state
`MAGNitude?`	Queries the zero value
`BEAMdiameter {MINimum| MAXimum|DEFault| <numeric_value>[mm]}`	Sets the beam diameter in mm
`BEAMdiameter? [{MINimum| MAXimum|DEFault}]`	Queries the beam diameter
`WAVelength {MINimum| MAXimum| <numeric_value>[nm]}`	Sets the operation wavelength in nm
`WAVelength? [{MINimum| MAXimum}]`	Queries the operation wavelength
`POWer`	
`[:PDIOde]`	Sets the photodiode response value in A/W

Command	Description
[:RESPonse] {MINimum| MAXimum|DEFault| <numeric_value>[A]}	
[:RESPonse]? [{MINimum|MAXimum| DEFault}]	Queries the photodiode response value
:THERmopile	
[:RESPonse] {MINimum| MAXimum|DEFault| <numeric_value>[V]}	Sets the thermopile response value in V/W
[:RESPonse]? [{MINimum|MAXimum| DEFault}]	Queries the thermopile response value
ENERgy	
[:PYRO]	
[:RESPonse] {MINimum| MAXimum|DEFault| <numeric_value>[V]}	Sets the pyro-detector response value in V/J
[:RESPonse]? [{MINimum|MAXimum| DEFault}]	Queries the pyro-detectro response value
CURRent[:DC]	
RANGe	
AUTO {OFF|0|ON|1}	Switches the auto-ranging function on and off
AUTO?	Queries the auto-ranging function state
[:UPPer] {MINmum|MAXimum| <numeric_valuje>[A]}	Sets the current range in A
[:UPPer]? [{MINimum| MAXimum}]	Queries the current range
REFerence {MINimum| MAXimum|DEFault| <numeric_value>[A]}	Sets a delta reference value in A
REFerence? [{MINimum| MAXimum|DEFault}]	Queries the delta reference value
STATe {OFF|0|ON|1}	Switches to delta mode
STATe?	Queries the delta mode state
ENERgy	
RANGe	
[:UPPer] {MINmum|MAXimum| <numeric_valuje>[J]}	Sets the energy range in J
[:UPPer]? [{MINimum| MAXimum}]	Queries the energy range
REFerence {MINimum| MAXimum|DEFault| <numeric_value>[J]}	Sets a delta reference value in J
REFerence? [{MINimum| MAXimum|DEFault}]	Queries the delta reference value
STATe {OFF|0|ON|1}	Switches to delta mode
STATe?	Queries the delta mode state
FREQuency	
Range	

Command	Description
[UPPer]?	Queries the frequency range
LOWer?	
POWer[:DC]	
RANGe	
AUTO {OFF|0|ON|1}	Switches the auto-ranging function on and off
AUTO?	Queries the auto-ranging function state
[:UPPer] {MINmum|MAXimum|<numeric_valuje>[W]}	Sets the power range in W
[:UPPer]? [{MINimum|MAXimum}]	Queries the power range
REFerence {MINimum|MAXimum|DEFault|<numeric_value>[W]}	Sets a delta reference value in W
REFerence? [{MINimum|MAXimum|DEFault}]	Queries the delta reference value
STATe {OFF|0|ON|1}	Switches to delta mode
STATe?	Queries the delta mode state
UNIT {W|DBM}	Sets the power unit W or dBm
UNIT?	Queries the power unit
VOLTage[:DC]	
RANGe	
AUTO {OFF|0|ON|1}	Switches the auto-ranging function on and off
AUTO?	Queries the auto-ranging function state
[:UPPer] {MINmum|MAXimum|<numeric_valuje>[V]}	Sets the current range in V
[:UPPer]? [{MINimum|MAXimum}]	Queries the current range
REFerence {MINimum|MAXimum|DEFault|<numeric_value>[V]}	Sets a delta reference value in V
REFerence? [{MINimum|MAXimum|DEFault}]	Queries the delta reference value
STATe {OFF|0|ON|1}	Switches to delta mode
STATe?	Queries the delta mode state
PEAKdetector	
[:THReshold] {MINimum|MAXimum|DEFault|<numeric_value>	Sets the trigger level in % for the energy mode
[:THReshold]? [{MINimum|MAXimum|DEFault}	Queries the trigger level setting

6.2.3.6 INPut subsystem commands

Command	Description

INPut
  [:PDIode]
    :FILTer
      [:LPASs]
        [STATe] {OFF|0|ON|1}
        [STATe]?
	
	Sets the bandwidth of the photodiode input stage
	Queries the bandwidth of the photodiode inut stage

:THERmopile
  :ACCelerator
    [STATe] {OFF|0|ON|1}
    [STATe]?
    :AUTO {OFF|0|ON|1}
    ?
    :TAU {MINimum|
    MAXimum|DEFault|
    <numeric_value>[s]}
    :TAU? [{MINimum|
    MAXimum|DEFault}]
	
	Sets the thermopile accelerator state
	Queries the thermopile accelerator state
	Sets the thermopile accelerator to auto mode
	Queries thermopile accelerator auto mode
	Sets thermopile time constant 0-63% in s
	
	Queries the thermopile time constant in s

:ADAPter
  [:TYPE] {PHOTodiode|
  THERmal|PYRo}
  [:TYPE]?
	
	Sets default sensor adapter type
	
	Queries default sensor adapter type

6.2.3.7 Measurement commands

Command	Description
`INITiate[:IMMediate]`	Start measurement
`ABORt`	Abort measurement
`CONFigure[:SCALar]`	
`[:POWer]`	Configure for power measurement
`:CURRent[:DC]`	Configure for current measurement
`:VOLTage[:DC]`	Configure for voltage measurement
`:ENERgy`	Configure for energy measurement
`:FREQuency`	Configure for frequency measurement
`:PDENsity`	Configure for power density measurement
`:EDENsity`	Configure for energy density measurement
`:RESistance`	Configure for sensor presence resistance measurement
`:TEMPerature`	Configure for sensor temperature measurement
`MEASure[:SCALar]`	
`[:POWer]`	Performs a power measurement
`:CURRent[:DC]`	Performs a current measurement
`:VOLTage[:DC]`	Performs a voltage measurement
`:ENERgy`	Performs a energy measurement
`:FREQuency`	Performs a frequency measurement
`:PDENsity`	Performs a power density measurement
`:EDENsity`	Performs a energy density measurement
`:RESistance`	Performs a sensor presence resistance measurement
`:TEMPerature`	Performs a sensor temperature measurement
`FETCh?`	Read last measurement data (SCPI Vol.2 §3.2)
`READ?`	Start new measurement and read data (SCPI Vol.2 §3.3)
`CONFigure?`	Query the current measurement configuration.

7 Maintenance and Service

Protect the PM200 from adverse weather conditions. The PM200 is not water resistant.

Attention

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

The unit does not need a regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the user himself. If a malfunction occurs, please contact Thorlabs[77] for return instructions.

Do not remove covers!

7.1 Troubleshooting

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

- PM200 turned on? Press On switch in the left side panel.
- PM200 battery discharged / defect -> Plug in AC Adapter

Unit automatically switches off
- Check auto-shutoff setting
- Check battery charging symbol
- Plug in AC Adapter

Power or Energy reading is negative
- A photodiode or thermal sensor is connected
  - ➢ Check if the unit is in relative measurement mode
  - ➢ Conduct the dark current adjustment procedure
- A photodiode is connected
  - ➢ Check the polarity of the connected photodiode
- A thermal element is connected
  - ➢ Check the polarity of the connected thermal element
- A pyro-electric element is connected
  - ➢ Check the polarity of the connected pyro element

Pulse energy cannot be measured or is measured wrongly
- Check for the right trigger level between noise level and expected pulse height
- Check if energy sensor can handle the laser pulse repetition rate

A connected USB stick is recognized, but not read out
- Try another USB stick

If you cannot resolve your issue using above hints, please contact Thorlabs[77].

8 Appendix

8.1 Sensor Connector Pinning

The PM200 is capable to support custom made detectors. Please read carefully the following instruction prior to connecting a self made sensor.
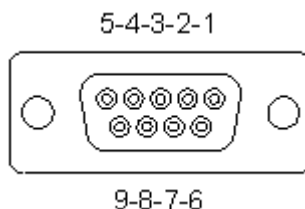
*Pin-out of the 9pin DSUB
sensor connector (female)*

pin	connection
3	AGND (analog ground): photodiode ground (anode), thermal and pyro sensor ground
4	photodiode cathode
5	pyroelectric sensor +
8	thermal sensor +
7	PRESENT: Connect this pin via a 1kΩ – 10kΩ resistor to pin 3 (AGND) to enable a custom sensor
1	+5V (max. current 50mA from this pin)
6	DGND (digital ground)
9	n.c.

Warning

Pin 2 is uniquely used for the EEPROM Digital I/O (memory in Thorlabs sensor heads) and ***MUST NOT*** be used. Connecting this pin may cause malfunction of the PM200.

8.2 Technical Data

Features	
Detector Compatibility	Photodiode Sensors S100C Series Thermal Sensors S300C Series Pyroelectric Sensors ES100C/ES200C Series Photodiodes (Max 5 mA) Thermopiles (Max 1 V) Pyros (Max 100 V)
Display Type	5.7" TFT, 640 x 480 Pixels, 18 bit Color
Viewing Area	118 mm x 88 mm
Display Update Rate (max)	100 Hz
Display Format	Numerical, Bargraph, Trendgraph, Statistics, Simulated Analog Needle
Backlight Display	LED, Adjustable
Features	Rotatable Two Position Kickstand, Removable Rubberboot, Touch-Pen, Fixture for Optional Fiber Inspection Camera
Current Input (Photodiode Sensors)	
Connector	DB9F, Left Side
Units	W, dBm, W/cm², A
Measurement Ranges	6 Decades; 50 nA - 5 mA Ranges Selectable in W, Sensor Dependent
Display Resolution	1 pA / Responsivity Value (A/W)
AD Converter	16 bit
Accuracy	±0.2% f.s. (5 µA - 5 mA) ±0.5% f.s. (50 nA)
Bandwidth	DC - 100 kHz, Dependent on Sensor and Settings
Wavelength Correction	nm (A/W)
Beam Area Setting	Diameter 1/e² or Rectangular x,y
Voltage Input (Thermopile Sensors)	
Connector	DB9F, Left Side
Units	W, dBm, W/cm², V
Measurement Ranges	4 Decades; 1 mV - 1 V Ranges Selectable in W, Sensor Dependent
Display Resolution	1 µV / Responsivity Value (V/W)
AD Converter	16 bit
Accuracy	±0.5% f.s. (10 mV - 1 V) ±1% f.s. (1mV)
Bandwidth	DC - 10 Hz, Dependent on Sensor and Settings
Time Constant Correction Range	1 s - 30 s
Wavelength Correction	Sensor Dependent; nm, (V/W)
Beam Area Setting	Diameter 1/e² or Rectangular x,y

Voltage Input (Pyro Sensors)	
Connector	DB9F, Left Side
Units	J, J/cm², W, W/cm², V
Measurement Ranges	4 Decades; 200 mV - 2V - 20 V - 100 V Ranges Selectable in J, Sensor Dependent
Display Resolution	100 µV / Responsivity Value (V/J)
AD Converter	16 bit
Accuracy	± 0.5% f.s.
Trigger Threshold	0.1% - 99.9% f.s.
Max. Repetition Rate	3 kHz
Wavelength Correction	Sensor Dependent [nm, V/J]
Beam Area Setting	Diameter 1/e² or Rectangular x,y
Analog Output	
Connector	Audio 3.5 mm, Left Side
Signal	Amplified Input Signal - Not Corrected
Voltage Range	0 to 2 V
Accuracy	±3%
Bandwidth	up to 100 kHz, Dependent on Sensor and Settings
Auxiliary In-/Output	
Connector	2 x 6 Pins, 0.1" Socket, Top Side
Function	External Trigger Input 4 x GPIO 2 x 10 bit ADC
Sensor Temperature Control	
Supported Temperature Sensor	Thermistor
Temperature Measurement Range	-10 °C to +80 °C
Sound	
Type	Speaker 300 Hz - 5 kHz
Function	Laser Tuning Support, Console Function Support
Memory	
Type	Nand Flash
Size	128 MB
Interfaces	
Type	USB2.0
Connector (Host)	Mini USB, Top Side
Connector (Device)	USB Type A, Left Side
Power Management	

Battery	LiPo 3.7 V 2600 mAh
Charger / DC Input	5 V / 2 A
Power Connector	Center Hole
General	
Operating Temperature Range [1]	0 - 40 °C
Storage Temperature Range	-40 to 70 °C
Dimensions (W x H x D)	170 mm x 125 mm x 38 mm
Weight	0.57 kg

[1] non-condensing

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

8.3   Certifications and Compliances

Category	Standards or description
EC Declaration of Conformity - EMC	Meets intent of Directive 2004/108/EC [1] for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:
EN 61326:2006	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A Radiated and Conducted Emissions [2,3,4] and Immunity. [2,3,4]
IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion B)
IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance criterion A)
IEC 61000-4-4	Electrical Fast Transient / Burst immunity (Performance criterion B)
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B [2,3,4].
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 2006/95/EC [5]
EN 61010-1:2001	Safety requirements for electrical equipment for measurement, control and laboratory use.
UL 61010-1 2nd ed.	Safety requirements for electrical equipment for measurement, control and laboratory use.
CAN/CSA C22.2 No. 61010-1 2nd ed.	Safety requirements for electrical equipment for measurement, control and laboratory use.
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] Replaces 89/336/EEC
[2] Compliance demonstrated using high-quality shielded interface cables.
[3] Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.
[4] Minimum Immunity Test requirement.
[5] Replaces 73/23/EEC, amended by 93/68/EEC.

8.4 Warranty

Thorlabs warrants material and production of the PM200 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. 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/or 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 software 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 at any time.

8.5   Copyright and Exclusion of Reliability

Thorlabs has taken every possible care in preparing this document. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this document is regularly updated and adapted to reflect the current status of the hardware and/or software. We furthermore do not guarantee that this product will function without errors, even if the stated specifications are adhered to.

Under no circumstances can we guarantee that a particular objective can be achieved with the purchase of this product.

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8.6   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 below)
- 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.).

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.

WEEE Number (Germany) : DE97581288

Ecological background

It is well known that waste treatment 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-life products will thereby avoid negative impacts on the environment.

Crossed out
"Wheelie Bin" symbol

8.7 List of Acronyms

The following acronyms and abbreviations are used in this manual:

ADC	Analog-to-Digital Converter
CW	Continuous Wave
dB	Dezibel
DB-9	Standard 9 pin D-SUB connector
DC	Direct Currect
GPIO	General Purpose Input / Output
LED	Light Emitting Diode
NTC	Negative Temperature Coefficient
USB	Universal Serial Bus

8.8 Thorlabs Worldwide Contacts

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