



Optical Power Monitor

Operation Manual



2021

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We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to live up to your expectations and constantly improve our products 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 preceded 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 this advice carefully!

1 General Information

The Thorlabs Optical Power Monitor (OPM) is a graphical user interface (GUI) designed for the straightforward use of Thorlabs' power meters. The OPM monitors and saves power meter measurements and features an interface for data viewing and analysis. A variety of settings for the connected devices, the display, and the measurement can be easily configured.

To control complex setups, the OPM can monitor up to 8 Thorlabs power meters in parallel, connected via USB or Bluetooth also on your tablet computer.

The OPM software provides continuous data logging, also for long-term measurements. Short-term measurements are monitored and recorded by the software with a high resolution.

The user can switch between displayed parameters at any time during an active measurement or use the simulated analog needle view for assistance during tuning.

Log files saved by the OPM or data saved by a PM400 power meter can be loaded into the OPM Data Viewer for viewing or analysis. Additionally, the OPM provides statistics parameters to evaluate the results.

The display language can be set to English, German, or Chinese.

Beyond these capabilities, the OPM provides a user-friendly design with reduced overall brightness for comfortable work in dark environments and high contrast and minimized use of color coding for operability with laser safety glasses.

The OPM supports the following Thorlabs power meters and appropriate sensors and can administer them in parallel.

- [PM101x](#) (PM101, PM101A, PM101R, PM101U)
- [PM102x](#) (PM102, PM102A, PM102U)
- [PM103x](#) (PM103, PM103A, PM103U)
- [PM100USB](#)
- [PM16-Series](#)
- [PM160](#)¹⁾
- [PM160T](#)¹⁾
- [PM160T-HP](#)¹⁾
- [PM400](#)
- [PM100A](#)
- [PM100D](#)
- PM200

¹⁾ Bluetooth connection possible

Different Thorlabs power meters provide additional functions, listed in the chapter "[Power Meter Dependent Variations](#)^[42]".

Note

The OPM contains the functions provided by the **Optical Power Meter Utility**, **Multi Power Meter**, and **Power Meter Monitor** software packages and provides many additional features.

Attention

New Instrument Driver

Please note that the Optical Power Monitor installs and uses the newer power meter driver TLPM.dll instead of the formerly used NI-VISA™-based driver PM100D.dll. In case you want to use any of the old software packages **Optical Power Meter Utility**, **Multi Power Meter** or **Power Meter Monitor** or if you are using **Custom Made Software**, please read the [Instrument Driver for Thorlabs Power Meters](#)^[60] section to revert to the driver PM100D.dll.

2 Requirements

These are the requirements for the PC intended to be used for the installation of the Optical Power Monitor.

Hardware Requirements

CPU:	2.4 GHz or Faster
RAM:	Min. 4 GB
Graphic Card:	Min. 1024 x 768 Pixel Graphic Resolution
Hard Disc:	Min. 1 GB of Available Free Space (32 bit Operating System) Min. 2.3 GB of Available Free Space (64 bit Operating System)
Interface	Free USB 2.0 Port, USB Cable According to the USB 2.0 Specification

Software Requirements

The OPM software is compatible with the following operating systems:

- Windows® 8.1 (32 bit, 64 bit)
- Windows® 10 (32 bit, 64 bit)

3 First Steps

The Optical Power Monitor can be downloaded from the Thorlabs website:

https://www.thorlabs.com/software_pages/ViewSoftwarePage.cfm?Code=OPM

Note

Do not connect a power meter to the PC during software installation! Please make sure that the installation is carried out completely, including the reboot requests.

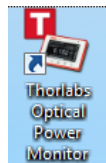
- Save the ZIP file to your computer and unpack the archive.
- Double click the setup.exe to install Shield Wizard.
- Read and accept the End-user License Agreement and the GNU Lesser general Public License.
- Note the Readme Information during the installation process: A new and improved instrument driver ([TLPM Instrument Driver](#)^[60]) is installed.
- After installing the OPM, connect the power meter(s) to the PC.

Note

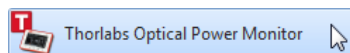
Up to 8 power meters can be connected and monitored in parallel in a single software instance. If your PC does not provide a sufficient number of USB-ports, use a powered USB-HUB to ensure that enough power is supplied to the power meters.

Start Application

Start the OPM from the desktop icon:



or access the OPM from the START button:



Attention

New Instrument Driver

Please note that the Optical Power Monitor installs and uses the newer power meter driver TLPM.dll instead of the formerly used NI-VISA™-based driver PM100D.dll. In case you want to use any of the old software packages **Optical Power Meter Utility**, **Multi Power Meter** or **Power Meter Monitor** or if you are using **Custom Made Software**, please read the [Instrument Driver for Thorlabs Power Meters](#)^[60] section to revert to the driver PM100D.dll.

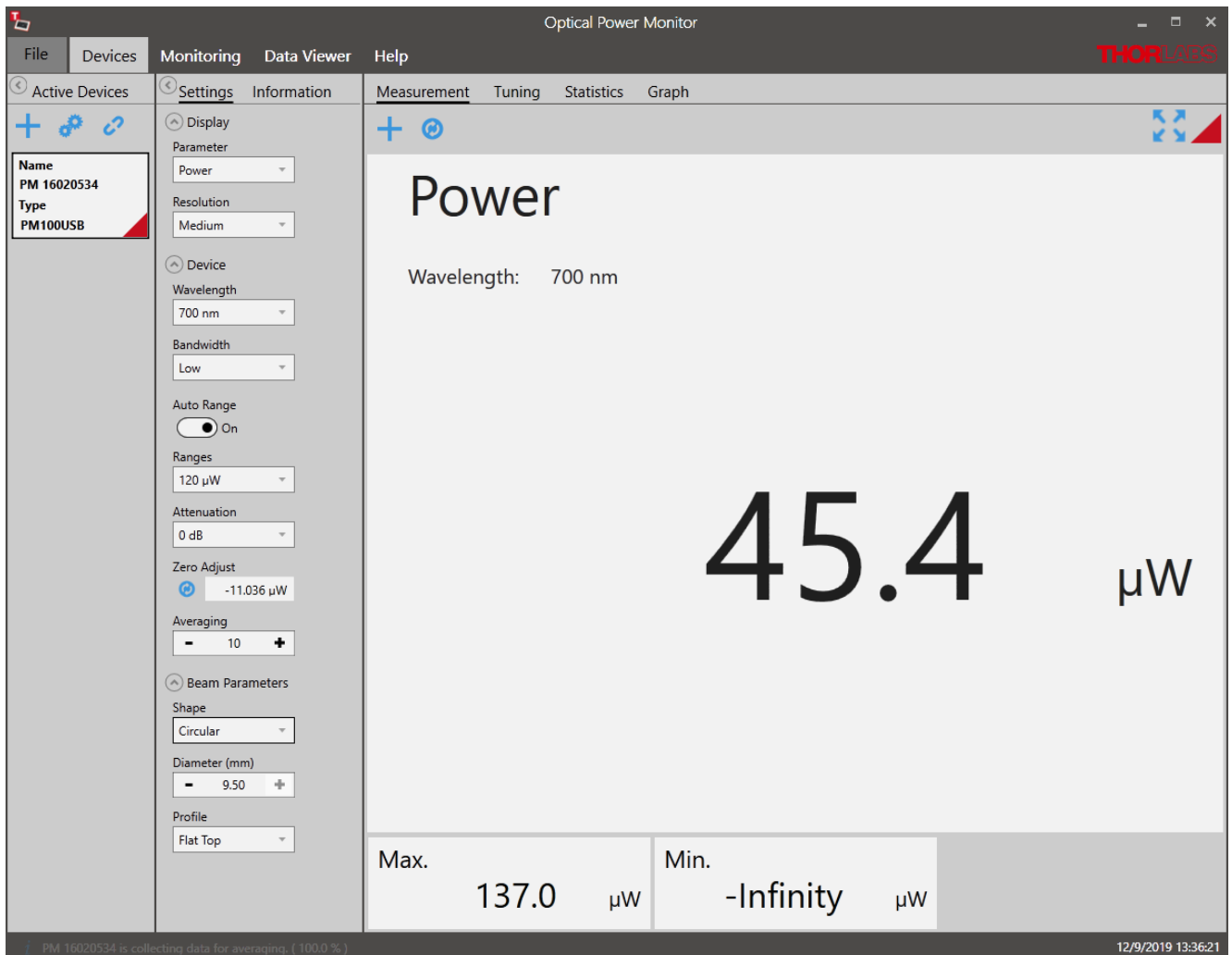
Note

When connecting an additional power meter, unknown to the PC, the driver for this power meter will be installed as indicated on the bottom right corner of the screen.

4 Graphical User Interface (GUI)

In this manual, the OPM interface is described based on a set up using a Power Meter console consisting of either a Thorlabs PM100USB with a Thorlabs Photodiode Power Sensor S122C, or a Thorlabs PM101 with a Thorlabs Photodiode Power Sensor [S120C](#), connected to a PC running with OS Windows® 10. Variations in the interface due to certain power meter consoles are described in the section [OPM with Different Devices](#)^[42].

The OPM automatically connects the first recognized power meter, lists it in the left panel in [Active Devices](#)^[10] (here: PM101) and shows the setting options for power measurements recorded by the connected power meter.



Menu Bar

[File](#)^[8]

Load File, Save, and Print Screen Shot and Exit the Software

[Devices](#)^[8]

Activate and Administer Devices and Measurements

[Monitoring](#)^[30]

Set Up a Measurement to be Logged and Saved (Active only after Device Setup)

[Data Viewer](#)^[37]

View and Analyze Loaded Files

[Help](#)^[41]

Language Settings, General Software Settings, Software Information and Link to the Manual

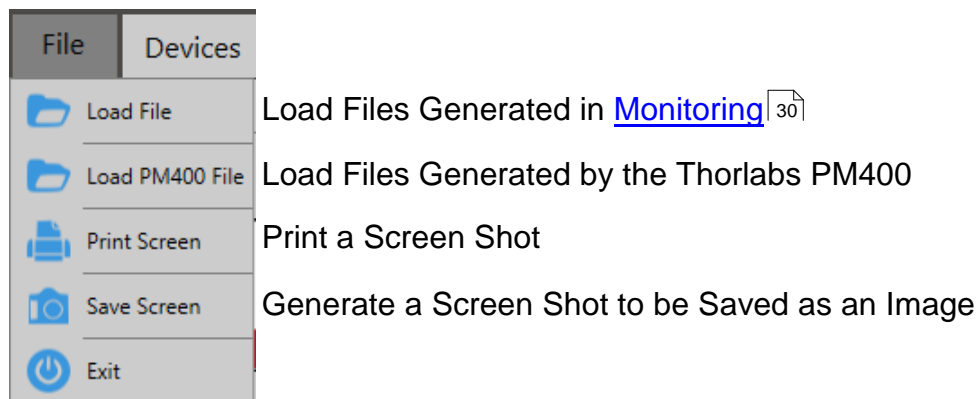
To setup a short measurement, go through the sub menu of [Devices](#)^[8] or use the [Monitoring menu](#)^[30] for long term logging.

Note

If no power meters are connected to the PC or automatically recognized, the OPM starts with the [Found Devices](#)^[10] panel instead of the [Measurement](#)^[21] panel. Use the [Found Devices](#)^[10] panel to scan for devices and connect them to the software.

4.1 File

The **File** menu provides the following options:



Note

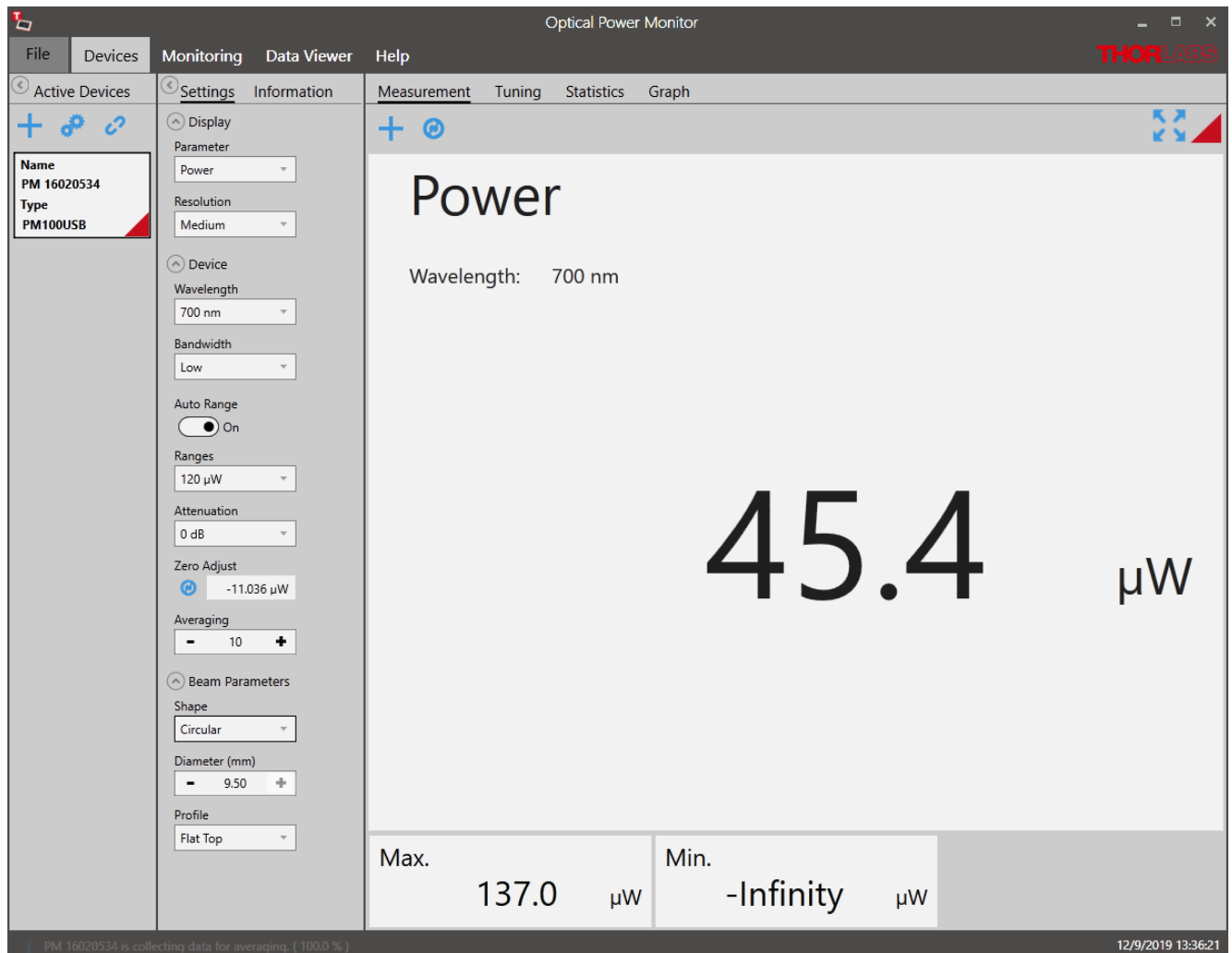
[PM400 files](#)^[43]: The file structure of data saved by the Optical Power Monitor and the PM400 differ. Both file formats can be loaded by the OPM by selecting the appropriate import option. Also note the information given in the section [file formats](#)^[36].

4.2 Devices

The **Devices** menu administers the currently connected devices, short-term measurements and the respective settings.

To start a measurement, follow the sequence suggested by the menu bar from left to right:

- [Activate Devices](#)^[10]
- Adjust [Settings](#)^[13]
- Observe the [Measurement](#)^[21]



Menu Bar

- [Active Devices](#) ^[10] Administer Connected Power Meters
- [Settings](#) ^[13] Administer Settings of the Display and Connected Devices
- [Information](#) ^[15] Information about the Connected Devices
- [Measurement](#) ^[21] Active Measurement Display
- [Tuning](#) ^[23] Analog Needle Simulation with Digital Measurement Value
- [Statistics](#) ^[26] Statistics Tool to Setup, Display, and Save Statistics of the Active Measurement
- [Graph](#) ^[28] Tool for Short-Term Measurements with High Sampling Resolution

Note

If no power meters are connected to the PC or automatically recognized, the OPM starts with the [Found Devices](#) ^[10] panel instead of the [Measurement](#) ^[21] panel. Use [Found Devices](#) ^[10] to scan for devices and connect them to the software. The OPM automatically connects the first recognized power meter.

4.2.1 Active Devices

Devices connected to the software will automatically appear in the list [Active Devices](#)^[10]. To activate additional devices, connect them in the [Found Devices](#)^[10] panel. The OPM automatically recognizes devices connected to the PC and connects to the first recognized device any time the software is started.

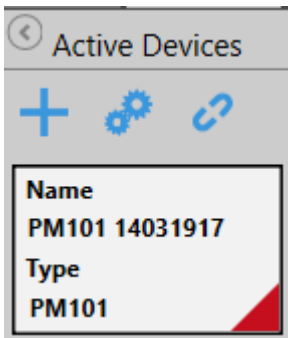
In the example below, the PM101 and a sensor with the Serial Number 14031917 are connected to the PC. This combination has automatically been connected to the OPM and therefore appears in the panel **Active Devices**.

Active devices receive a default name consisting of the power meter type and the serial number of the sensor. This default name can be [edited](#)^[13] to a name of choice.

Note

Devices that were connected to the software in the previous session are automatically reconnected to the software. Device name and settings from the previous session are automatically loaded in the new session.

Use the **Tool Bar**, to add or edit the active devices:



+: [Add devices](#)^[10] to the list of **Active Devices**

⚙️: [Edit](#)^[13]: **Rename devices**

🔗: Disconnect: **Disconnect devices** from the software.

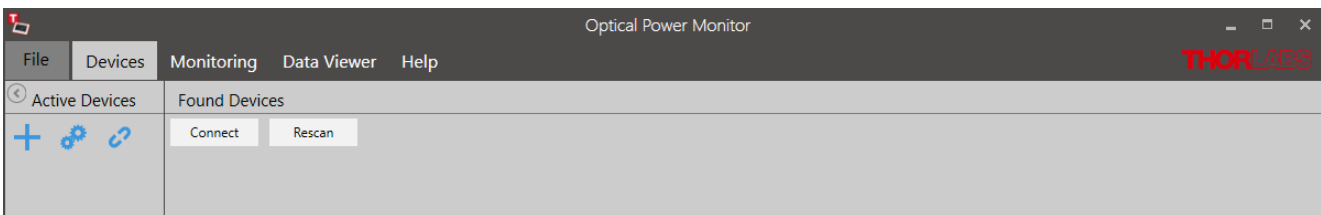
Note

In case a device was not recognized by the Optical Power Monitor, please reconnect it to the PC.

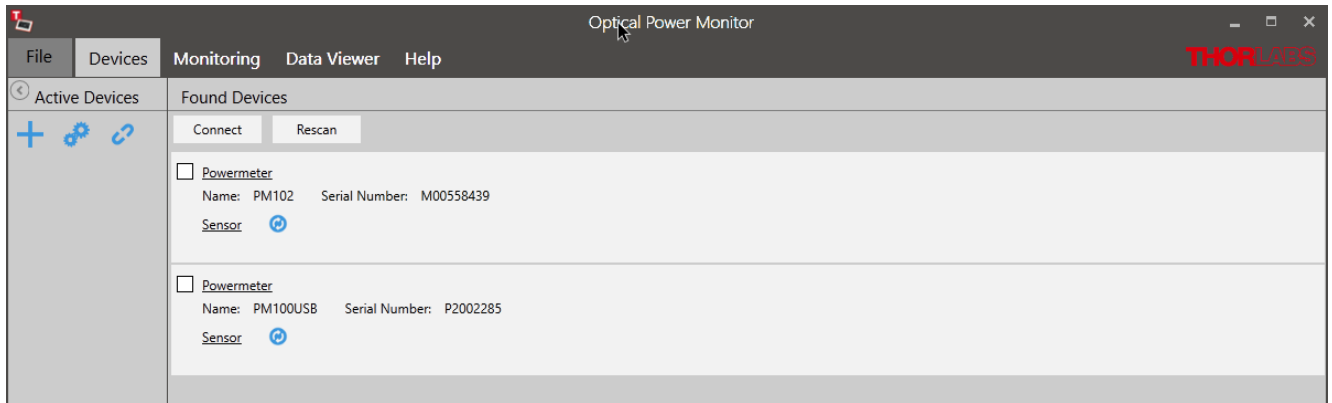
4.2.1.1 Add Devices

Use the **Found Devices** panel to connect power meter consoles to the software by activating them in the "Active Devices" list.

- Click **+** in the **Active Devices** table to add devices.



- Click **Rescan** if no devices are detected to find all devices connected to the PC or reconnect devices to the PC.



Here, PM102 and PM100USB are recognized. The panel **Found Devices** shows details about the devices that are connected to the PC.

Click  to view sensor information.

- Mark the tick-box in **Found Devices** and click **Connect** to activate devices.
- Click on a device in **Active Devices** to return to the **Devices** menu and view measurements.

Note

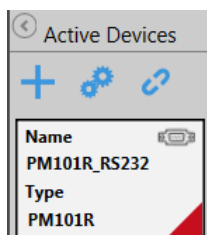
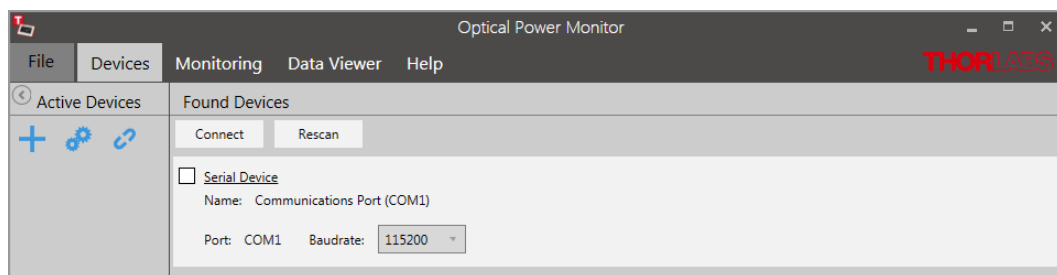
When the first recognized device is connected to the software, the display changes to monitor a measurement as shown in [Devices](#)⁸.

Note

If no power meters are connected to the PC or automatically recognized, the OPM starts with the [Found Devices](#)¹⁰ panel.

COM-PORT

When using a PM101, PM101R, PM102, or PM103 device over a serial interface, the COM Port can be selected by clicking the respective field. Please also adjust the Baud rate in this interface. For more information, please see the manuals for [PM101x](#) and [PM102x](#), [PM103x](#).



The power meter is now controlled via RS232 operation via the DE-9 or DA-15 port. The status is shown in the field Active Devices next to the device name.

Attention Instrument Driver

Be aware that different [instrument drivers](#)⁶⁰ may be used by your device. The OPM recognizes and runs with power meters using the new driver TLPM or a legacy driver PM100D. However,

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when running the software with a connected PM400, PM101x, PM102x, or PM103x with the old PM100D driver, the software will not provide all functions.

In case the legacy driver PM100D is used, the information panel under devices will show a field USB driver, indication NI-VISA™. In this case, please use the [driver switcher](#)^[60], that is automatically installed with the OPM to change to the new driver TLPM.

The screenshot displays the Optical Power Monitor software interface. The main window is titled "Optical Power Monitor" and features a menu bar with "File", "Devices", "Monitoring", "Data Viewer", and "Help". Below the menu bar, there are tabs for "Active Devices", "Settings", "Information", "Measurement", "Tuning", "Statistics", and "Graph".

The "Active Devices" panel on the left shows a list of devices. The selected device is "PM101 12052346" with a type of "PM101".

The "Information" panel on the left provides details for the selected device:

- Powermeter:**
 - Type: PM101
 - Serial Number: M12345678
 - Date of Calibration: 08-Apr-2019
 - Firmware Revision: 1.0.0
 - USB Driver: NI-VISA (Warning icon)
- Sensor:**
 - Name: S150C
 - Serial Number: 12052346
 - Date of Calibration: 23-May-2012 (Warning icon)
 - Type: Photodiode
 - Wavelength Range: 350 - 1100 nm

The "Measurement" panel on the right displays the current power reading: **1.943 μW**. The wavelength is set to 350 nm. Below the main display, there are two summary boxes:

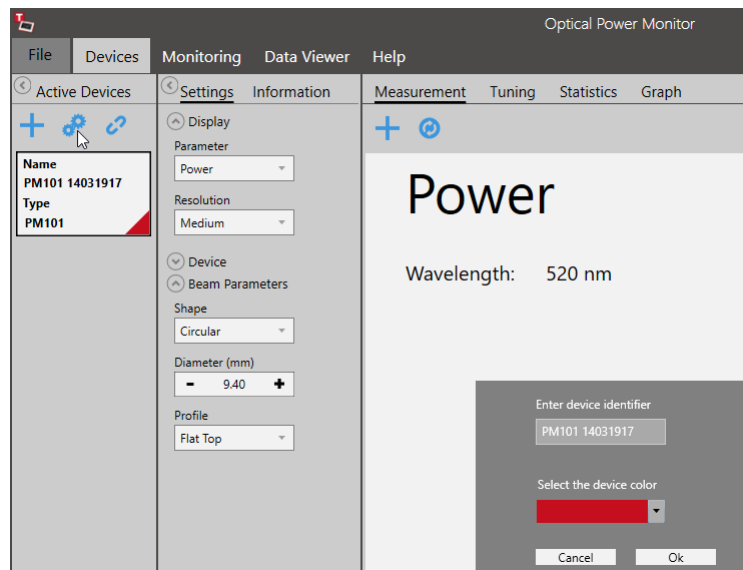
Max.	1.971 μW	Min.	1.907 μW
------	----------	------	----------

The bottom right corner of the interface shows the date and time: 8/6/2019 12:12:28.

4.2.1.2 Edit Devices

Click  to edit the **Active Devices** list.

Use the below panel to rename the device or change the identification color.



4.2.2 Settings

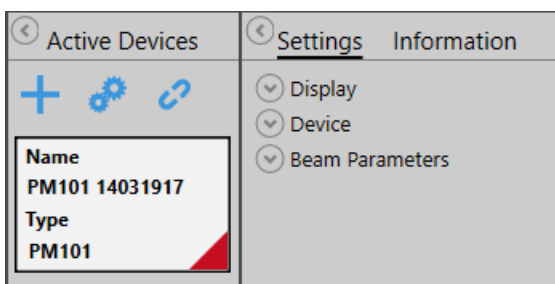
Device settings and measurement settings need to be adjusted in the **Settings** menu prior to the measurement by using the drop down menus shown below.

Note

Changes in the settings made during a measurement are applied immediately and impact the measurement. Changes in settings during active measurements are not saved!

Attention

As the OPM calculations depend on these settings, correct settings are essential for best measurement accuracy.

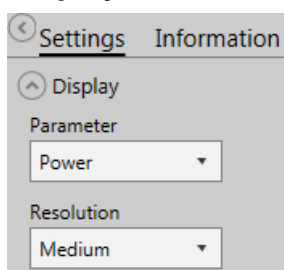


Display: Adjust Display Settings

Device: Adjust Device Settings

Beam Parameters: Adjust Light Source Settings

Display



Parameter: Select the parameter that should be displayed as the main parameter in all 4 measurement monitors: Measurement, Tuning, Statistics, and Graph.

Resolution: Set the desired measurement resolution.

Device

The screenshot shows the 'Device' configuration panel with the following settings: Wavelength: 520 nm; Bandwidth: Low; Auto Range: Off; Ranges: 1.4 mW; Attenuation: 0 dB; Zero Adjust: 6.177 μW; Averaging: 10; AO2 Responsivity: 0.1 MKV/W.

Wavelength: Set the wavelength of the measured light. This is essential in order to compensate the measurement result for the wavelength-dependent responsivity of the sensor.

Bandwidth: Set the bandwidth of the photodiode to low or high, depending on the incoming signal and the properties of your photodiode sensor (please see the specification of your sensor and the [Thorlabs Photodiode Tutorial](#)).

Range: Maximum value to be measured within the selected power range. This displayed value is calculated by the power meter. It is recommended to use the default setting **Auto Range ON**.

Use **Auto Range OFF**, to set the measurement range manually, for example for measurement of pulsed light sources.

Attenuation: To account for the attenuation of optical components placed between the light source and the power meter sensor (e.g. filters, beam splitters, etc.), a correction factor can be assigned. For exceptions see the section [Power Meter Dependent Variations](#)^[42].

Zero Adjust: Compensate the measurement result for the measured dark signal or noise.

Averaging: Choose the number of values averaged. Averaging is calculated by the software and thus the measurement values may differ from the values displayed on the power meter consoles. Measurement values are provided to the software by the connected Thorlabs power meter at the specified refresh rate described in the [power meter manual](#). When choosing to average the measurement values, all measurement values displayed within the OPM will be averaged.

AOx Responsivity: For PM101 (AO2) and PM101A (AO), and PM102 and PM102A (POWER AO), and PM103 and PM103A (AO2), the OPM allows to define the voltage level of the analog output by configuring the responsivity. Please see the manuals of [PM101x](#), [PM102x](#), and [PM103x](#) for more details.

Note

Depending on the power meter, not all options may be displayed.

Beam Parameters

The Beam Parameters are relevant when calculating Irradiance or Fluence (for pyro sensors).

The screenshot shows the 'Beam Parameters' configuration panel with the following settings: Shape: Circular; Diameter (mm): 3.35; Profile: Flat Top.

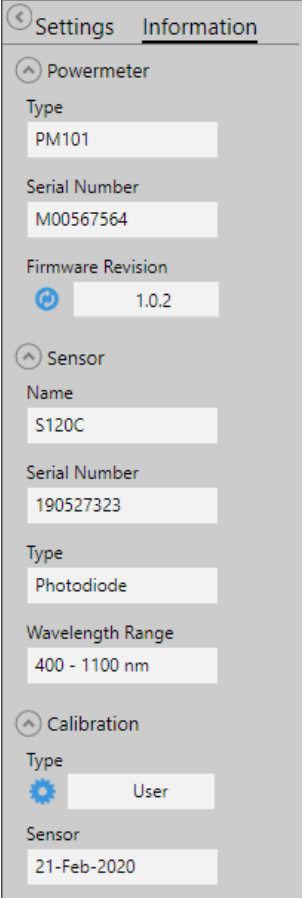
Shape: Choose between **Circular**, **Square** or **Rectangular** according to your light source and optics.

Size: Adjust the size of the beam arriving on the photo sensor according to your light source and optics.

Profile: Adjust beam profile arriving at the photo sensor according to your light source and optics.


4.2.3 Information

This menu lists information about the connected devices, **Power Meters** and **Sensors**, as retrieved from the connected device.




The screenshot shows the 'Information' menu with three expandable sections: Powermeter, Sensor, and Calibration. Each section contains several fields with their values.

Section	Field	Value
Powermeter	Type	PM101
	Serial Number	M00567564
	Firmware Revision	1.0.2
Sensor	Name	S120C
	Serial Number	190527323
	Type	Photodiode
	Wavelength Range	400 - 1100 nm
	Calibration	User
Calibration	Sensor	21-Feb-2020

Power Meter
Type: Type of Thorlabs Power Meter
Serial Number: Serial Number of the Device
Firmware Revision: Current Firmware Version of the Power Meter. Update the Firmware by selecting the button .

Sensor
Name: Sensor Name
Serial Number: Serial Number of the Sensor
Type: Type of Sensor: Photodiode, Thermal-, or Pyroelectric Sensor
Wavelength Range: Wavelength Range of Detection of the Sensor

Calibration
Type: Type of Sensor Calibration. Select  to [calibrate the sensor](#) ¹⁵.
Sensor: Date of last sensor calibration

Attention

When the software uses the power meter driver PM100D.dll, this is shown in the interface in the power meter section below "Firmware". When running the software with a connected PM400, PM101x, PM102x, or PM103x with the old PM100D driver, the software will lack certain functions. To switch the driver, please see the chapter [Power Meter Driver Switcher](#) ⁶⁰.

4.2.3.1 User Calibration of Sensors

The OPM provides a Calibration Wizard for the user to calibrate Thorlabs Photodiode and Thermopile Sensors in combination with a power meter.

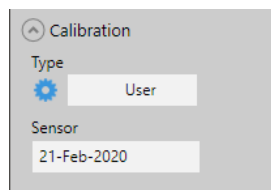
In principle, the Calibration Wizard uses a measured single point signal from a trusted reference sensor to calibrate the sensor connected to the power meter. The determined correction factor and calibration data are then saved with the serial numbers of the sensors in the internal memory of the power meter and retrieved by the OPM. Up to 5 datasets can be saved. Information remains there until new calibration data overrides it. The user can revert the recalibration any time and return to the factory calibration.

The following power meters support this function: PM400, PM101x, PM102x, PM103x.

Calibration protocol

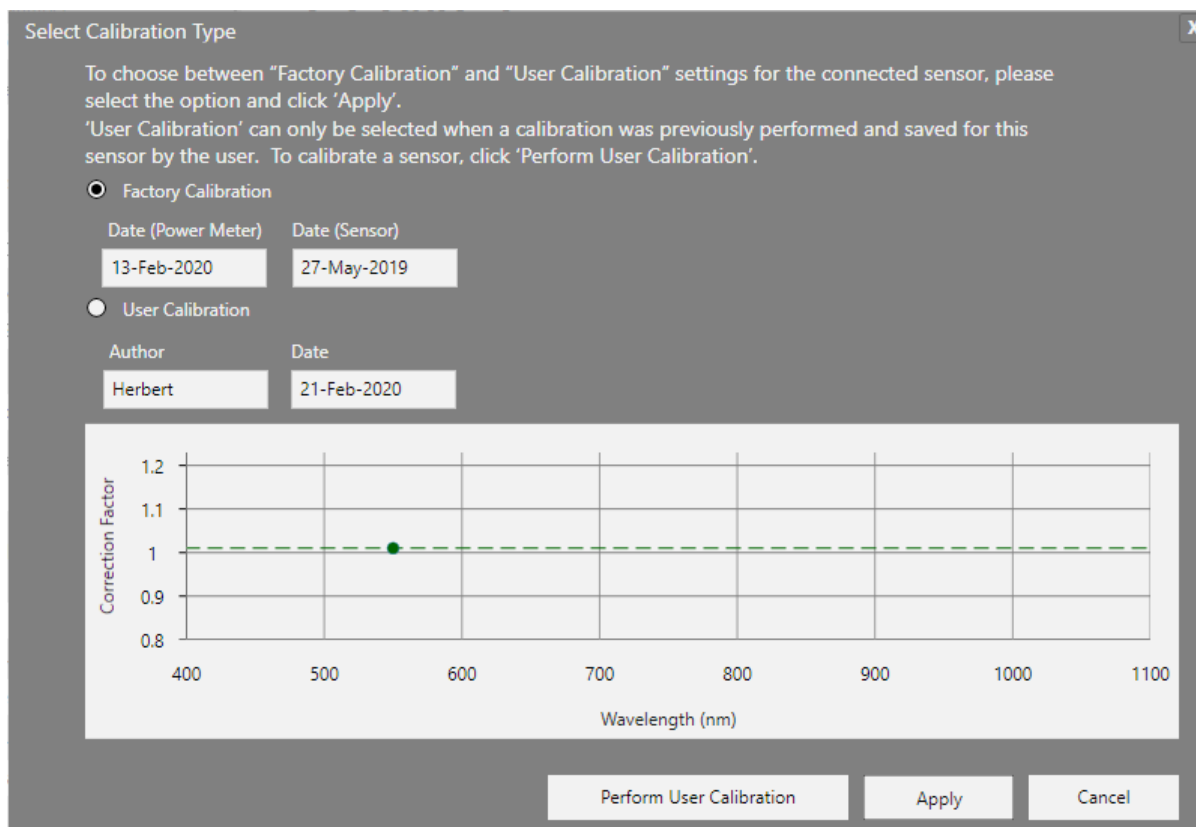
Before starting the calibration, provide a power meter, a light source, a reference sensor, and the sensor to be calibrated.

Open the Calibration Wizard by clicking  in the Information panel.



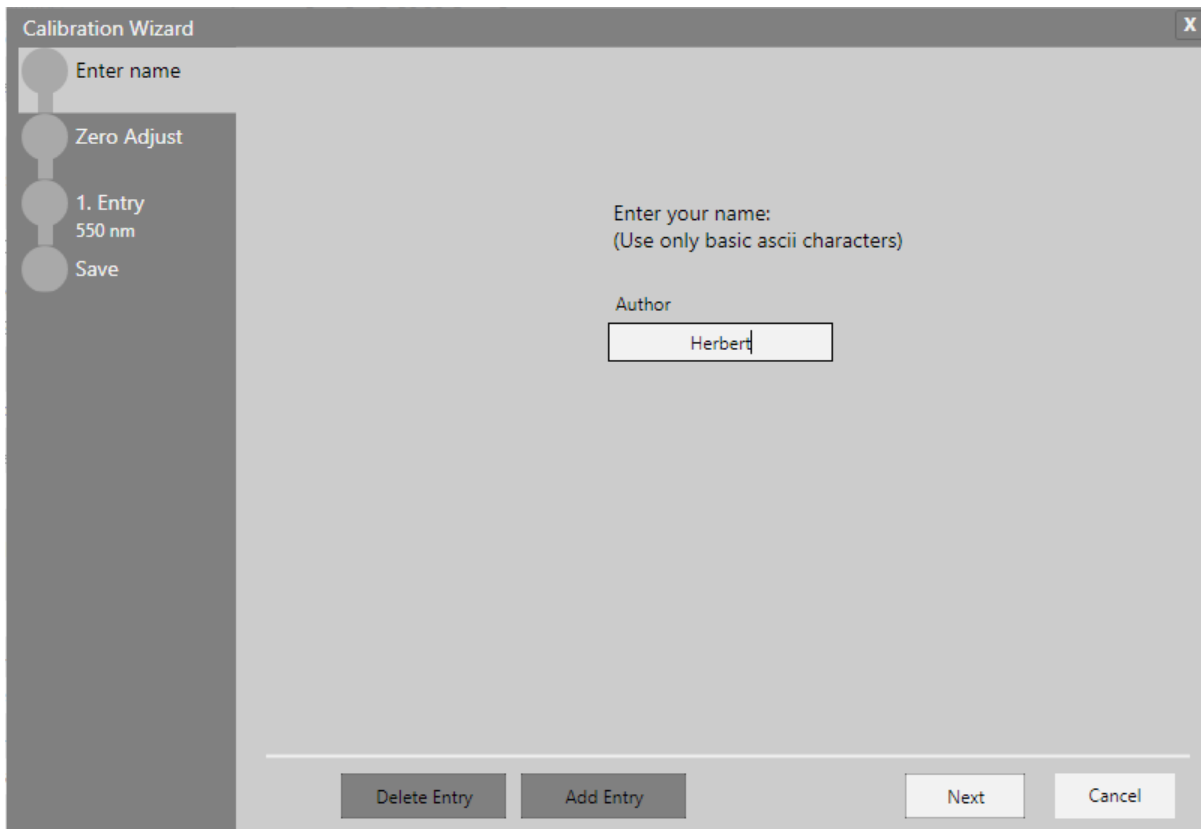
The wizard leads the customer through the protocol.

The start screen allows to choose between the factory calibration and a user calibration.



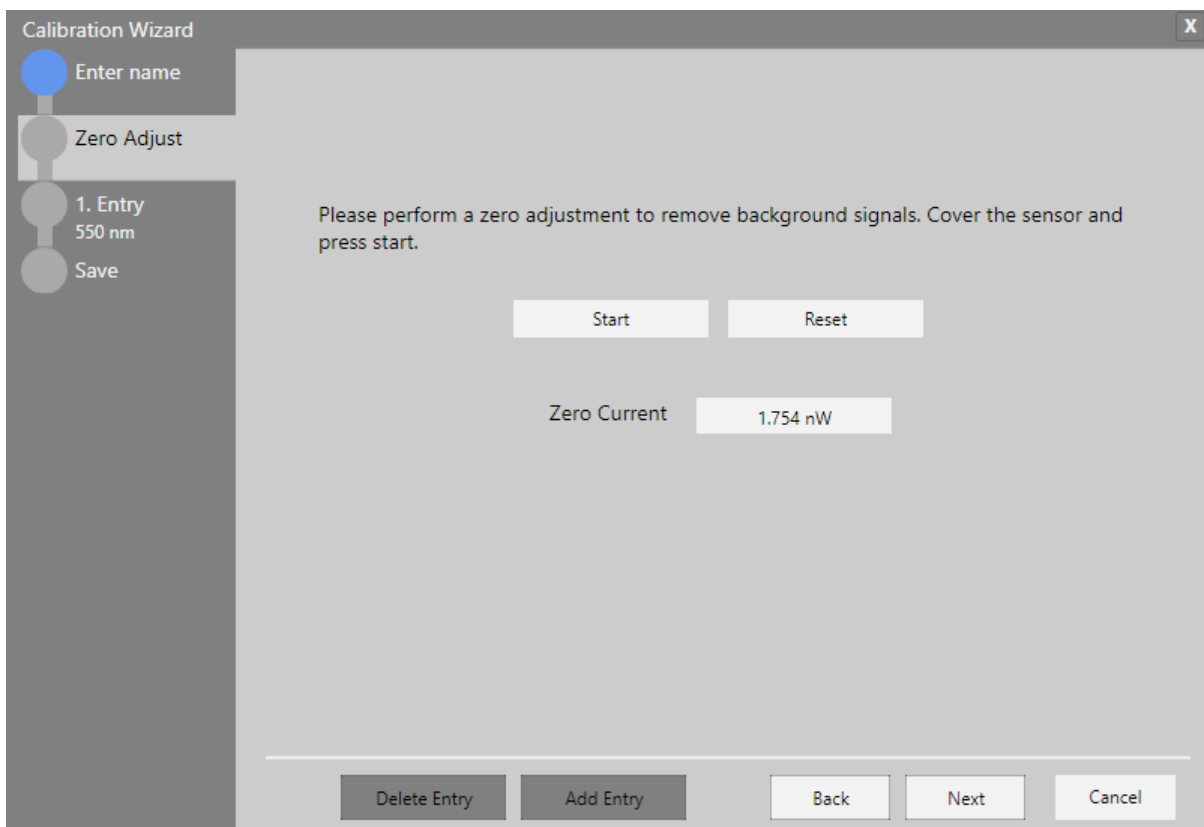
Click "Perform User Calibration" to start a calibration or select and apply a previously saved calibration.

To start a new calibration, define the user and click NEXT to adjust the background noise "Zero Adjust".



The screenshot shows the 'Calibration Wizard' window. On the left, a vertical sidebar contains four steps: 'Enter name' (selected with a blue circle), 'Zero Adjust', '1. Entry 550 nm', and 'Save'. The main area displays the text 'Enter your name: (Use only basic ascii characters)' and a text input field labeled 'Author' containing the text 'Herbert'. At the bottom, there are four buttons: 'Delete Entry', 'Add Entry', 'Next', and 'Cancel'.

Follow the instructions and click "START".



The screenshot shows the 'Calibration Wizard' window at the 'Zero Adjust' step. The sidebar on the left now has 'Zero Adjust' selected with a blue circle. The main area contains the instruction: 'Please perform a zero adjustment to remove background signals. Cover the sensor and press start.' Below this are two buttons: 'Start' and 'Reset'. Further down, the text 'Zero Current' is followed by a text box containing the value '1.754 nW'. At the bottom, the buttons are 'Delete Entry', 'Add Entry', 'Back', 'Next', and 'Cancel'.

The background is measured. This can be repeated. When the background measurement is finished, click "NEXT" to proceed to the calibration.

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Type the power (in mW) measured by the reference sensor into the field "Reference". Turn on the light source and click "Calibrate" to determine the correction factor.

The screenshot shows the 'Calibration Wizard' window. On the left, a vertical sidebar contains four steps: 'Enter name', 'Zero Adjust', '1. Entry 550 nm' (which is highlighted), and 'Save'. The main area contains the following elements:

- Instruction: "Select the unit for the power range. Enter the wavelength of the source and the power reference value."
- Unit: A dropdown menu set to "mW".
- Wavelength (nm): A numeric input field with "550" and minus/plus adjustment buttons.
- Reference (mW): A numeric input field with "6.000" and minus/plus adjustment buttons.
- Instruction: "Expose your sensor to the laser beam and press calibrate."
- Measured Power: A display showing "0.000 mW".
- Calibrate: A button.
- Power (mW): A numeric input field showing "0.000".
- Correction Factor: A numeric input field showing "0.0000".
- Navigation buttons: "Delete Entry", "Add Entry", "Back", "Next", and "Cancel".

When the calibration is done the following screen appears. To ensure that the calibration is within a reasonable range, the calibration is limited to values differing less than 20% from the reference values. An error message appears if the sensor that is calibrated is out of range.

The screenshot shows the 'Calibration Wizard' window after a successful calibration. The sidebar is the same as in the previous screenshot. The main area contains the following elements:

- Instruction: "Select the unit for the power range. Enter the wavelength of the source and the power reference value."
- Unit: A dropdown menu set to "mW".
- Wavelength (nm): A numeric input field with "550" and minus/plus adjustment buttons.
- Reference (mW): A numeric input field with "6.034" and minus/plus adjustment buttons.
- Instruction: "Expose your sensor to the laser beam and press calibrate."
- Measured Power: A display showing "6.097 mW".
- Calibrate: A button with a dashed border.
- Success message: A green checkmark icon followed by the text "Calibration was successful."
- Power (mW): A numeric input field showing "6.098".
- Correction Factor: A numeric input field showing "1.01".
- Navigation buttons: "Delete Entry", "Add Entry", "Back", "Next", and "Cancel".

Click "NEXT" to write the calibration data in the internal memory of the power meter and save the results as a .pdf file on the PC.

Calibration Wizard

Enter name
Zero Adjust
1. Entry
550 nm
Save

These are the calibration points for the user calibration. Press 'Write data and save protocol' to successfully write the data on the device.

Wavelength (nm)	Power	Reference	Correction Factor
550	6.098 mW	6.034 mW	1.01

Write data and save protocol

Delete Entry Add Entry Back Cancel

To take a second measurement at, for example, a different wavelength, click "Add Entry".

Calibration Wizard

Enter name
Zero Adjust
1. Entry
550 nm
2. Entry
550 nm
Save

Select the unit for the power range. Enter the wavelength of the source and the power reference value.

Unit: mW Wavelength (nm): 550 Reference (mW): 1.000

Expose your sensor to the laser beam and press calibrate.

Measured Power
6.098 mW

Calibrate

Power (mW): 0.000 Correction Factor: 0.0000

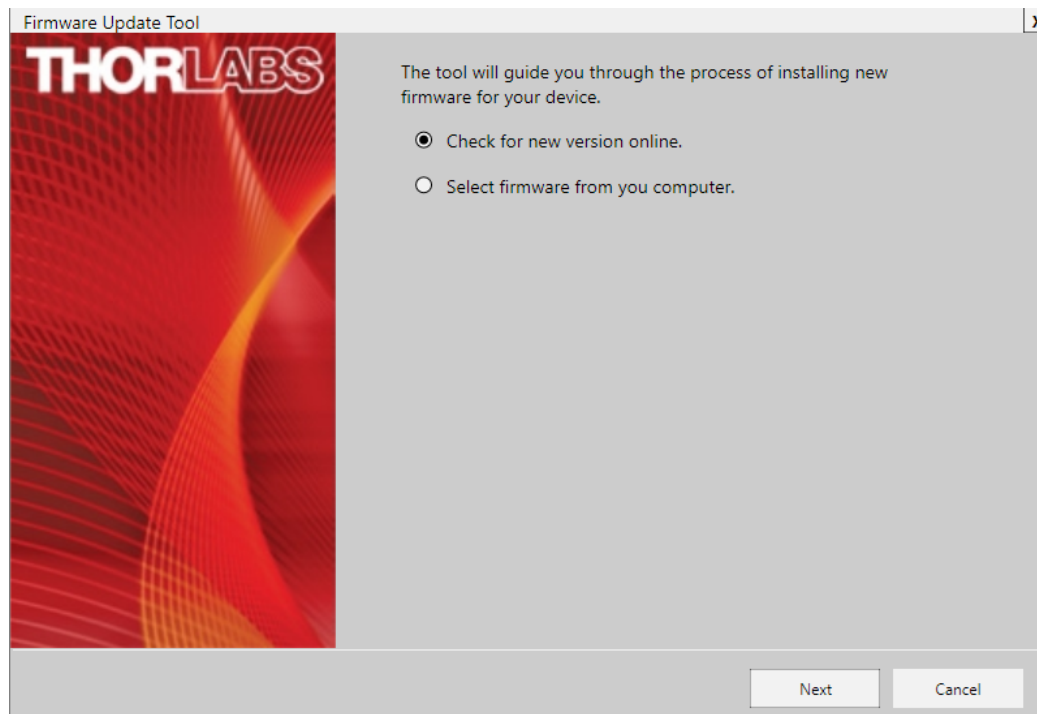
Delete Entry Add Entry Back Next Cancel

4.2.3.2 Firmware Update Tool for Power Meters

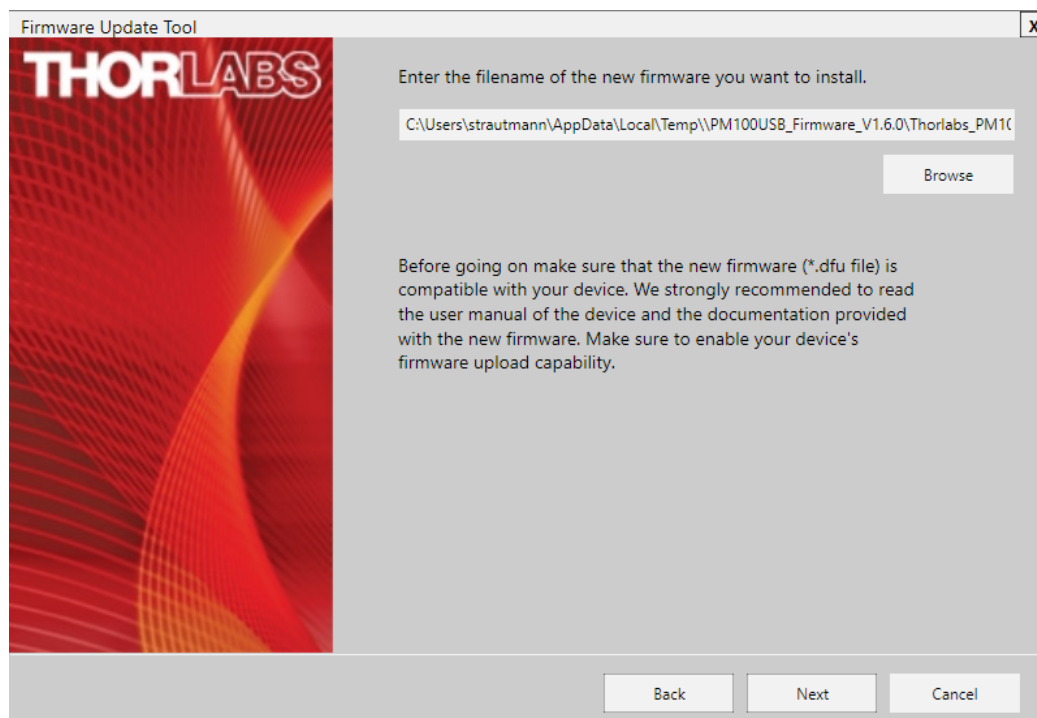
The OPM provides a GUI to update firmware of all Thorlabs power meters [supported by the OPM](#)⁴. For PM100A and PM100D, please see the respective manual.

To update firmware, click the  under "Firmware revision" in the information panel.

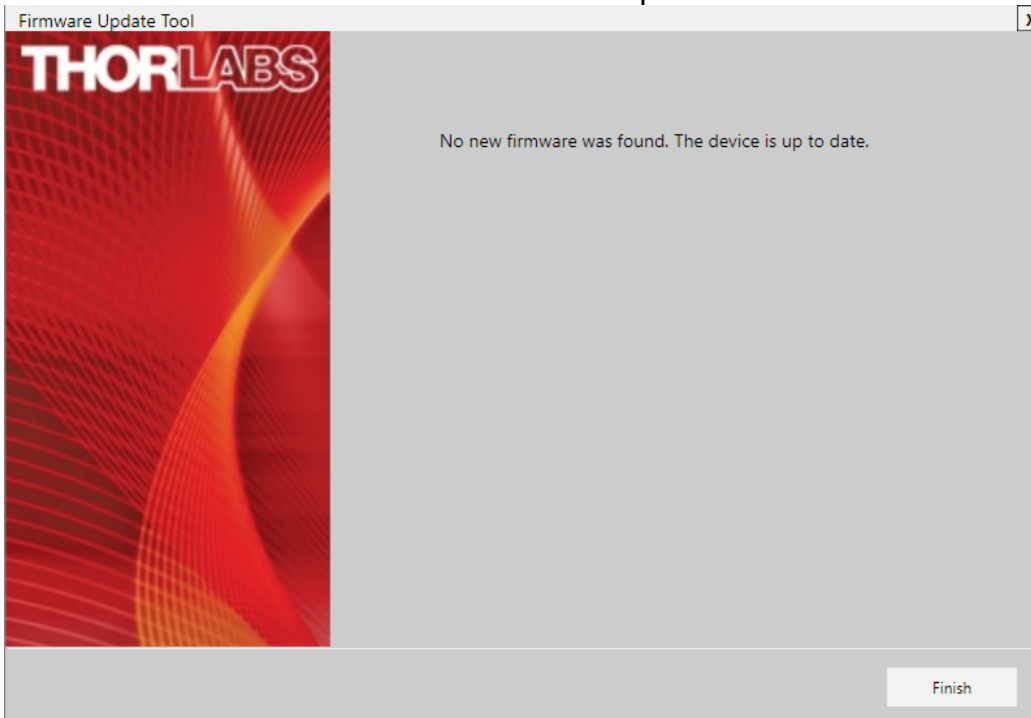
A start screen appears:



Either have the OPM search the web for the latest firmware or download the firmware for your power meter from the Thorlabs software website. In case you download the firmware to your PC, choose the desired file and click "Next".



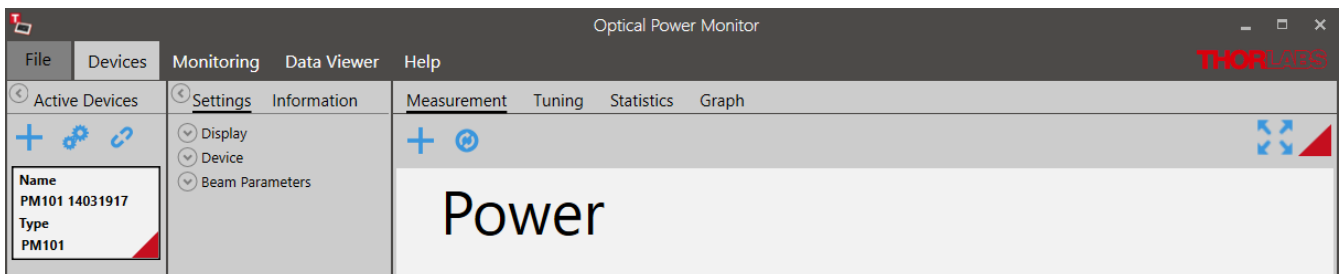
The desired firmware is now installed on the power meter:



4.2.4 Measurement

In the measurement panel, the currently measured numerical values of selected parameters are displayed. Use the **Tool Bar** to add more parameters to the display, maximize the display screen, or reset the measurement.

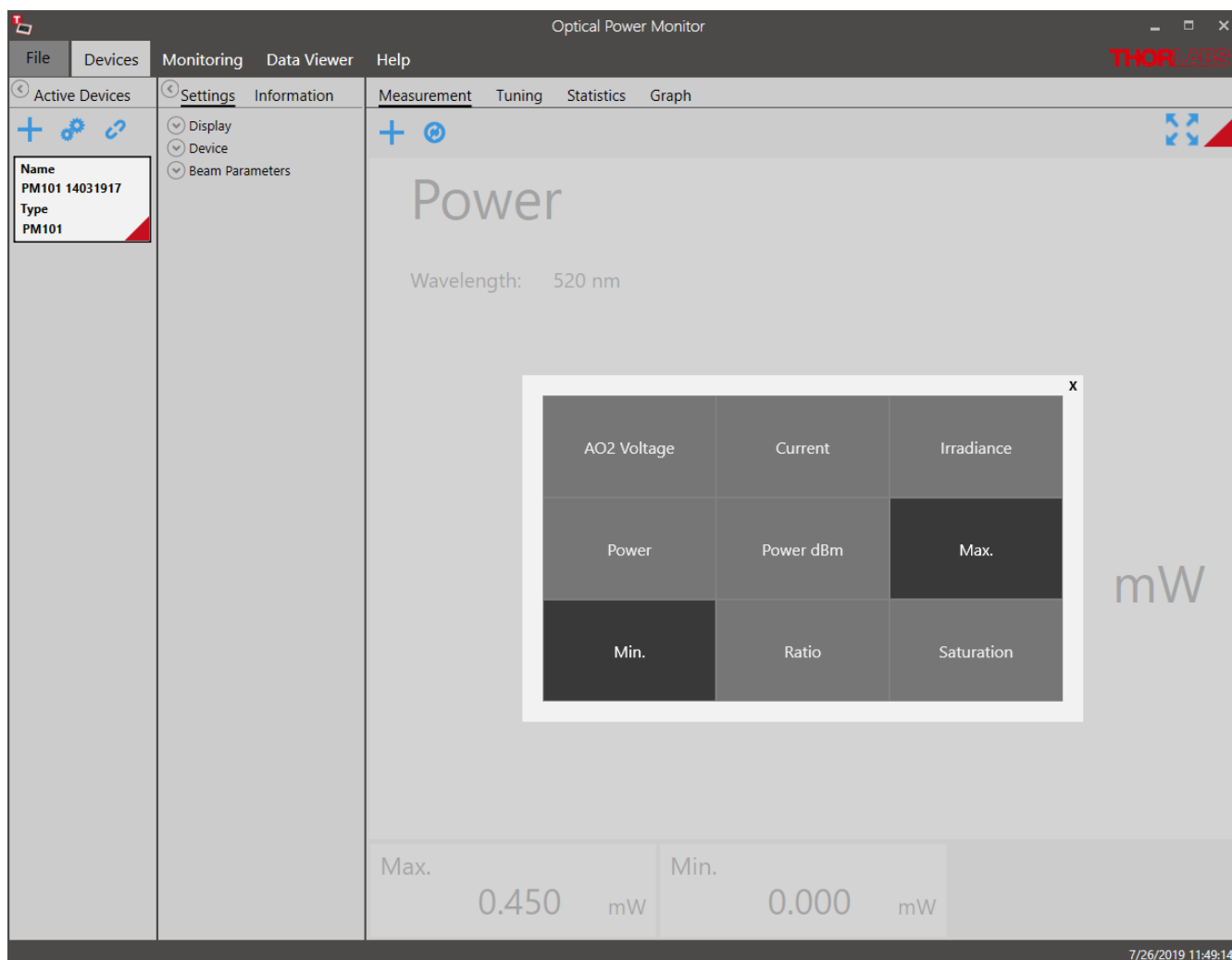
The display resets when a different device is selected.



Tool Bar

+ Add/Remove Parameter

Several numerical measurement values can be displayed simultaneously in the main screen. To select the parameter of interest from the panel, click + to open the following interface:



⊗ Reset min/max:

Click the icon to reset the displayed minimum and maximum values and recalculate their ratio.

⌵ Maximize the Screen:

Switch to full screen mode. Only the main parameter and wavelength will be displayed.



Bright/dark design:

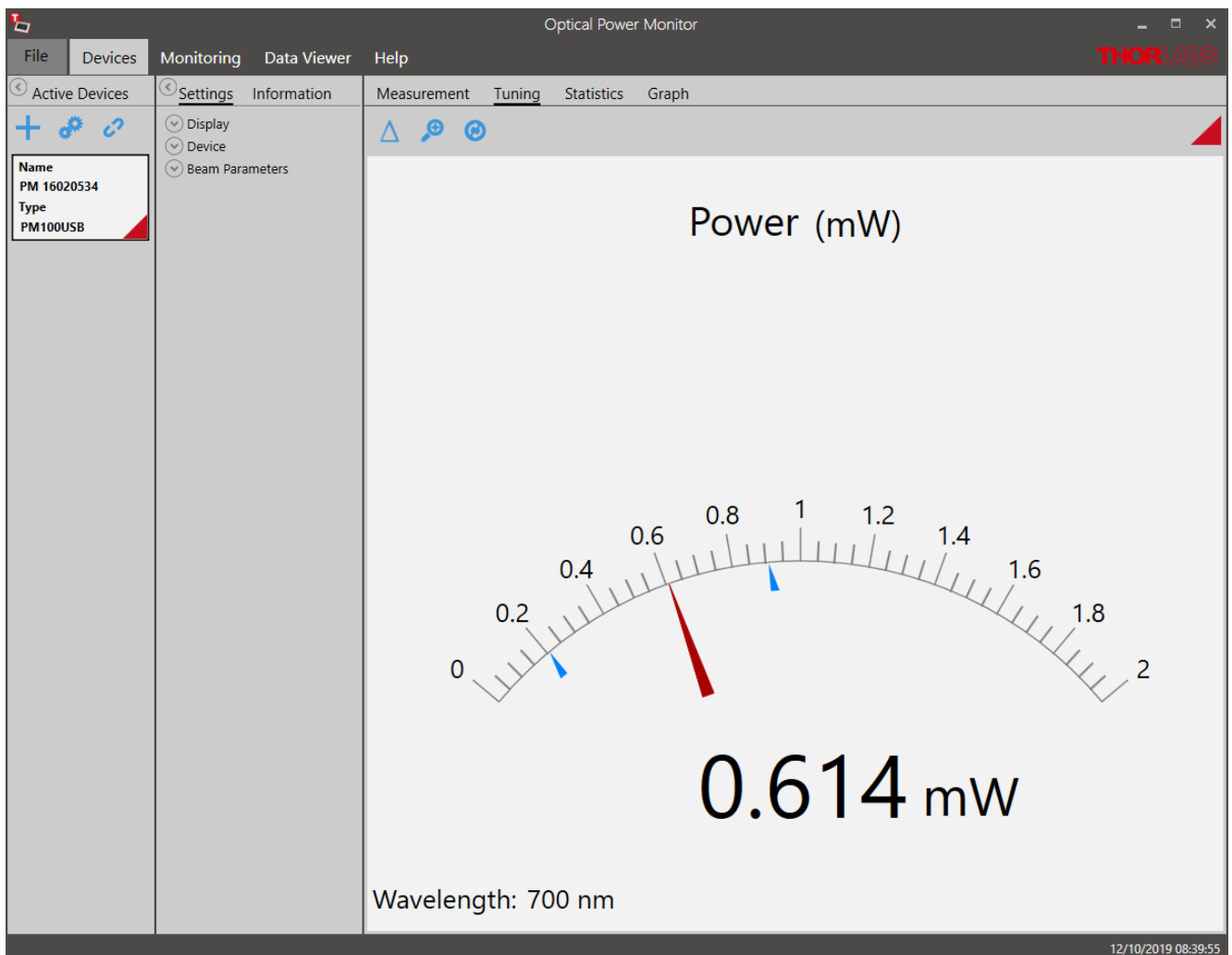
When the screen is maximized, the user can switch to dark design to reduce background light in the maximized display.

Shrink:

Reduce size of the display to view all selected parameters.


4.2.5 Tuning

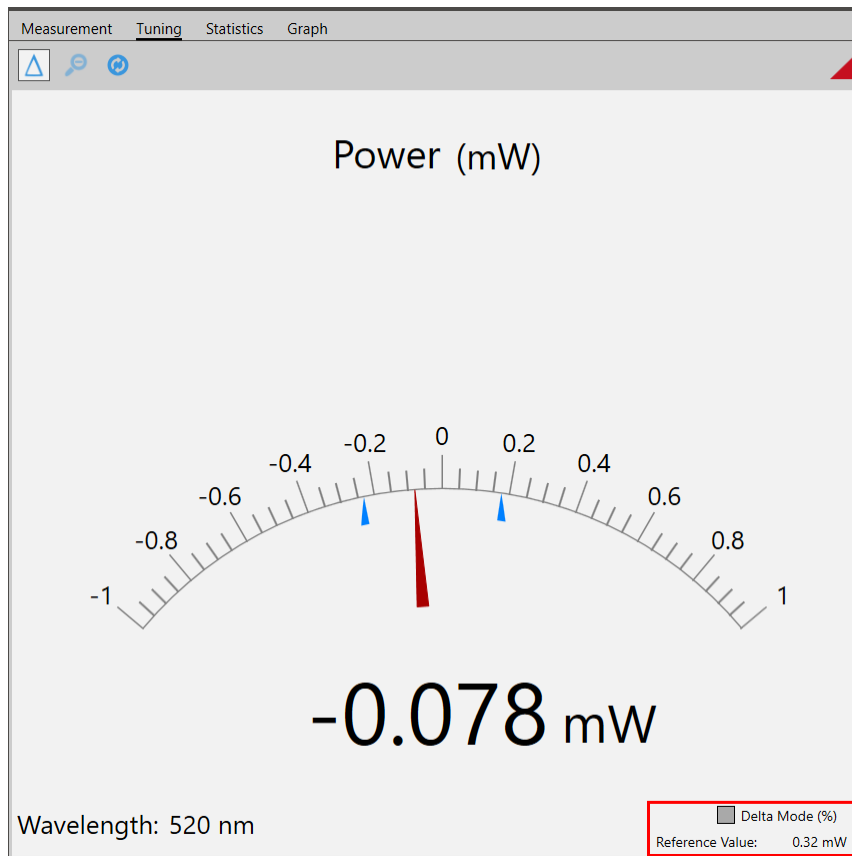
This panel shows the analog needle simulation of the currently measured value along with the digital numerical value.



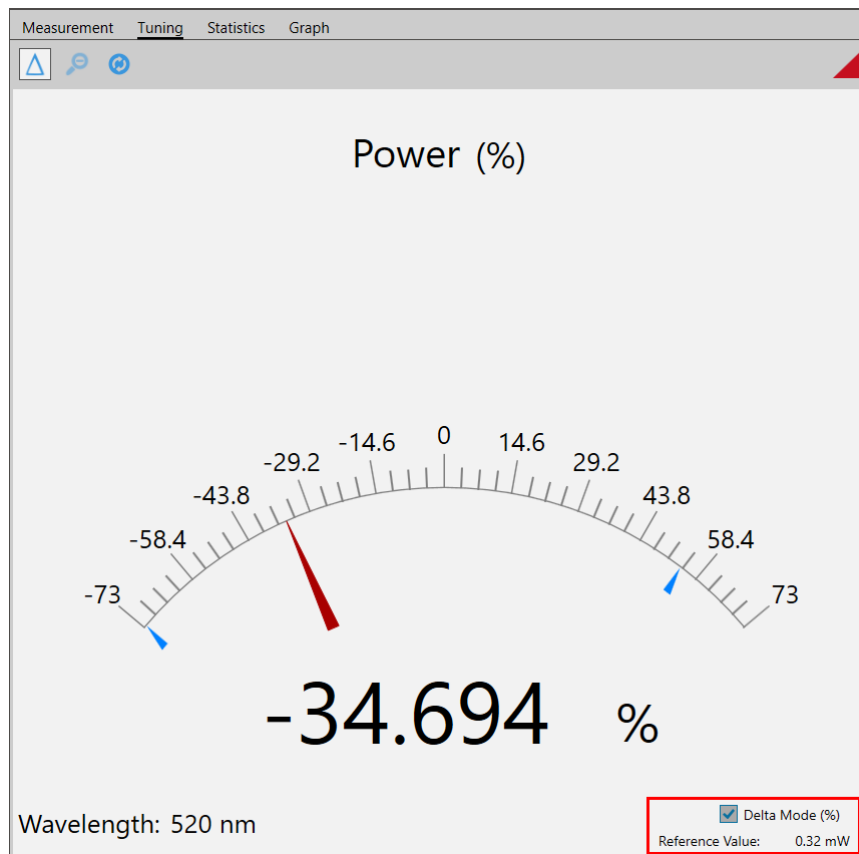
The display can be adjusted using the **Tool Bar**.


Enable/Disable Delta Mode


The Delta Mode shows the fluctuation around the measured value at the moment of starting the delta mode. This value is reset to zero by clicking .



View the **Delta Mode** in % by selecting the tick-box: **Delta Mode (%)** in the lower right display, marked red.

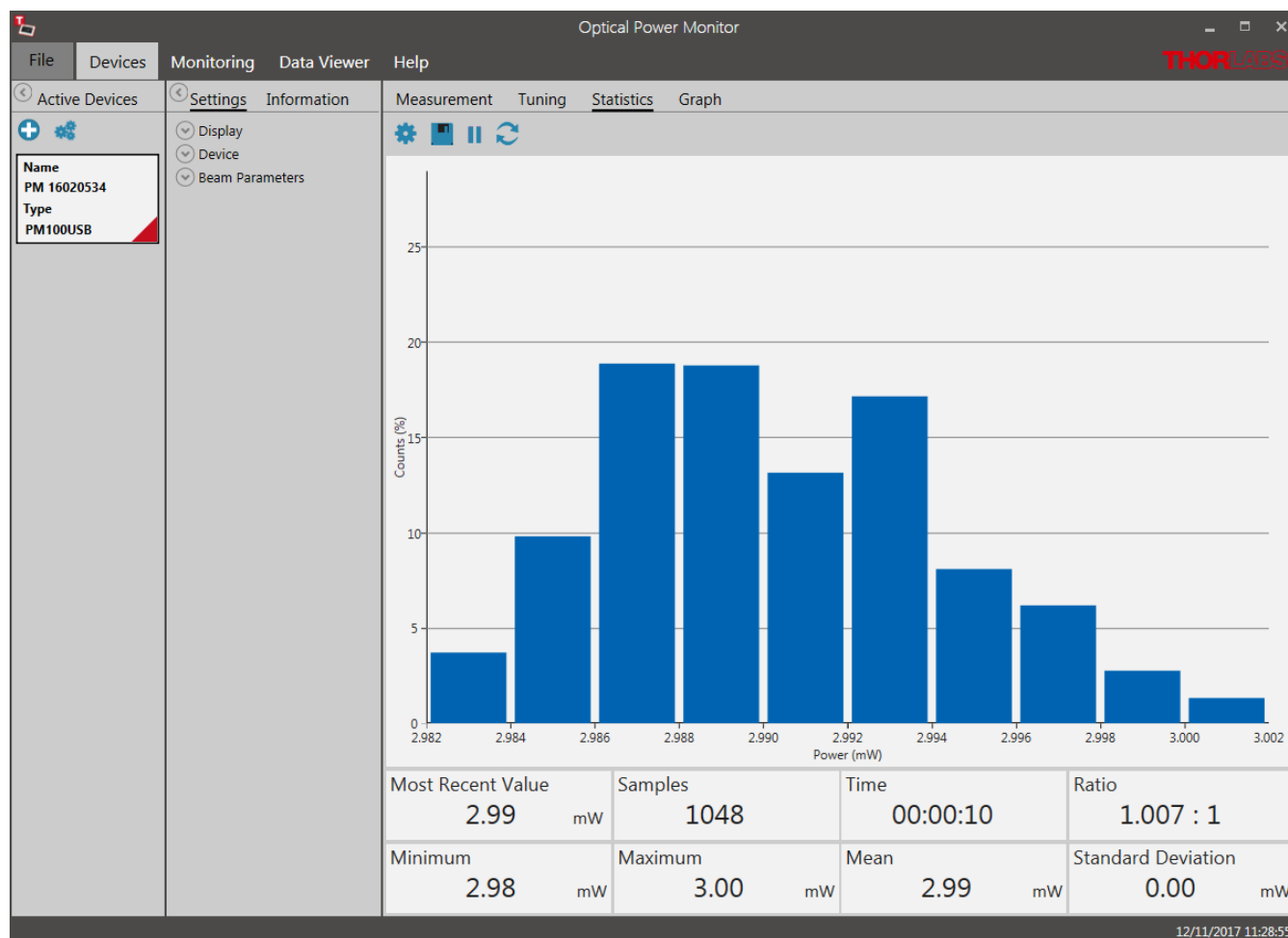


 **Zoom in/out:** The zoom-factor is determined by the current Min and Max-values.

 **Reset min/max:** Reset the displayed zero-, minimum and maximum values and recalculate their ratio.

4.2.6 Statistics

The **Statistics** panel shows the measurement statistics in chart and table format.



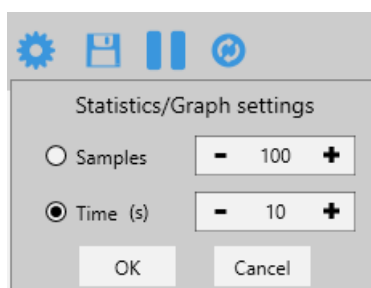
The chart displays the distribution of counts [%] for the parameter selected in [Settings](#)⁸. This parameter can be changed during the active measurement. The OPM starts a new data acquisition for statistical analysis when parameter or monitored device were changed.

To configure, save, start and restart measurement statistics, use the **Tool Bar**. The **Status Bar** below shows the currently measured values and the measurement progress.

Tool Bar

Statistics/Graph Settings

The number of data points used for statistics can be set as the duration of acquisition (Time) or number of data points (Sample). These settings are also applied in the [Graph](#)²⁸ panel for the display of power meter signal over time.



Note

Statistics are calculated as a rolling average. After the set duration or number of samples is reached, the next sample data point is evaluated at the expense of the first data point. Statistics are shown even when the set sample number or measurement time is incomplete.

 **Save Histogram Data**

Saves a snapshot of the statistics. The file will be saved in .csv-format and can be opened in a text editor. When the recording is stopped prior to full data acquisition as set in Statistics/Graph setting, this incomplete set of data can be saved.

 **Stop/Start Collecting Data**

Sampling for statistics can be stopped and restarted at any time. When the recording is stopped prior to full data acquisition, this incomplete set of data is statistically evaluated and can be saved. At **START**, the last set of acquired data is deleted.

 **Restart**

Deletes the acquired statistics and graph mode data and starts a new acquisition for both, the statistics and graph mode.

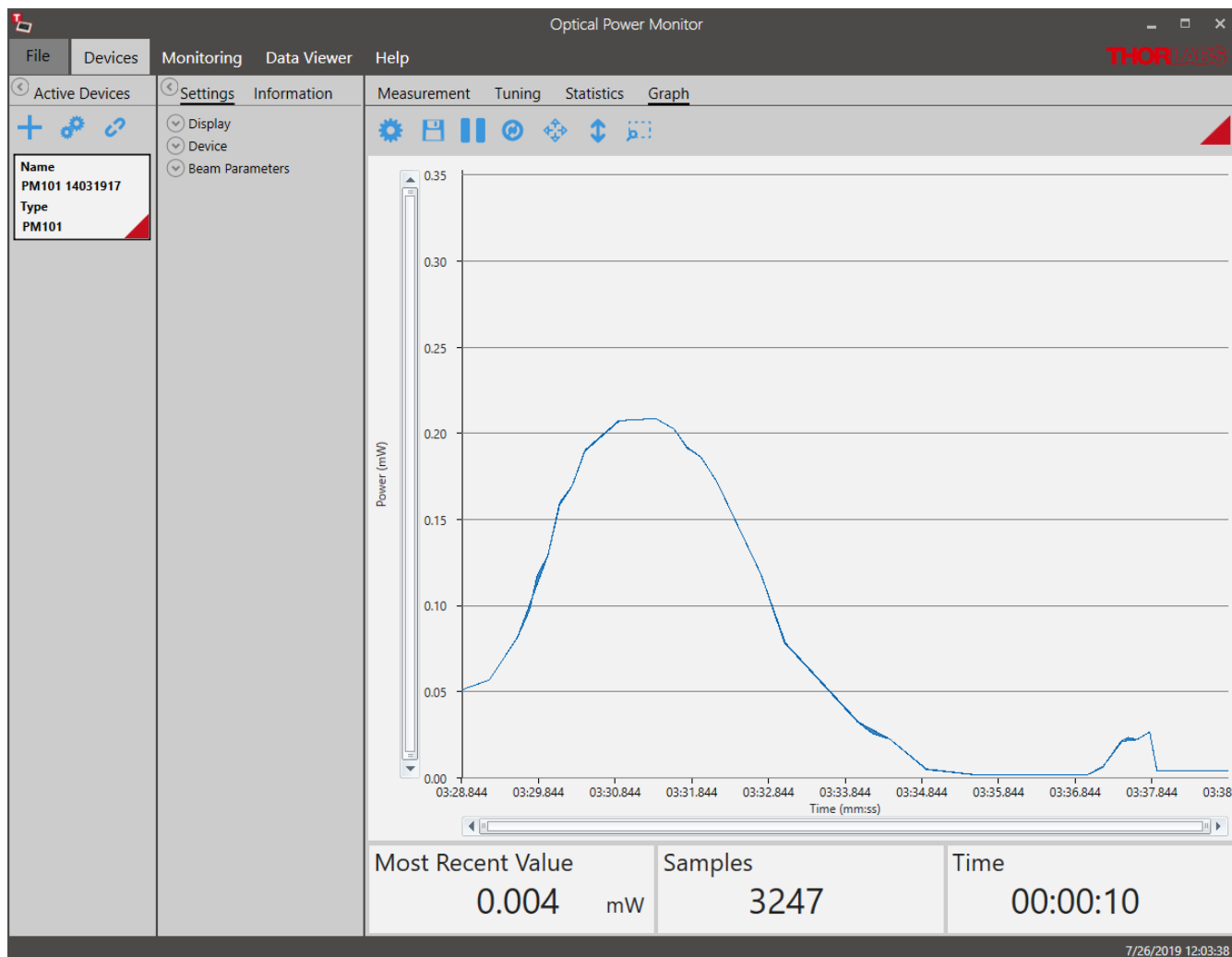
Status Bar

Most Recent Value:	Most Recent Value Used for Statistics
Samples:	Number of Samples Acquired for Statistics
Time:	Duration of Acquisition for Statistics
Ratio:	Ratio Between the Minimum and Maximum Values Recorded During the Interval Set in Statistics/Graph Settings
Minimum:	Lowest Value Recorded During the Interval Used for the Statistics Calculation
Maximum:	Highest Value Recorded During the Interval Used for the Statistics Calculation
Mean:	Mean Calculated Based on the Data Recorded During the Interval Set in Statistics/Graph Settings
Standard Deviation:	Standard Deviation Calculated Based on the Data Recorded During the Interval Set in Statistics/Graph Settings

4.2.7 Graph

The **Graph** panel displays the signal over time as measured by the power meter. Shorter power meter measurements can be configured, flexibly displayed and saved, using the options given in the **Tool Bar**. Use the Graph panel to acquire high-resolution measurements of over 100Hz, depending on the refresh rate of the power meter.

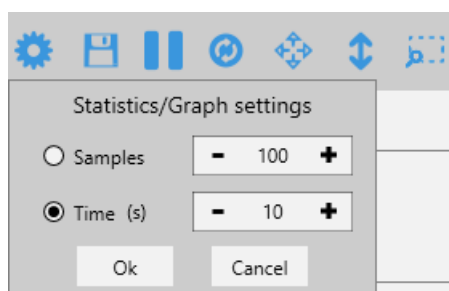
Data acquisition in **Graph** panel is reset when a different power meter is selected in the **Active Devices** panel.



Zoom: To zoom into the chart, place the mouse cursor over the diagram and scroll.

Tool Bar

- ⚙️ **Settings:** Set the displayed time interval of the measurement in time or sample number. These settings are also applied in the [Statistics](#) panel





Save graph data: Save a snap shot of the measurement in .csv format. When the recording is stopped prior to full data acquisition as set in **Statistics/Graph settings**, this incomplete set of data can be saved.



Start/Pause collecting data: Sampling for the graph mode can be stopped and re-started at any time. When the recording is stopped prior to full data acquisition, this incomplete set of data is displayed and can be saved.



Restart: This deletes the acquired data in **Graph** mode and **Statistics** and starts a new measurement and statistics evaluation.



Zoom out: Zooms out to the original resolution in both, the X and Y axis.



Zoom out Y-Axis: Zooms out to the original resolution in the Y axis only.



Zoom selection: Zooms into an area selected with the mouse.

Note

In **Graph** mode, data are acquired in a rolling manner: After the set duration or number of samples is reached, the next sample data point is inserted at the expense of the first data point.


Status Bar:

The status bar at the bottom shows the data acquisition progress with the following values

Most Recent Value: The value of the most recent data point collected in the time interval.

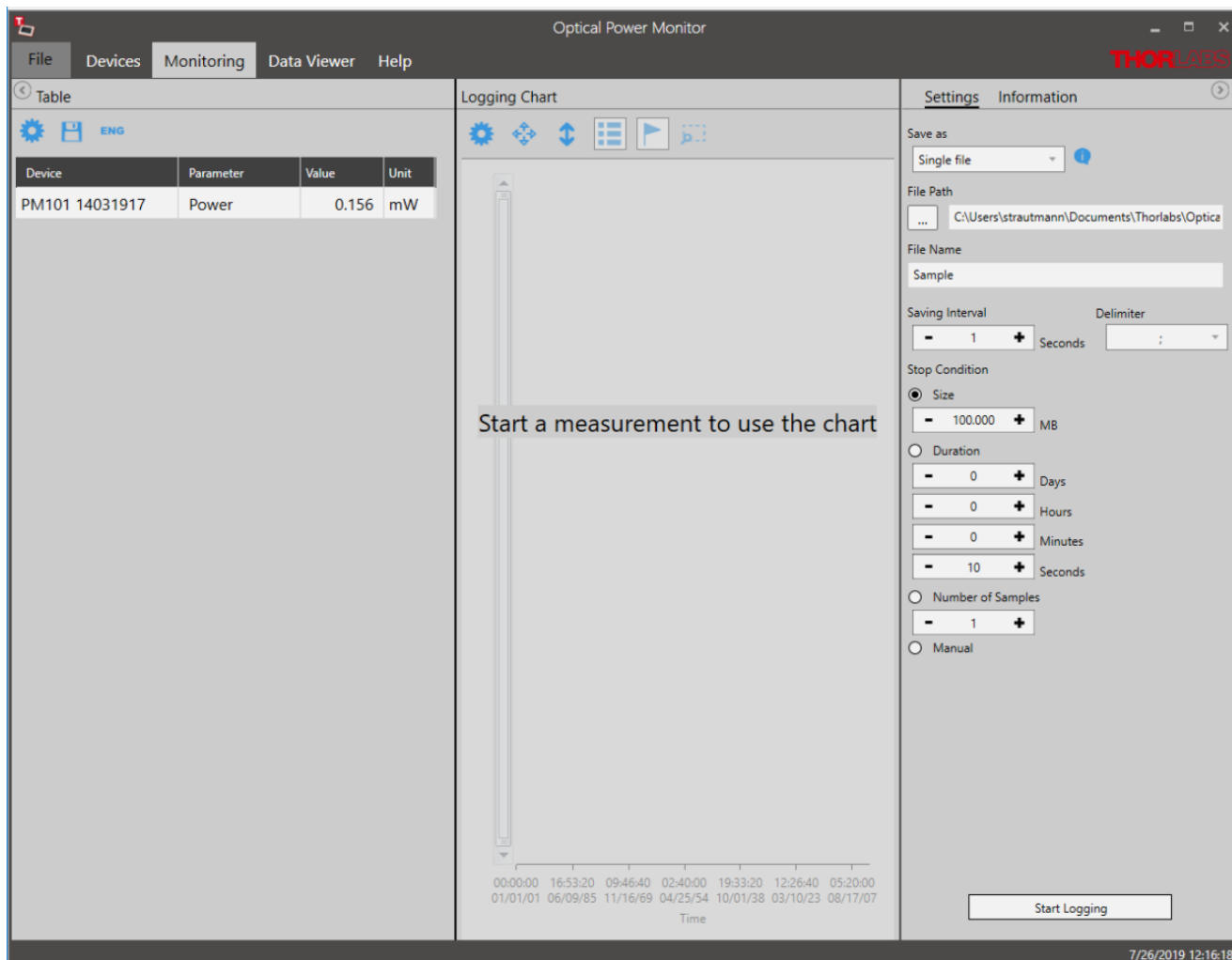
Samples: Number of samples acquired for the time interval set in [Statistics/Graph settings](#) ²⁸



Time: Recording time acquired for the display of the time interval set in **Statistics/Graph settings** 

4.3 Monitoring

Use the Monitoring panel to configure, execute, observe, and save long-term monitoring of up to 8 connected power meters in parallel and for different parameters. Long-term measurements can be recorded with a minimal interval of one second. The Optical Power Monitor uses this resolution in order to display data acquired from devices with different refresh rates in parallel.

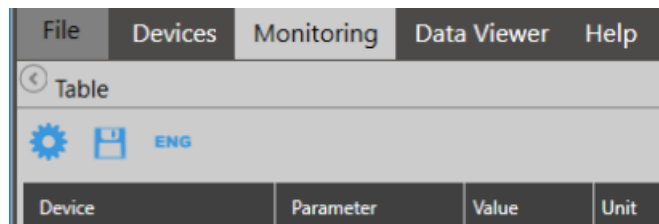



To log a measurement, follow the sequence below:

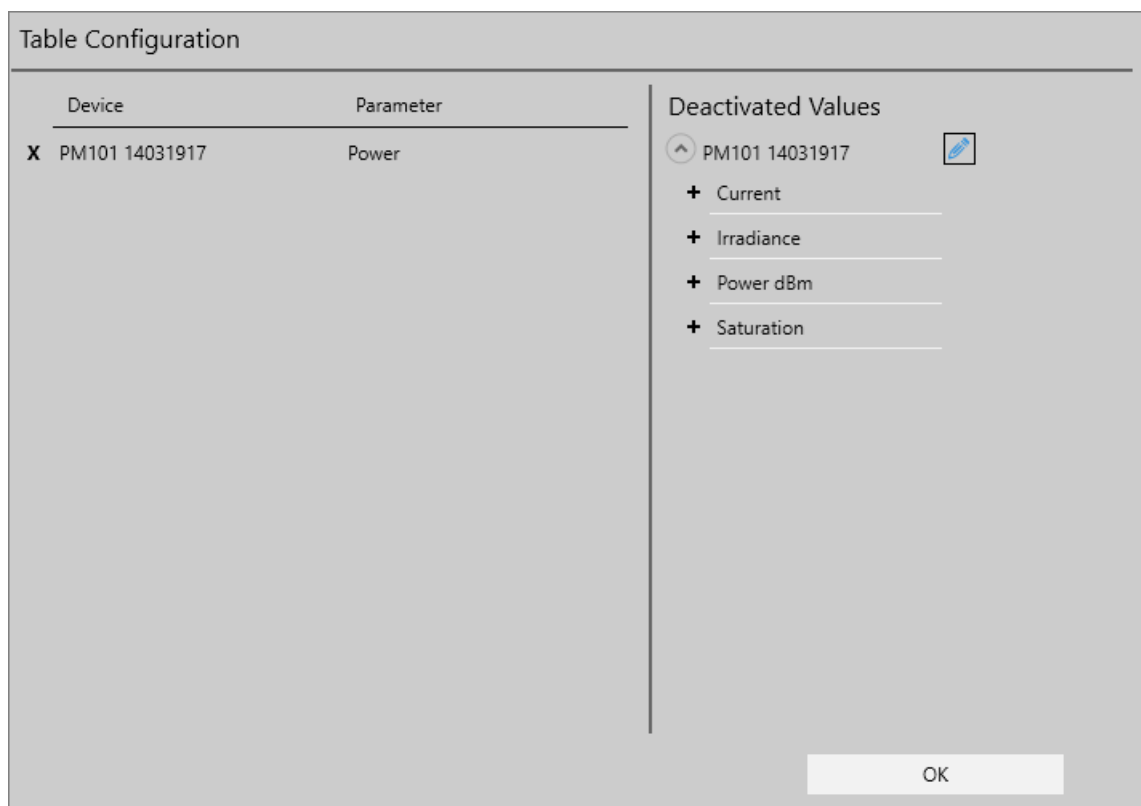
1. [Table](#) ³¹ **Select the devices** and parameters to be monitored.
2. [Logging Settings and Logging Information](#) ³² **Select the settings** for recording and saving of the measurement and review settings in the panel **Information**. **Start Logging**.
3. [Logging Chart](#) ³⁵ **Select the displayed parameters**.


4.3.1 Table Configuration

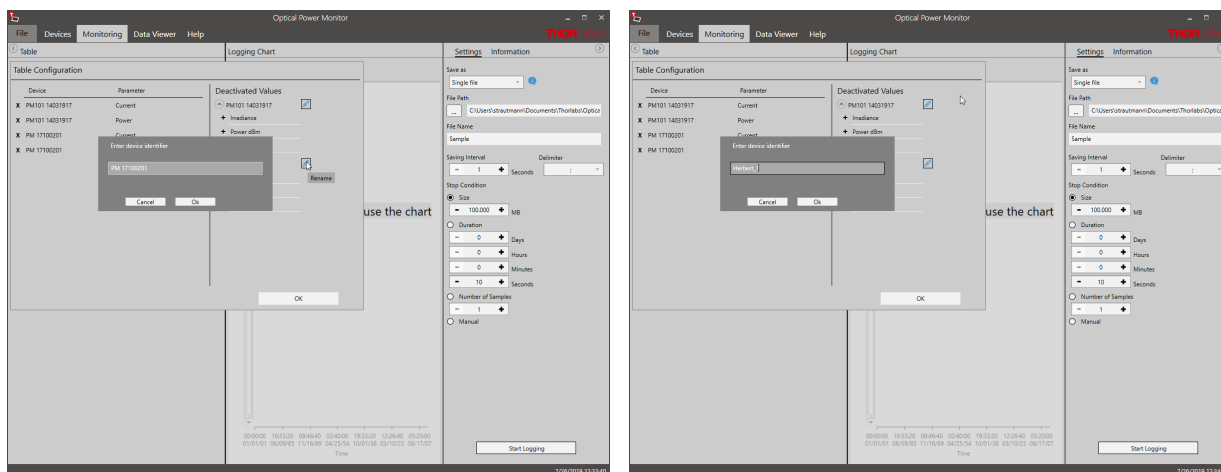
The **Table** menu lists the devices and parameters to be logged in the experiment and continuously displays the currently measured values. To add devices and parameters to the table, use the **Tool Bar**.



 **Configuration:** Configure the devices and parameters to be monitored in the table, logged in the measurement and displayed in the [Logging Chart](#)^[35].



- + Add devices and parameters from the list of **Deactivated Values** to the **Table Configuration**.
- x Remove Values by deselecting them in the left panel.
-  Choose a custom name for the device in your setup.





The order of the selected values can be changed using the mouse.

Click **OK** to return to the **Table**.

The monitoring **Table** now lists the devices and parameters with their currently recorded data that are logged in the experiment.

Device	Parameter	Value	Unit
PM101 14031917	Current	5.856	μA
PM101 14031917	Power	0.154	mW
Herbert_1	Current	107.219	nA
Herbert_1	Power	47.003	μW

 **Snapshot:** Save a snapshot of the current values in .csv-format.

 **Engineering Notation:** Switch the table to engineering notation of the monitored values.

Following the selection of devices and parameters to be monitored, go to the Logging Configuration menu.

4.3.2 Logging Settings and Information

Configure the logging of a measurement and select the output file format, location and name and set the duration and resolution for logging in the **Settings** menu.

Please read the section [File Format](#) ³⁶ to learn about the data saved in the log files.

Review the **Logging Settings** prior to starting the measurement:

Save as: Choose to save data either as single files or multiple files, depending on the data volume.

- **Single files:** The Optical Power Meter saves a .csv file for short measurements with small data volume.

- **Multiple files:** The Optical Power Meter saves multiple .cvs files for measurements with large data volumes such as longer measurements or measurements with multiple power meters in parallel. When the software saves multiple files, an associated .tcsv file is saved for accelerated loading of data into the data viewer. Do not move or delete any files from the common folder. Please find more information in the section [File Format](#)³⁶.

File Path: Select the Output File location

File Name: Choose the file name

Saving Interval: Set the time interval between saved data points. The minimal interval is one second. Choose the **Delimiter** for easy access and analysis of your saved data.

Stop Condition: Select the criteria for terminating the logging process.

- **Size:** Measure up to a file size of 99 999 MB. Approximation of the file size: 100 samples of one parameter of one power meter require ~ 4kb disc space. The required disc space is not strictly linear. To log measurements > 99 999 MB, choose either the stop condition "Duration" or "Manual".

- **Duration:** Measure for a certain duration

- **Number of Samples:** Measure a set number of samples

- **Manual:** Stop logging manually

Note

Logging can not be started if no parameters were selected in the **Table Settings**.

Attention

General settings in the [Settings](#)¹³ panel can be changed even during a logged long-term measurement. Changes will be applied immediately but the changes in the settings will not be saved in the logged file. Please note such changes, as evaluation of such data may otherwise be complicated.

Attention

Disable hibernation and sleep mode of the PC. Otherwise, the PC loses the connection to the monitored devices, the measurement stops, and the OPM software may freeze when entering sleep mode or hibernation.

Start Logging

Click this button to start logging of the measurement. If the file name was already used, a warning window appears.

Optical Power Monitor

The Logging Settings panel will change to the **Logging Information** panel and show the status of the measurement.

The screenshot displays the 'Optical Power Monitor' software interface. The main window is divided into three sections:

- Table:** A table showing measurement data for two devices: PM101 14031917 and Herbert_1. The columns are Device, Parameter, Value, and Unit.
- Logging Chart:** A line graph titled 'PM101 14031917-Current' showing current in μA over time. The y-axis ranges from 3.51 to 9.51 μA . A red line shows a fluctuating signal. A legend indicates 'Current (μA)' with a value of 8.516 at the time 7/26/2019 12:45:57.
- Settings Information:** A panel on the right showing logging configuration. It includes fields for Files, Progress (%), Logging Interval (s), Elapsed time, Start, Stop at, and Samples.

Device	Parameter	Value	Unit
PM101 14031917	Current	9.227	μA
PM101 14031917	Power	0.243	mW
Herbert_1	Current	242.467	nA
Herbert_1	Power	106.294	μW

Logging Information:

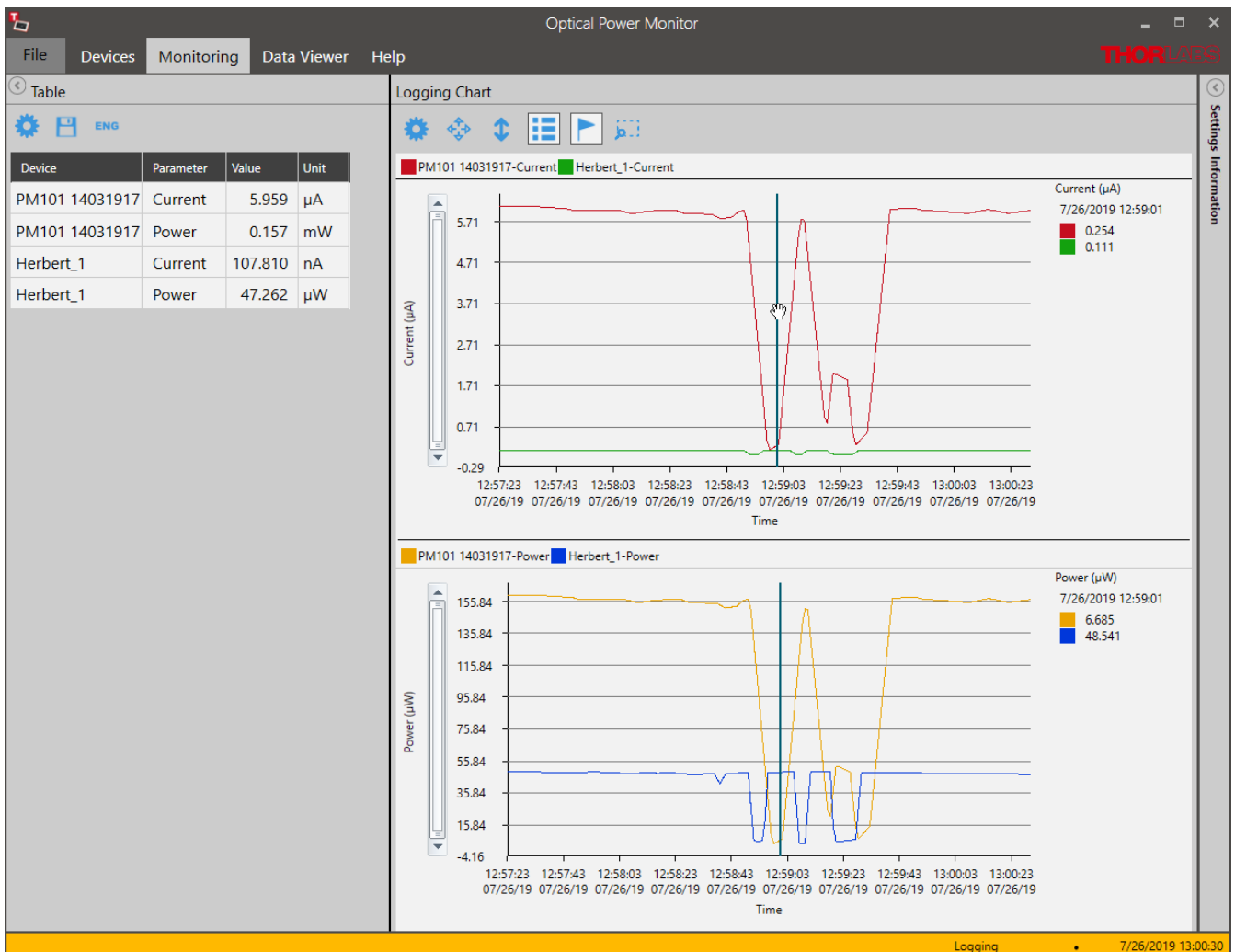
- Files: C:\Users\strautmann\Desktop\Sample.csv
- Progress (%): 0
- Logging Interval (s): 1
- Elapsed time: 000d:00h:00m:54s
- Start: 7/26/2019 12:45:37
- Stop at: 8/13/2019 03:46:20
- Samples: 56

Stop Logging

Logging 7/26/2019 12:46:32

4.3.3 Logging Chart

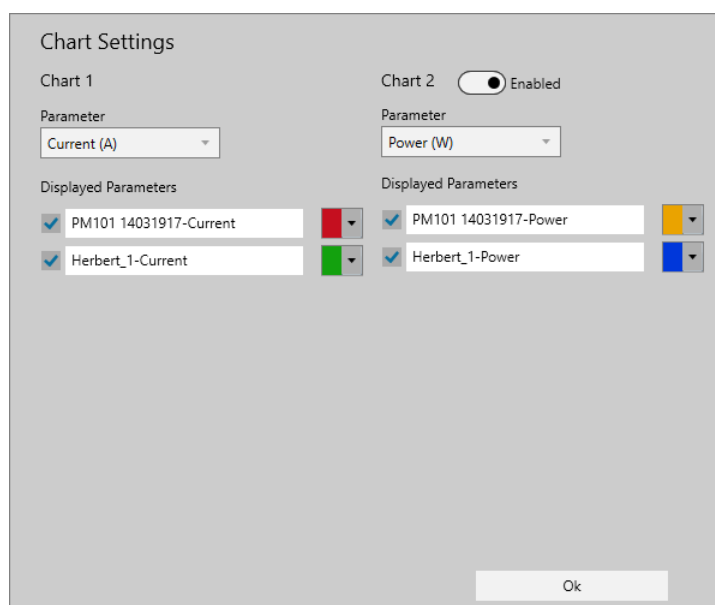
The **Logging Chart** displays the logged data over time. Use the **Tool Bar** to set up the display and analyze the data. The **Logging information** panel displays the progress of the measurement.



Tool Bar

Settings

To configure the chart display settings in the real-time measurement, choose any parameter and device (**Displayed Devices**) selected in the monitoring [Table](#)³¹. Assign different colors to easily distinguish power meters and parameters in the display. Enable a second chart by moving the toggle switch in **Chart 2** to **Enabled**.









Click **Ok** to set the selection.

Note

If parameters or devices do not appear for selection, they were not selected in the [Table](#)^[31] menu. To add them, click "**Stop Logging**" in the **Logging Information** panel, go to the [Table](#)^[31] menu on the left side of the display, add the desired devices and parameters and **Start Logging** in the **Logging Information** panel.

Zoom: To zoom into the chart, place the mouse pointer over the chart and scroll.

-  **Zoom out:** Zooms out to the original resolution in both, the X and Y axis.
-  **Zoom out Y-Axis:** Zooms out to the original resolution in the Y axis only.
-  **Enable/Disable Legend:** Add the legend listing the used devices to the chart area as shown above
-  **Enable/Disable Marker:** Add the marker to display the measurement value at a chosen single time point next to the chart.
-  **Zoom selection:** Zoom into the region of interest (ROI) by selecting the area. You can then move a window of the size of the ROI through the whole chart area. Click  for the chart to resume the original resolution.

4.3.4 File Format

The user can record and save data in different formats, depending on the size of the measurement data.

1) Small Data Volumes

All data saved in the [Statistics](#)^[26] or [Graph](#)^[28] panel are saved as .csv files. Choose this setting to save data than can easily be opened in a text editor without reaching the line limit of about 1 million lines. This format can be opened in a text editor, but can not be loaded into the [Data Viewer](#)^[37].

Data recorded in the [Monitoring](#)^[30] panel when choosing to save as single file only are also saved as .csv files. These data can be opened in the [Data Viewer](#)^[37] or in a text editor.

2) Large Data Volumes

All data saved in the [Monitoring](#)^[30] panel when choosing to save as "multiple files" are saved as multiple .csv files with an associated .tcsv file in the same folder.

The .tcsv files are compressed files of the associated .csv files for fast loading into the [Data Viewer](#)^[37]. For high resolution viewing in the data viewer, the .csv files are required to be in the same location as the .tcsv file. The uncompressed .csv files carry the name: filename_Raw#.

The log-file in .tcsv format saves the following data:

- Device Information (Power Meter and Sensor with Serial Numbers)
- Values of the Selected Devices and Parameters, Saved with the Selected Sampling Interval (Sorted by Sample Number, Date and Time down to Seconds)
- Wavelength

Note

DO NOT DELETE, MOVE or RENAME the uncompressed .csv files in the .tcsv file folder, because the uncompressed files are required for high resolution viewing in the data [Data Viewer](#)^[37]. However, the uncompressed "raw" csv files can be used in your own analysis software. To do this, please copy the desired files first to a location different from the original location.

PM400 .csv Format

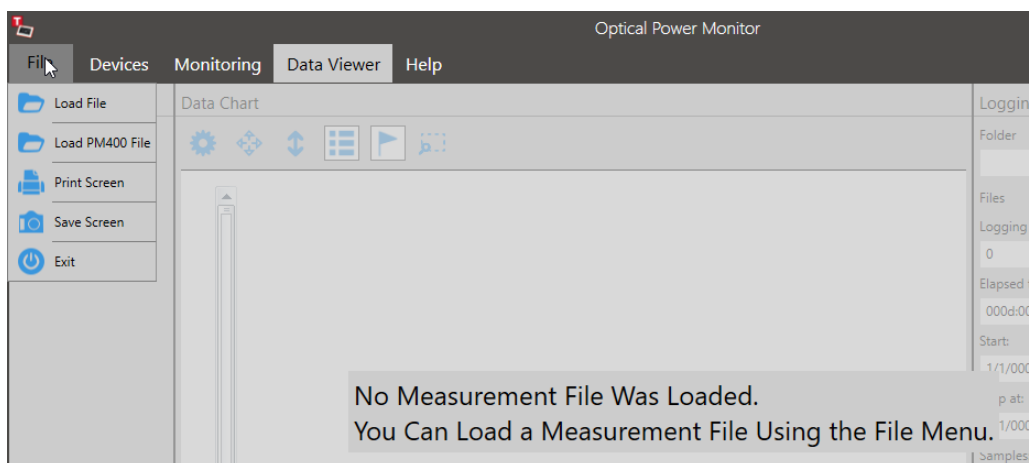
To load data saved by the PM400 into the Data Viewer of the OPM, go to the File Menu and choose Load PM400 File.

4.4 Data Viewer

Data logged by the OPM can be loaded and displayed in the **Data Viewer**.

Loading Data:

To load data into the Data Viewer, go to [File](#)^[8] and select **Load** to open the file of interest.



The loaded data are displayed as a list of **Devices**, the **Data Chart** of data points over time and the **Logging Information**.

Devices:

The **Devices** menu lists the power meters and sensors that were used in the loaded measurement.

First Device: Name as Set in [Edit Devices](#) ¹³ →

Type of the Power Meter →

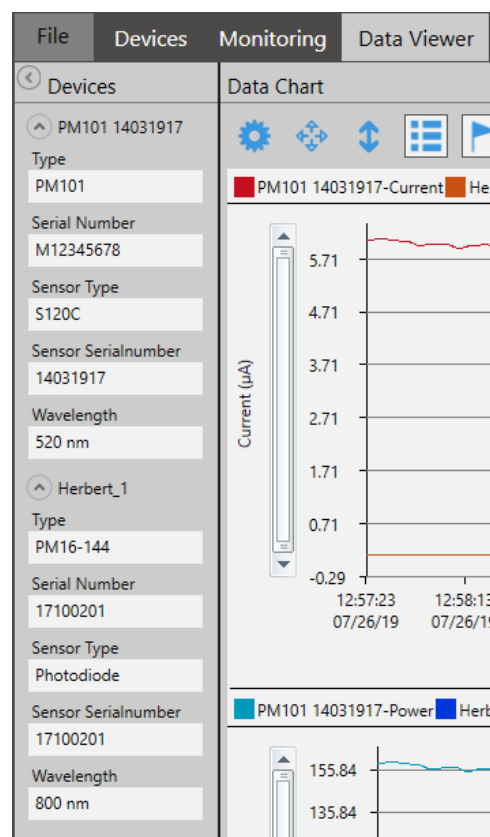
Serial Number of the Power Meter →

Type of the Sensor →

Serial Number of the Sensor →

Wavelength Analyzed in the Optical Setup →

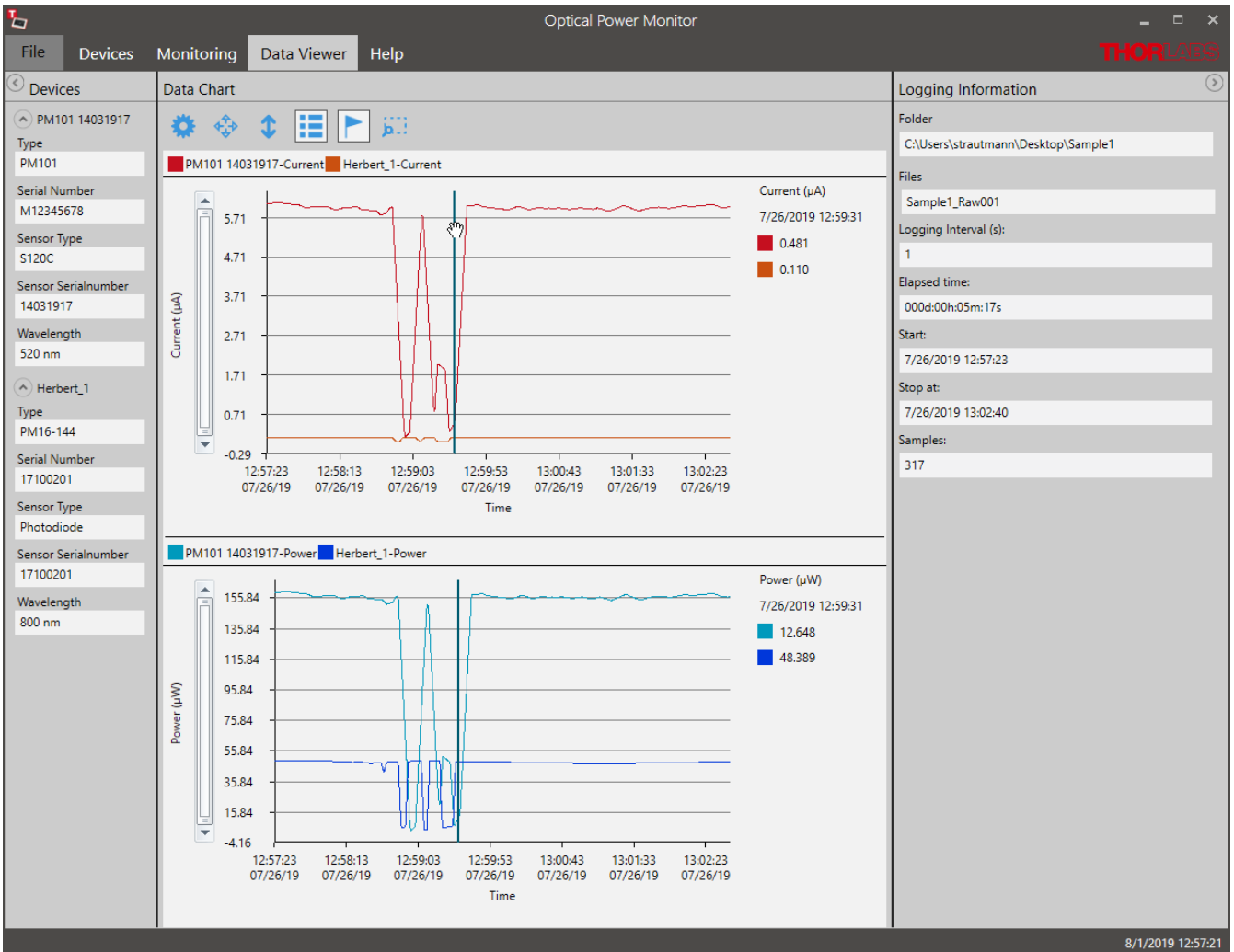
Second Device: Name as Set in [Edit Device](#) ¹³ →



Go to the **Data Chart** and use the [Tool Bar](#) ⁴⁰ to configure the display of devices and parameters.

Data Chart:

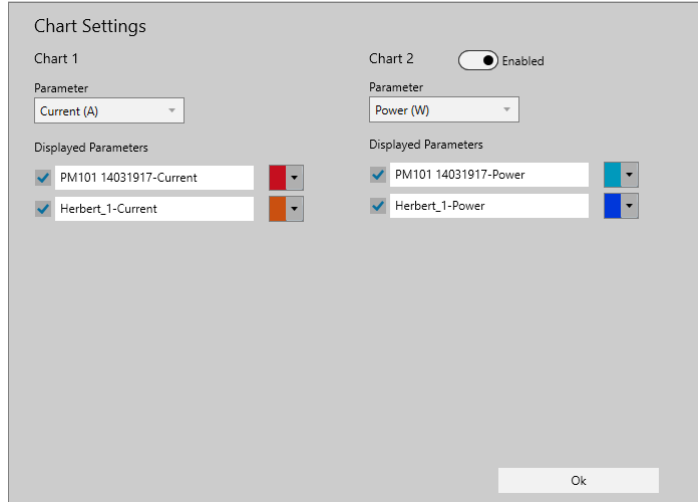
The **Data Chart** displays the loaded data over time. The display optionally includes a legend for the monitored devices and a cursor to choose the display of a specific measurement value. Use the **Tool Bar** on top of the chart to edit the display and analyze the data set.



Tool Bar

Settings:


To analyze the measurement, add any parameter and device (Displayed Devices) of the loaded file to the **Data Chart**. Assign different colors to easily distinguish power meters and parameters in the display. Move the toggle switch in **Chart 2** to **Enabled** to display the second chart.





Click **OK** when the selection is finished.


Zoom: To zoom into the chart, place the cursor over the chart and scroll.

 **Zoom out:** Zooms out to the original resolution in both, the X and Y axis.

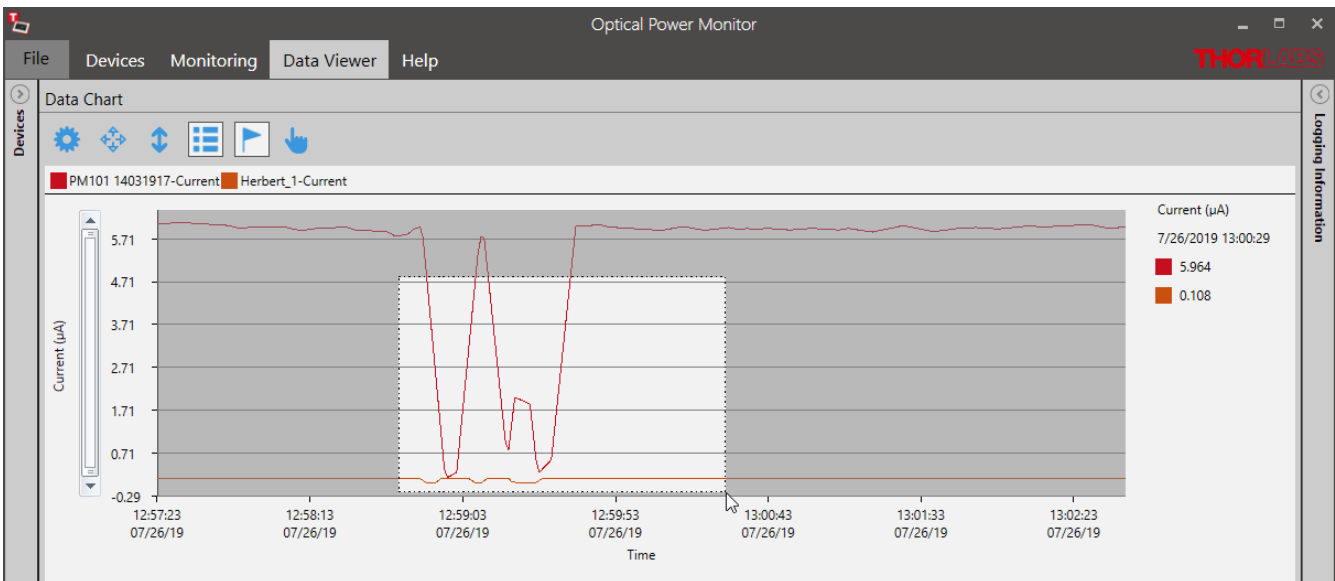
 **Zoom out Y-axis:** Zooms out to the original resolution in the Y axis only.

 **Enable/Disable Legend:** Add the legend listing the used devices to the chart area as shown above.

 **Enable/Disable Marker:** Add the marker to display the measurement value at a chosen single time point next to the chart.

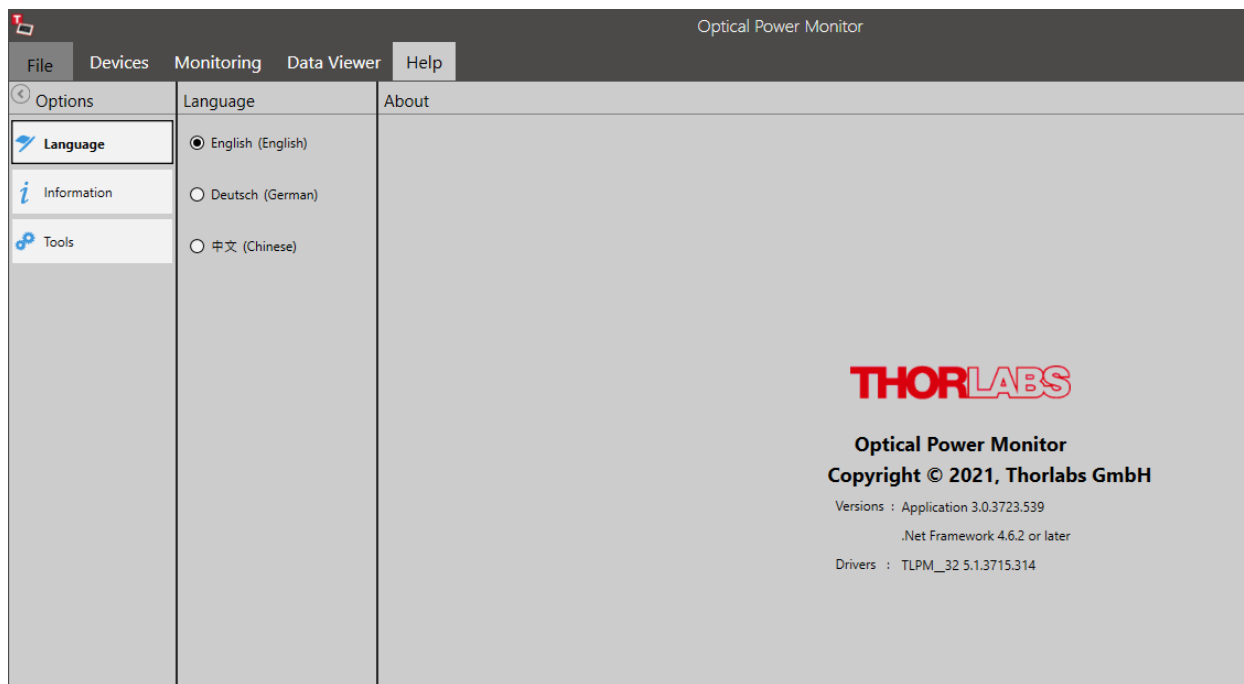
 **Zoom Selection:** Zoom into a ROI by selecting the area. The user can then move a window of the size of the ROI through the whole chart area.

Zoom Selection:

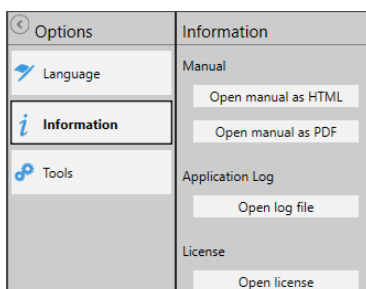


4.5 Help

In the HELP interface, choose the language, find the operating instructions, of files and software license under Information and change instrument drivers or update firmware of software.



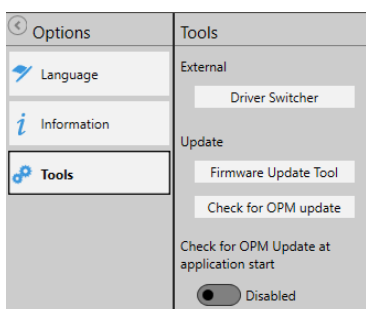
Information



Please find the operating manual as online help (.chm file) or .pdf as well as the log file and the software license here.

Please feel free to check for updates frequently.

Tools



This interface leads you to the driver switcher to change the power meter driver from the former PM100D.dll to the newer TL.dll. While the PM100D.dll supports older software, generated with the older driver, the TL.dll supports all functions of all Thorlabs power meters. Visit the section [Instrument Driver for Thorlabs Power Meters](#)^[60] for more details.

The Firmware Update tool allows to search your PC for already downloaded firmware. In case you did not download a firmware and wish to search the web for the update, please go to the DEVICES menu and open the panel [Information](#)^[15]. Here, you will find a firmware update tool which searches the web for updates of the firmware for the connected power meter. For questions, please contact [Thorlabs](#)^[72].

5 Optical Power Monitor with Different Devices

The Optical Power Monitor automatically responds to the functional differences of connected devices and adjusts the interface with the additional options.

This chapter describes differences and additional options with respect to different power meter consoles or sensors compared to [PM100USB](#) and a Photodiode Power Sensor [S120VC](#).

5.1 Power Meter Dependent Variations

5.1.1 PM101x

When using the power meters of the PM101x models, the software shows the following additional options:

PM101

- **Analog Output:** For the PM101, the OPM allows to define the voltage level of the analog output by configuring the responsivity. Please see the chapter Settings under [Device](#) ^[14] for more information or the [PM101x manual](#) for more details.
- **NTC:** With the PM101, the user can monitor the temperature with an attached NTC. for more information on this feature, please see the PM101x manual or the section [Temperature Sensor TSP-TH on PM400 and PM101](#) ^[48].
- **COM-Port:** The PM101 can use a DB-15 connector run with RS232 operation for input and output. The OPM provides an interface to switch to the COM-port of the power meter. Please see the chapter [Add Devices](#) ^[11] for more information.

PM101R

- **COM-Port:** The PM101R can use a serial DE-9 connector run with RS232 operation for input and output. The OPM provides an interface to switch to the COM-port of the power meter. Please see the chapter [Add Devices](#) ^[11] for more information.

PM101A

- **Analog Output:** For the PM101A, the OPM allows to define the voltage level of the analog output by configuring the responsivity. Please see the chapter Settings under [Device](#) ^[14] for more information or the [PM101x manual](#) for more details.

5.1.2 PM102x

When using the power meters of the PM102x models, the software shows the following additional options:

PM102

- **Analog Output:** For the PM102, the OPM allows to define the voltage level of the analog output by configuring the responsivity. Please see the chapter Settings under [Device](#) ^[14] for more information or the [PM102x manual](#) for more details.
- **NTC:** With the PM102, the user can monitor the temperature with an attached NTC. For more information on this feature, please see the [PM102x manual](#) or the section [Temperature Sensor TSP-TH on PM400, PM101, and PM102.](#) ^[48]

- **COM-Port:** The PM102 can use a DB-15 connector run with RS232 operation for input and output. The OPM provides an interface to switch to the COM-port of the power meter. Please see the chapter [Add Devices](#)^[11] for more information.

PM102A

- **Analog Output:** For the PM102A, the OPM allows to define the voltage level of the analog output by configuring the responsivity. Please see the chapter Settings under [Device](#)^[14] for more information or the [PM102x manual](#) for more details

PM102x with Thermal Position Sensors S44xC

All PM102x power meters are compatible with Thorlabs Thermal Position Sensors. When connected to a S44xC sensor, the OPM shows the interfaces described in the section [Thermal Position Sensors](#)^[50] in the chapter "Sensor Dependent Functions".

5.1.3 PM103x

When using the power meters of the PM103x models, the software shows the following additional options:

PM103

- **Analog Output AO2:** For the PM103 and PM103A, the OPM allows to define the voltage level of the analog output AO2 by configuring the responsivity. Please see the chapter Settings under [Device](#)^[14] for more information or the [PM103x manual](#) for more details.
- **NTC:** With the PM101, the user can monitor the temperature with an attached NTC. For more information on this feature, please see the PM103x manual or the section [Temperature Sensor TSP-TH on PM400 and PM101](#)^[48].
- **COM-Port:** The PM103 can use a DB-15 connector run with RS232 operation for input and output. The OPM provides an interface to switch to the COM-port of the power meter. Please see the chapter [Add Devices](#)^[11] for more information.

PM103A

- **Analog Output AO2:** For the PM103A, the OPM allows to define the voltage level of the analog output AO2 by configuring the responsivity. Please see the chapter Settings under [Device](#)^[14] for more information or the [PM103x manual](#) for more details.

5.1.4 PM400

The file structure of data saved by the Optical Power Monitor and the PM400 differ. Both file formats can be loaded by the OPM by selecting the appropriate import option. Also note the information given in the section [file formats](#)^[36].

5.2 Sensor-Dependent Variations

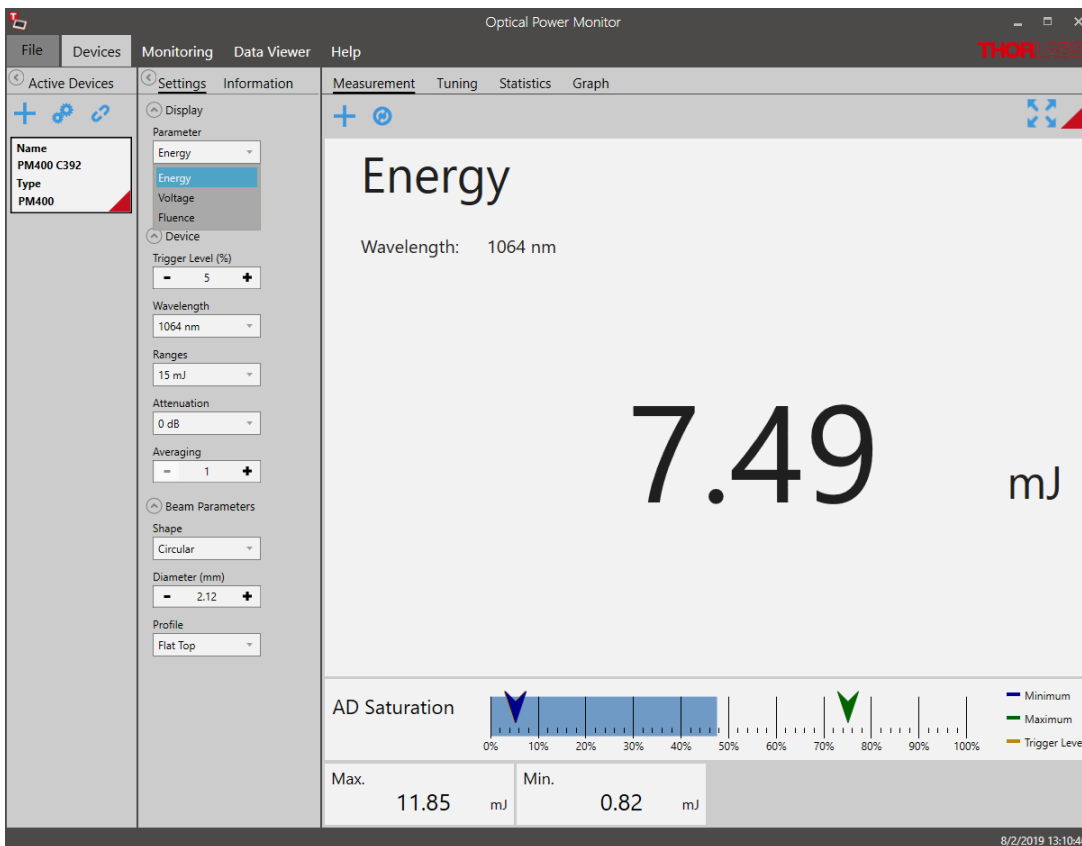
5.2.1 Pyroelectric Energy Sensors ESxxxC

The Thorlabs [ESxxxC Pyroelectric Sensors](#) are designed to measure pulsed light from coherent and incoherent sources. Pyroelectric sensors convert energy from light pulses into voltage pulses.

Because in this case the measured light signal is not continuous, the OPM requires different settings for processing and display.

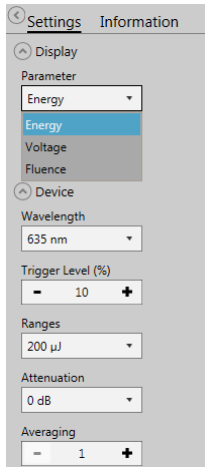
Find below the relevant changes in the OPM when using a pyroelectric energy sensor, described for a setup using a ES111C pyroelectric sensor connected to a PM400 power meter.

The interface looks the following way:



1. Settings Menu

The list of settings differs in the following:



Parameter: Energy and Fluence are parameters of choice instead of Power and Irradiance as Energy and Fluence are calculated independent of time.

Range: Auto Range is not available when using a pyroelectric sensor because this can not be accommodated with pulsed signals.

Trigger Level: The Trigger Level can be set as a threshold to eliminate small pulses caused by fluctuations in the light source or intrinsic noise from the detector.

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 as a percentage of each selected energy range. Only pulses that are higher than the adjusted trigger level are recognized by the OPM. The trigger level should be set between the noise level and the expected pulse height.

2. Measurement Menu: Add/Remove Parameters

For pyroelectric sensors, the measurement interface additionally displays the **AD Saturation** in a bar, as shown on the [previous page](#) ^[44].

When selecting **+**, the available parameters now list **Energy, Fluence and Average Power**.



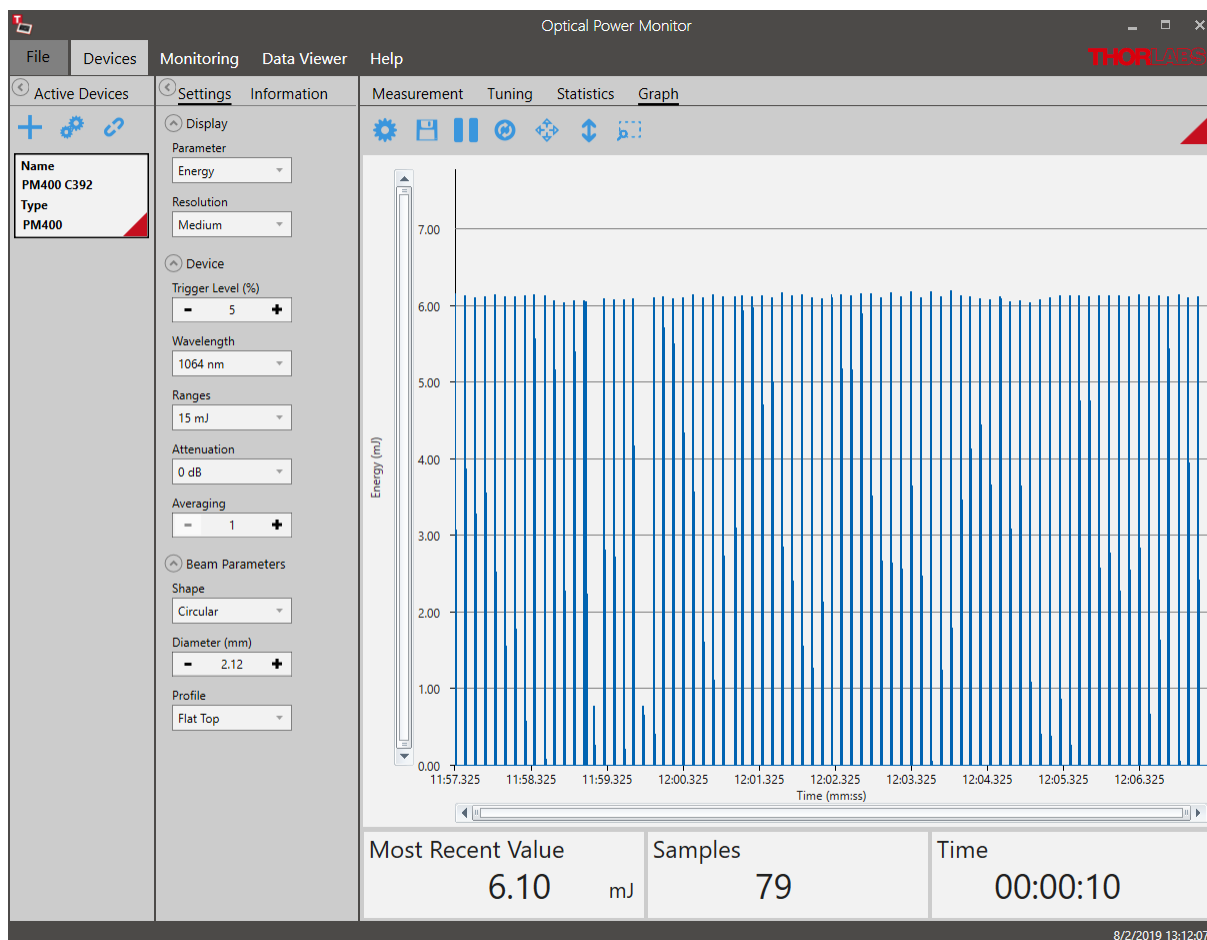
Average Power: The Average Power is calculated as an average of 3 measurement values. The calculation of the measurement values is based on the set [Averaging](#) ^[14].

When **Averaging** is set to 1, each signal pulse results in one measurement value. Since this is a rolling average, the second value of the average power is calculated using the pulse signals 2 to 4 and so on.

When **Averaging** is set to 2, the average of pulse 1 and 2 generates the first measurement value. The average of pulse 2 and 3 gives the second measurement value and so on. As above, the average power is calculated as the average of measurement values 1-3 calculated from signal pulses 1-4. Since this is a rolling average, the second average power value is calculated using signal pulse 2 to 5 and so on.

3. Graph Menu

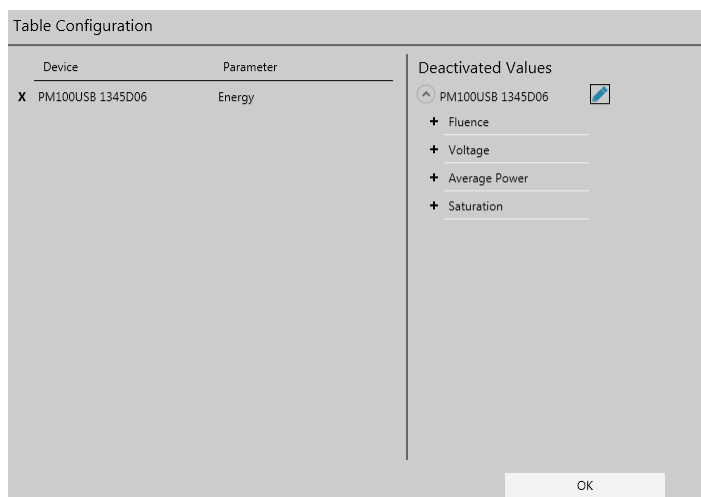
For pulsed laser applications, the Graph panel changes from a line-display, as shown for continuous signal, to a bar graph.



4. Monitoring Menu

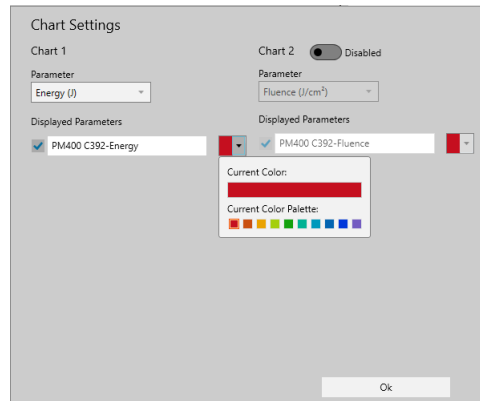
Table configuration

For pyroelectric sensors, the [Table Configuration](#) ³¹ now additionally lists the parameters **Energy**, **Fluence** and **Average Power** that can be logged in the experiment and continuously displayed.

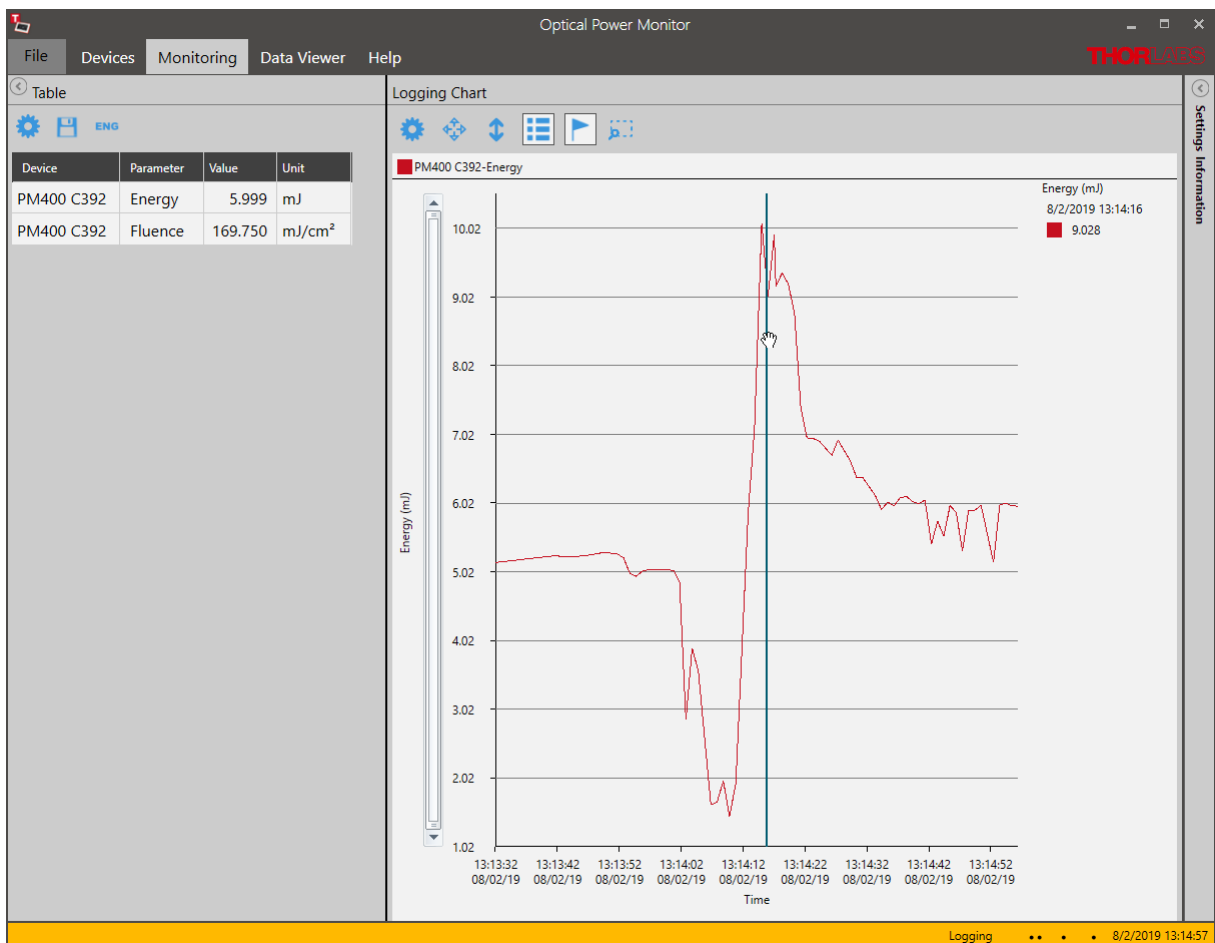


5. Logging Chart

Corresponding to the parameters selected in the above **Table Configuration**, the additional parameters can be selected for display in the [Logging Chart](#)³⁵.



The **Logging Chart** displays the pulse energy values in a continuous line. Please adjust the saving interval according to the interval between the laser pulses in your setup to avoid data points without signal. For pulse intervals shorter than the saving interval, the displayed value is the last value sent by the power meter. For higher resolution measurements, please use the [Graph](#)²⁸ mode.



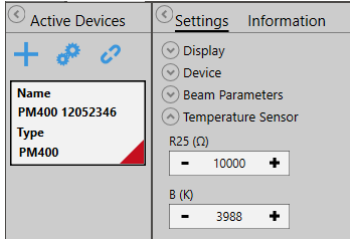
5.2.2 Temperature Sensor TSP-TH on PM400, PM101, PM102, PM103

For [PM400](#), [PM101](#), [PM102](#), and [PM103](#) the temperature can be recorded by the Optical Power Monitor if a Thorlabs Temperature Sensor [TSP-TH](#) or alternative NTC is attached. Please see the [PM400 Manual](#) and the manual for [PM101x](#), [PM102x](#), or [PM103x](#) for more details.

This section describes the additional options available in the software when a temperature sensor is recognized.

1. Settings Menu

Specify the following **Temperature Sensor** settings.



R25: Resistance @ 25 °C in Ohm [Ω]

B: NTC-Constant (NTC: Negative Temperature Coefficient) [K]

To find the appropriate parameters, please see the specifications of the temperature sensor.

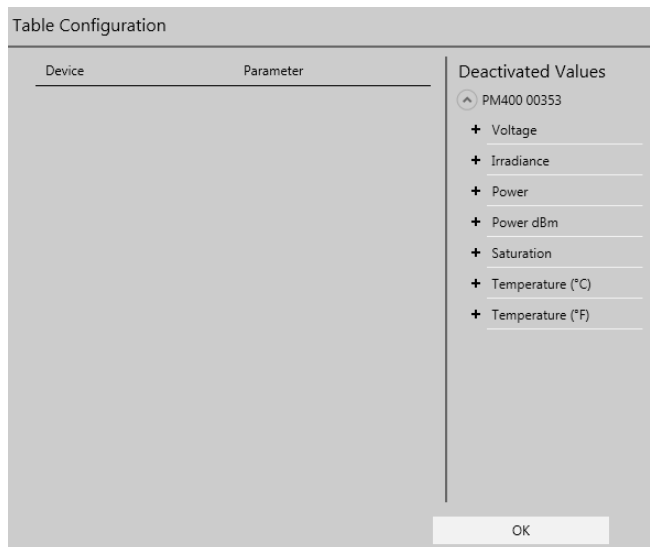
2. Measurement Menu: Add/Remove Parameters

For temperature sensors, the parameters list temperature in °C and °F, when selecting **+**.

Voltage	Irradiance	Power
Power dBm	Max.	Min.
Ratio	Saturation	Temperature (°C)
Temperature (°F)		

3. Monitoring Menu

When using a temperature sensor, the temperature in °C and °F can be logged and monitored by adding these parameters in the [Table Configuration](#) panel.

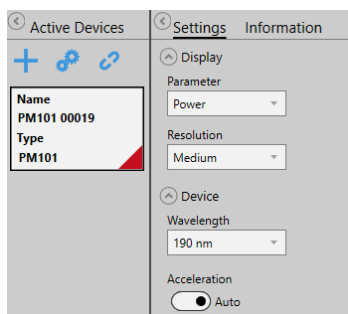


5.2.3 Thermal Sensors

Thermal detectors measure the optical power of incident light radiation. The absorber on the detector surface converts the incident light into heat energy. The heat flows from the absorber across the sensor into a heat sink. Due to the thermoelectric effect, the resulting temperature gradient across the multiple thermocouples in the sensor generates a voltage that is proportional to the optical power of the incident radiation.

Certain thermal sensors can show a fairly slow response. When laser power hits the active area in these sensors, it may take up to 20 seconds until the power reading shows the maximum power value. A slow sensor can be accelerated to up to 1-3 seconds by predicting the maximum power value based on the initial power reading.

Settings:



Acceleration:

Set the Acceleration to **Auto** when using a slow thermal sensor. As this function has a disadvantage in that it induces noise to the measurement value, the acceleration circuit can be set to **Off**.

Information: Power Measurement Prediction

The typical natural response of a thermal sensor to an instantaneous transition from darkness to being steadily illuminated is a step function. It produces a response that can be modeled using an exponential

function.

The sensor time constant is defined in terms of the duration until the sensor response reaches 99% of its maximum response. When the sensor has reached the 99% level, a time period equal to five sensor time constants has elapsed.

When the sensor's natural response characteristic function is known, the final power reading can be modeled and predicted well before the sensor reading has stabilized. Thorlabs' power meter consoles calculate and display predictions of the stabilized power reading when Thorlabs sensors with sensor time constants larger or equal to 0.5 s (natural response time larger than 1s) are connected. For this calculation, the sensor information stored in the EEPROM built into the C-Series connectors is used. Please refer to the specifications sheet of the used sensor for the response time of your sensor.

When Acceleration is switched to **Auto**, the first prediction is made after a duration equal to a single sensor time constant. This prediction is updated at time intervals of one sensor time constant until a total duration of seven sensor time constants has elapsed. Prediction is then turned off; the power reading after seven time constants is 99.9% of the final reading.

After prediction is turned off, the gradient of the power reading is monitored, and prediction is re-enabled if an increase is detected which exceeds a defined threshold.

5.2.4 Thermal Position Sensor

The Thorlabs Thermal Position Sensors [S44xC](#) measure the power and position of a light beam originating from low and medium power lasers and are controlled via a connected compatible power meter, either a PM400 or a PM102x. The OPM features an interface to display and analyse the signal from these Thorlabs Thermal Position Sensors.

At the core of the S440C and S442C are the Thorlabs Thermal Position Detectors [TD4HR18XP](#)^[50] and [TD4HP18XA](#)^[50], respectively. The sensors are wire connected to a D-Sub-9 Pin Male connector for instrument control via a compatible Thorlabs power meter.

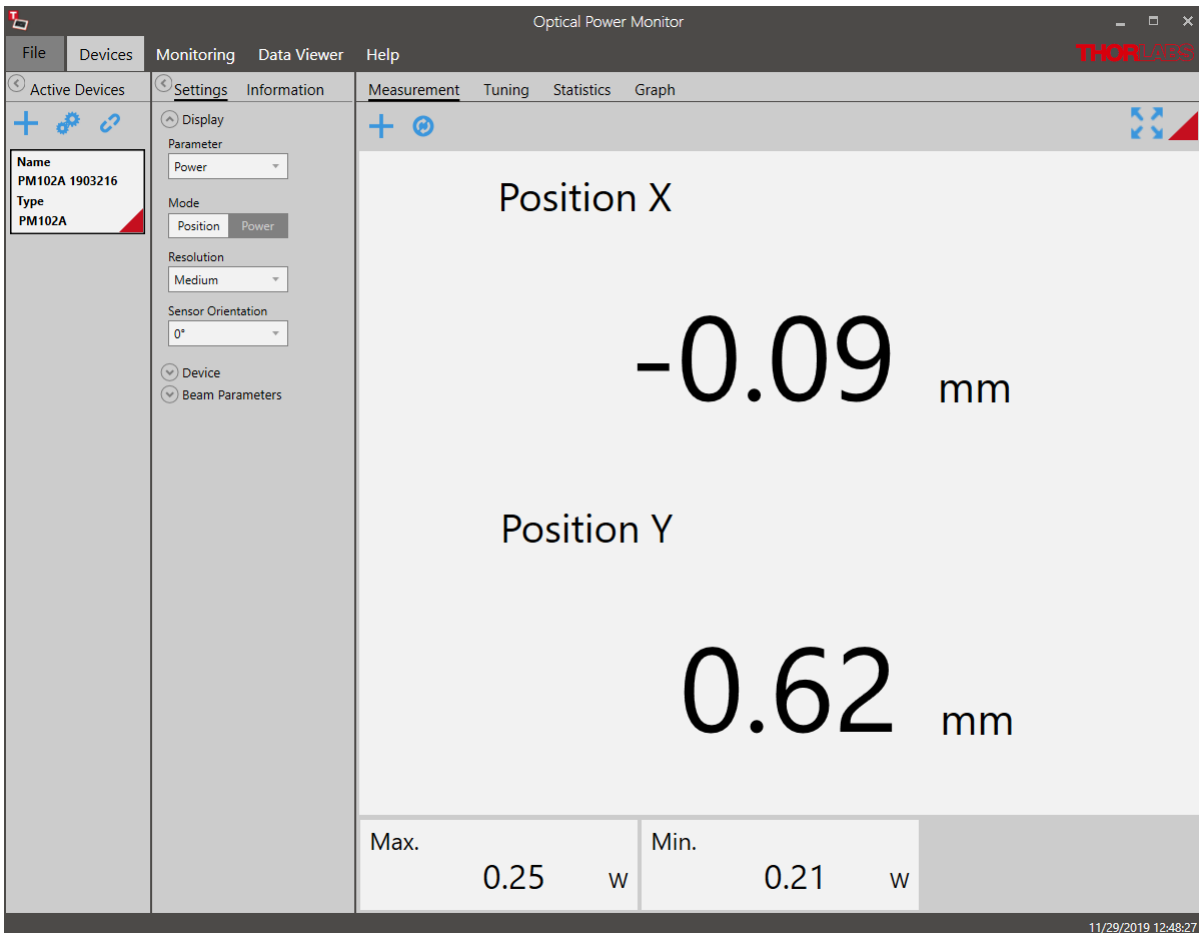
The core S44xC consists of four contiguous thermopile-based sensors arranged as quadrants of a square. Their mechanical integration thermally couples the four quadrants. However, the sensor in each quadrant is electrically independent and connected to only the thermocouples in that quadrant. This mechanical integration and electrical separation forms a position sensitive device (PSD). If the beam spot is incident on one quadrant, the output signal from this quadrant will be higher than the output signals of the other three quadrants. If the beam moves towards the center of the PSD, the signals from the four quadrants will become more similar. The X and Y position of the beam is determined by comparing the signal intensities of all four quadrants.

5.2.4.1 OPM Interface for Thermal Position Sensors

Find below the relevant changes in the OPM when using a Thermal Position Sensor, described for a setup using a S440C thermal position sensor connected to a PM102 power meter. The Thorlabs Thermal Position Sensors S44xC can be run using the PM400, PM102, PM102A, or PM102U and the OPM interface will appear correspondingly.

1. Devices - Settings Menu

Sub-section Display:

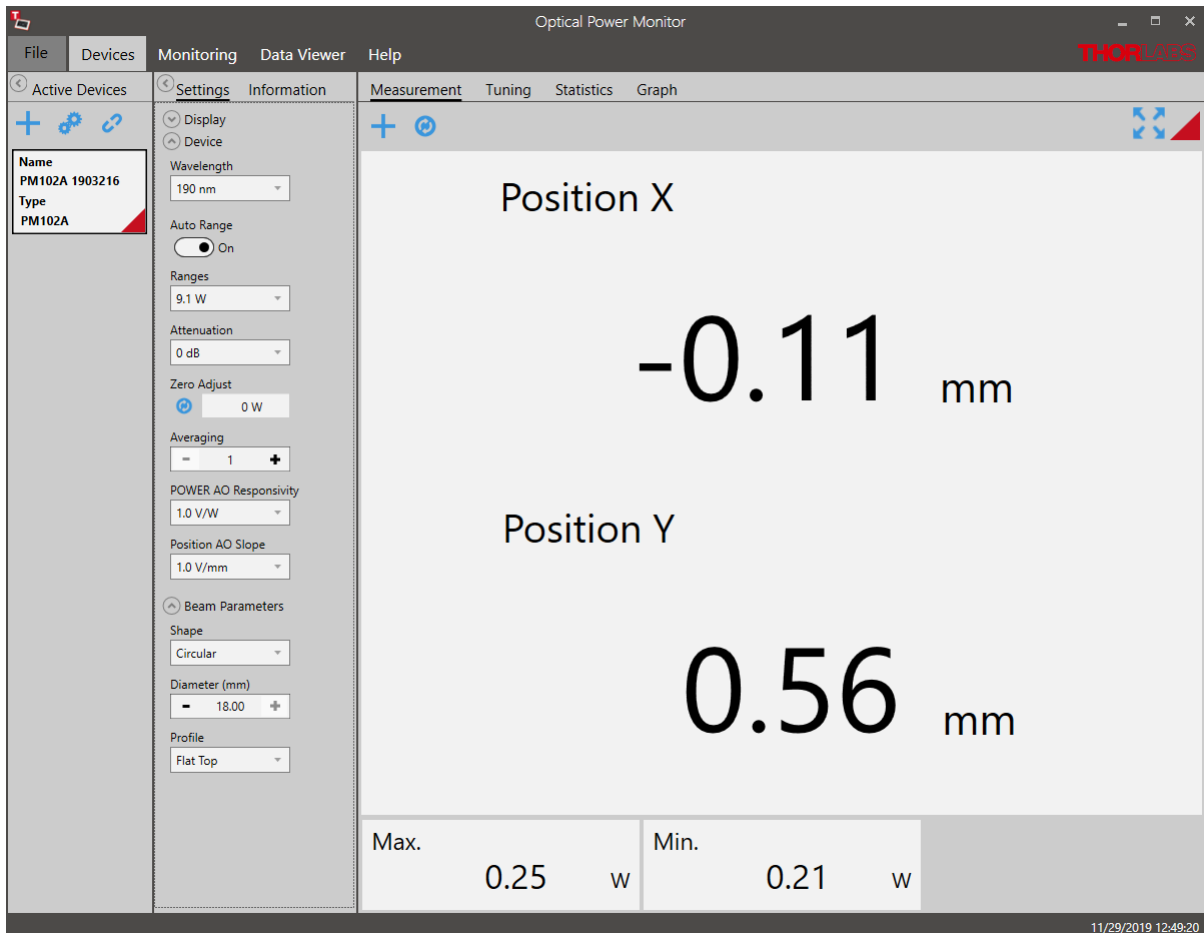


When a Thorlabs Thermal Position Sensor is connected to a power meter and run via the OPM, the OPM menu for "Devices" gives the option to display either the power signal or the positional signal.

When the "Power" is chosen in the section "Parameter", the OPM shows the standard interface.

When "Position" is chosen, the coordinates are shown in x and y. The user has the option to change the resolution and sensor orientation.

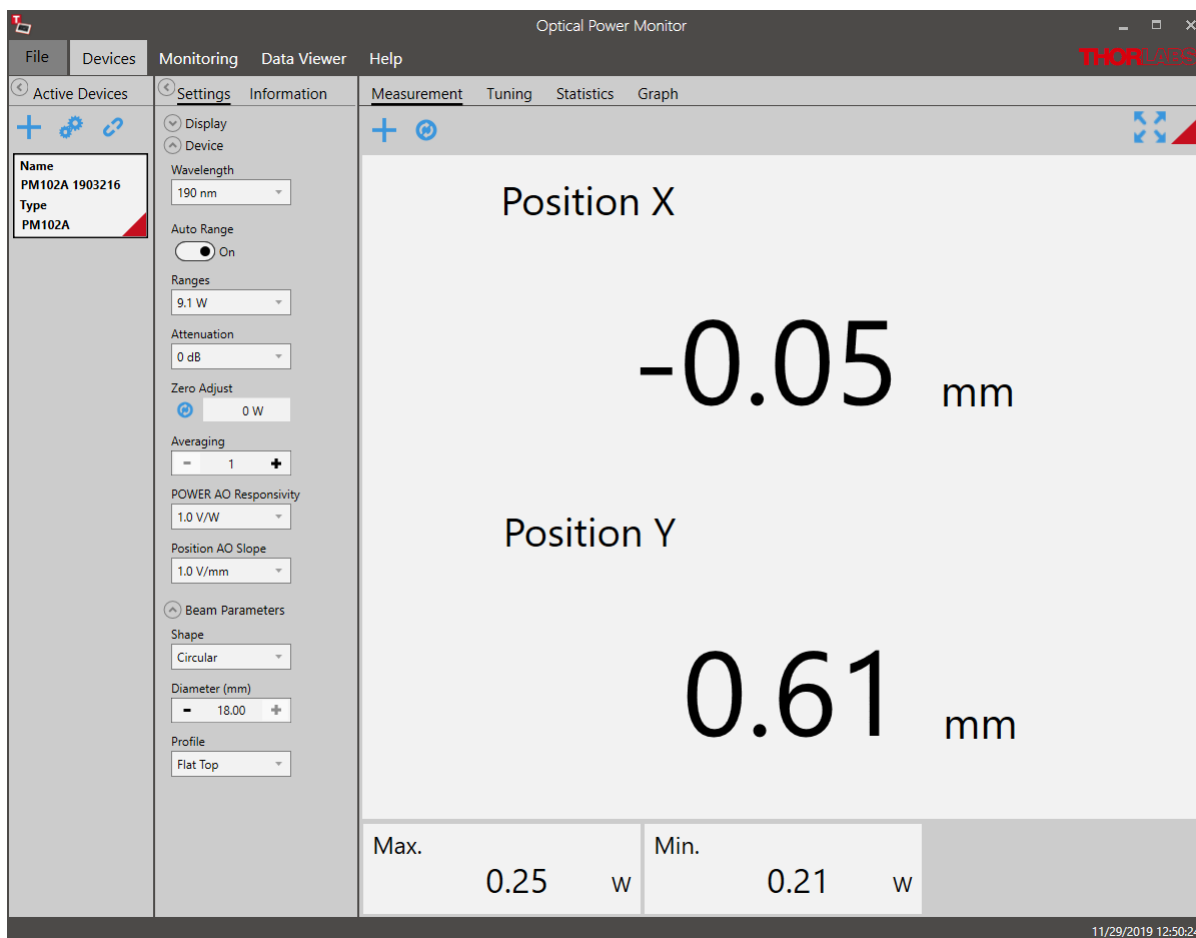
Sub-section Device:



Under devices, the standard settings described in the chapter [Settings](#)¹³ in the general section can be adjusted.

The Responsivity for the software-configurable analog output port POWER AO can be adjusted as well as the analog position output ports X POS and Y POS.


2. Devices - Measurement Menu

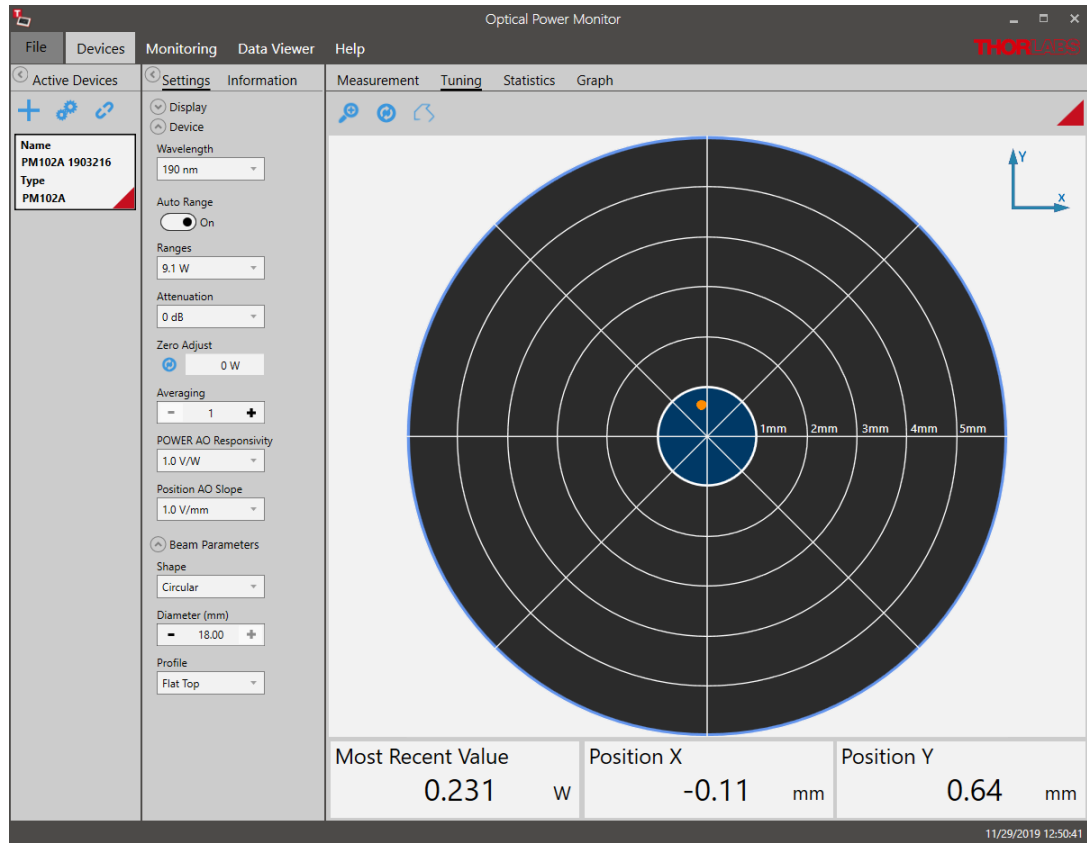


The Measurement interface displays the X and Y - position values and other values selected via the + icon. Options are shown below.

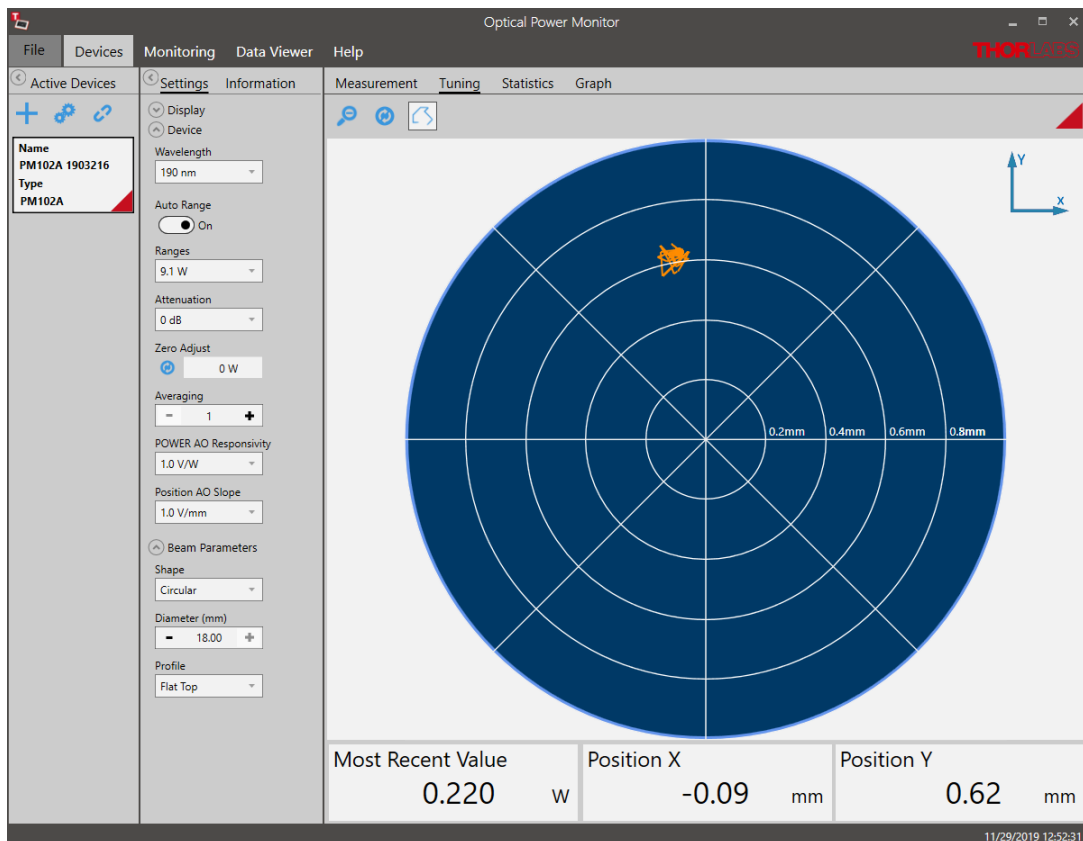
POWER AO Voltage	X POS AO Voltage	Y POS AO Voltage
Position X	Position Y	Voltage
Irradiance	Power	Power dBm
Max.	Min.	Ratio
Saturation		

3. Devices - Tuning Menu

The interface "Tuning" shows a graphic display of the beam position in a target. Use the icon  to zoom into the target.

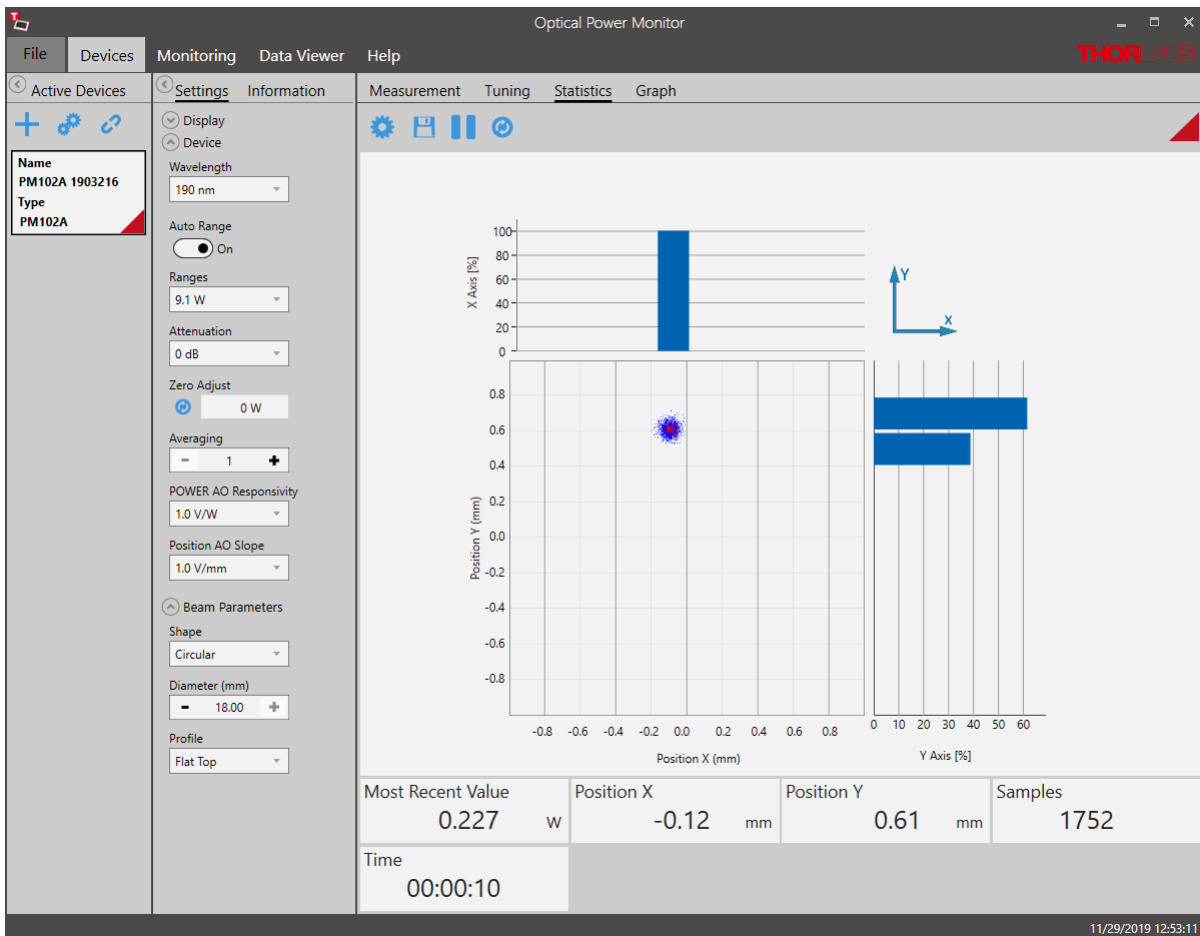


Use the button  to trace the position over time and the icon  to refresh the trace.



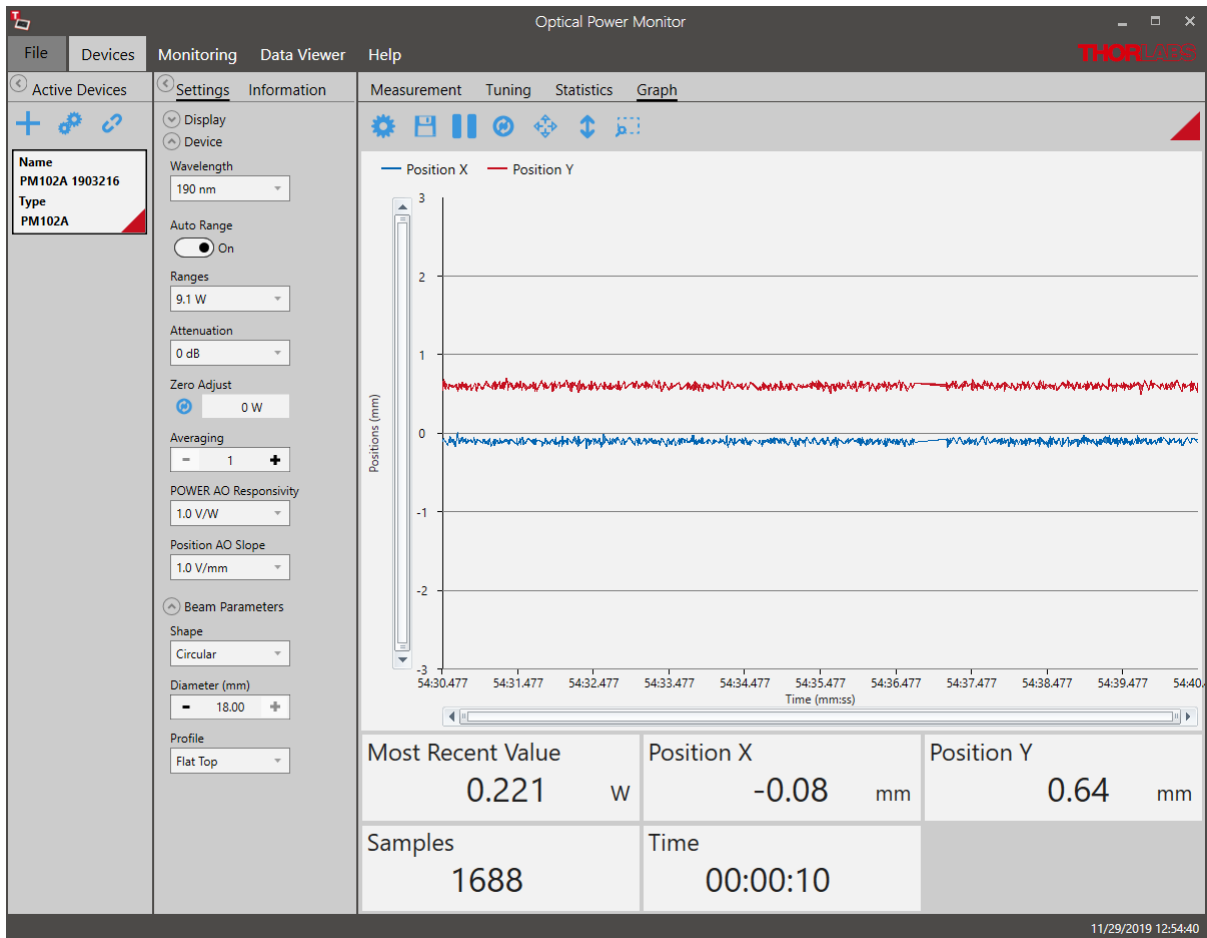
4. Devices - Statistics Menu

The interface "Statistics" shows the signal density on a particular position.




5. Devices - Graph Menu

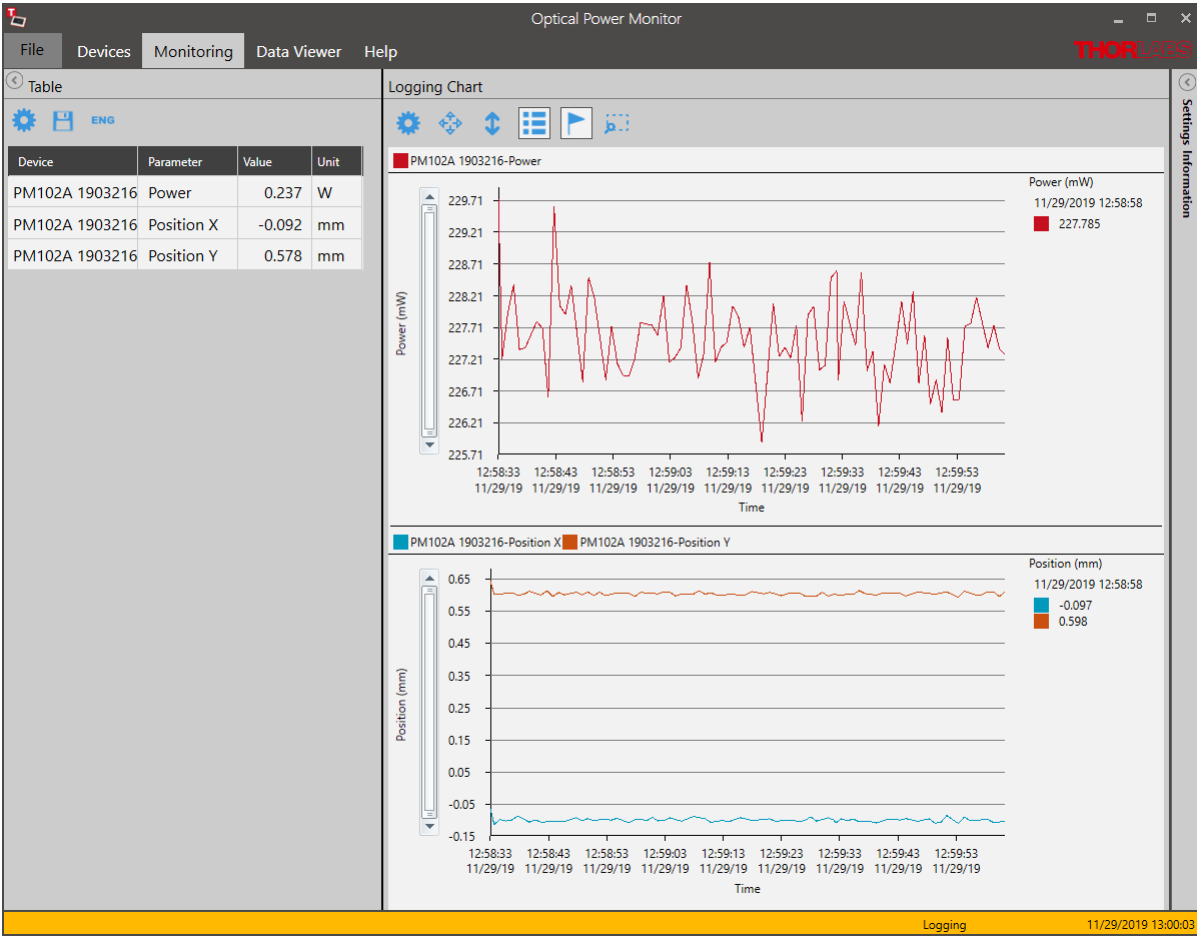
The interface "Graph" shows the signal position over time as a two-dimensional plot for the X and Y position.



The user can now change setting and zoom into the plot as for other graph displays.

6. Monitoring

When monitoring measurements with Thermal Position Sensors over time, the interface offers to view positional information in addition to the options available for other thermal sensors. To select those, go to the top left icon .



5.2.5 Custom Sensors

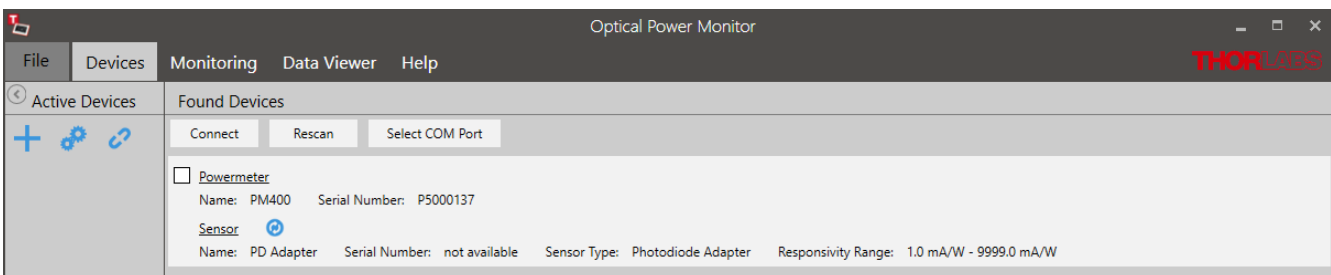
In addition to Thorlabs sensors, custom sensors can be used with the Optical Power Monitor.

Note

Please be aware that an adapter needs to be used to connect a custom sensor to a Thorlabs power meter. An adapter is not provided by Thorlabs. To build the adapter, please refer to the instructions in the manual of the respective power meter.

Setting the Sensor Type

The power meter and the OPM software will automatically recognize the adapter and set the sensor type in Found Devices to the last used adapter type.



The custom sensor type can be changed under **Settings** in the **Active Devices** panel to either "Photodiode Adapter", "Thermopile Adapter", "Pyro Adapter", or "Four Quadrant" sensor for thermal position sensors.

Optical Power Monitor

File Devices Monitoring Data Viewer Help

Active Devices Settings Information Measurement Tuning Statistics Graph

Name: PM400 P5000137
Type: PM400

Display
Parameter: Power
Resolution: Medium

Device
Adapter Type: Photodiode
Auto Range: On
Ranges: 55 nW
Attenuation: 0 dB
Zero Adjust: 0 W
Averaging: 1

Beam Parameters
Shape: Circular
Diameter (mm): 100.00
Profile: Flat Top

Power
Responsivity: 1000.0 mA/W

-0.01 nW

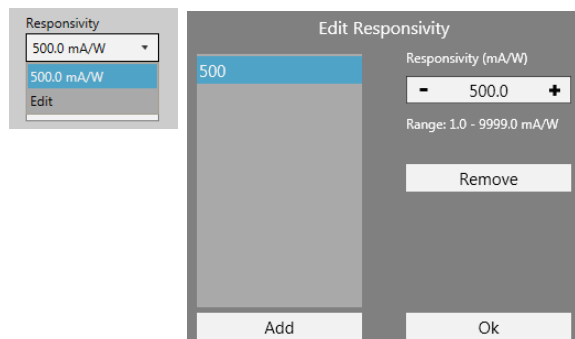
Max. 0.08 nW Min. -0.06 nW

8/2/2019 13:07:37

Required Setting Adjustments

The responsivity of the custom sensor is not recognized by the power meter and therefore not sent to the OPM software. This is indicated in the Found Devices Panel above: Responsivity Range: 1.0 mA/W - 9999.0 mA/W.

Therefore, it is necessary to account for it in your analysis or to set the responsivity of the used sensor at the operating wavelength in the **Settings** panel shown below.



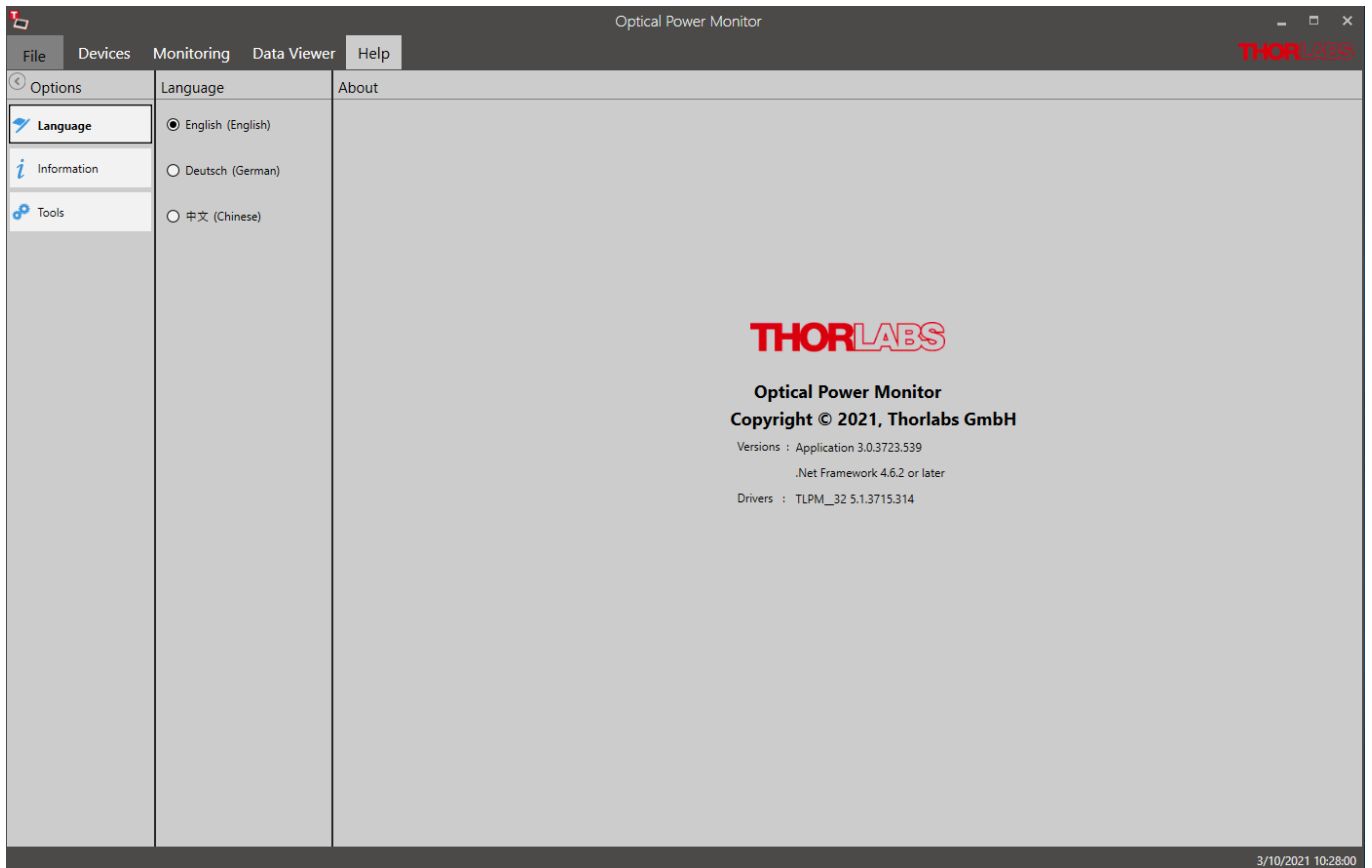
Several responsivities can be added to a list. This way, the correct responsivity can be quickly selected when using different wavelengths.

Note

If the adapter is not automatically recognized or the settings can not be adjusted in the software, please contact [Thorlabs](#)⁷².

6 Version Information

For information on the software version, please go to the Help menu.



7 Instrument Driver for Thorlabs Power Meters

The Thorlabs Optical Power Monitor (OPM) uses the newer power meter driver TLPM.dll instead of the Formerly used NI-VISA™-based driver PM100D.dll.

The new driver TLPM.dll is automatically installed with the OPM installation. We recommend using this driver as it is easier to install, uses less disk space and has a more robust algorithm for recognizing devices than the previously used NI-VISA™-based driver PM100D.dll. To change to the new driver or revert from the TLPM driver to the PM100D driver, please use the program [Power Meter Driver Switcher](#)^[60].

Attention

Custom Made Software

Be aware that the driver assignment of the power meters is changed upon installation of the OPM. If you created your own software for remote operation of Thorlabs power meters based on the PM100D.dll driver, the software needs to be modified to use the new TLPM.dll driver. Please read the chapters [Adaptation of Customer Software](#)^[63] and [Write Your Own Application \(WYOA\)](#)^[66] for instructions.

Alternatively, you can use the tool [Power Meter Driver Switcher](#)^[60] to switch between the two drivers, the PM100D.dll driver and the new TLPM.dll driver, according to your needs. The [Power Meter Driver Switcher](#)^[60], is installed together with the Optical Power Monitor.

Attention

Power Meter Monitor, Optical Power Meter Utility and Multi Power Meter

To keep using the software packages **Power Meter Monitor**, **Optical Power Meter Utility** or **Multi Power Meter** software after installing the Optical Power Monitor with the TLPM.dll driver, the user needs to revert to the driver PM100D.dll. To switch between the old PM100D.dll driver and the new TLPM.dll driver, a software tool, the [Power Meter Driver Switcher](#)^[60], is installed together with the Optical Power Monitor.

7.1 Power Meter Driver Switcher

The Power Meter Driver Switcher is a tool to switch between the NI-VISA™-based PM100D.dll driver and the TLPM.dll driver installed with the Optical Power Monitor in [cases listed above](#)^[60].

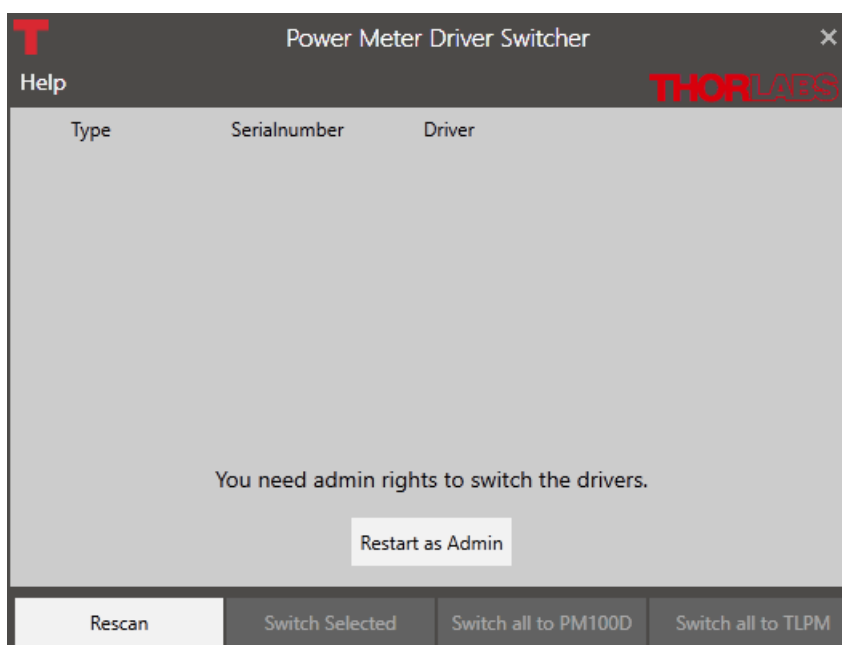
Attention

To use the Power Meter Driver Switcher and change instrument drivers, you need administrator rights on your PC.

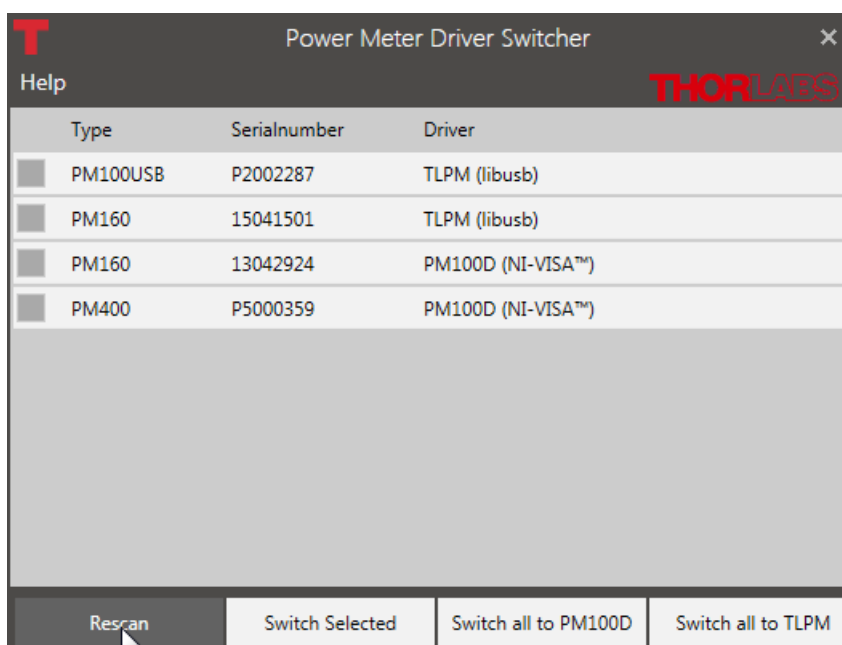
Open the Power Meter Driver Switcher through the Start button or from the Program Folder:

- Start Button:
All programs > Thorlabs > Power Meter > Tools > Power Meter Driver Switcher
- Program folder:
C:\Program File (x86)\Thorlabs\PowerMeters\Tools\DriverSwitcher

The Power Meter Driver Switcher opens with the following interface:



Use the **Menu Bar** at the bottom, to **Rescan** and see all attached devices. The table lists the **Type** of instrument, its **Serial Number** and the currently installed **Driver**.

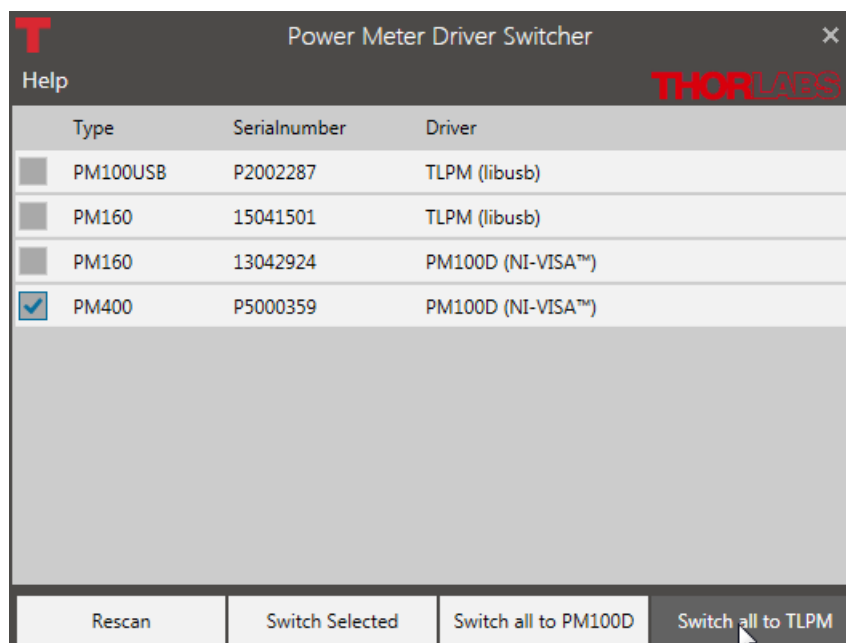


You can now convert the drivers for all or the selected devices to the driver appropriate for your application.

Note

Use the PM100D.dll for the Power Meter Monitor, Optical Power Meter Utility, or Multi Power Meter software.

The OPM can operate with either driver. However, some functions of PM101x, PM102x, PM103x, and PM400 will not appear when using the PM100D.dll.



The **Help** panel guides you to the Thorlabs website, the license agreement, and the software version number.

Close the Power Meter Driver Switcher after the driver exchange to prevent unintentional use.

Note

You can use the different drivers for different devices in parallel. Example: Power Meter PM100USB SerialNumber 1 and Power Meter PM100USB SerialNumber 2 are both connected to the PC. You can now use PM100USB SerialNumber 1 with driver TLPM.dll in the Optical Power Monitor and PM100USB SerialNumber 2 with the driver PM100D.dll using another software in parallel.

7.2 Adaptation of Customer Software

The driver assignment of the power meters is changed upon installation of the OPM. If you created your own software for remote operation of Thorlabs power meters based on the PM100D.dll driver, the software needs to be modified to use the new TLPM.dll driver.

Alternatively, you can use the tool [Power Meter Driver Switcher](#)^[60] to switch between the two drivers, the PM100D.dll driver and the new TLPM.dll driver, according to your needs. The [Power Meter Driver Switcher](#)^[60], is installed together with the Optical Power Monitor.

Instruction to switch to the new TLPM driver:

1. Replace the Header files in the project:

PM100D implementation:

```
#include "visa.h"
```

```
#include "PM100D.h"
```

→ TLPM Implementation:

```
#include "TLPM.h"
```

2. Replace the prefix of all functions and defines PM100D_ → TLPM_

E.g.:

PM100D_init → TLPM_init

PM100D_ATTR_SET_VAL → TLPM_ATTR_SET_VAL

3. Add the library TLPM_32.lib to the project

In the project settings add "TLPM_32.lib" to the project.

4. Be sure that the library "TLPM_32.dll" is either beside the application, in the path of the environment variable VXIPNPPATH or PATH or in the system folder. Use the same location as the PM100D_32.dll.

8 Troubleshooting

- **The OPM does not show all functions of PM101x, PM102x, or PM400**

- **Reason :** The instrument might be using the older legacy instrument driver PM100D.dll for the connected power meters. That is why some functions displayed in the GUI are missing.
- **Solution:** The problem is solved by switching to the new driver TLPM.dll. To switch between from the PM100D.dll to the TLPM.dll, use the [Power Meter Driver Switcher](#)^[60] tool. Read about the different instrument drivers in the section [Instrument Driver for Thorlabs Power Meters](#)^[60].

- **A power meter can not be connected, although it was found by the GUI (appears in the Found Devices Panel)**

- **Reason:** The power meter may have been recognized by the OPM while the sensor was not connected.
- **Solution:** Please ensure that the sensor is properly connected to the power meter, then unplug and replug the USB cable between the PC and the power meter. In case the problem persists, reboot the power meter.

- **A power meter is not automatically connected to the OPM after a hot-swap (disconnecting one sensor on the power meter and connecting a different one)**

- **Reason:** The power meter may have been recognized by the OPM while the sensor was not connected.
- **Solution:** Unplug and replug the USB cable between the PC and the power meter. In case the problem persists, reboot the power meter.

- **I can not use the software Power Meter Monitor**

- **Reason:** The Thorlabs Optical Power Monitor (OPM) uses a different driver for the connected power meters than the Thorlabs Power Meter Monitor. The instrument driver of the power meters was changed to the new driver upon installation of the Optical Power Monitor. That is why a driver may be incompatible.

Former instrument driver: NI-VISA™-based driver PM100D.dll.
OPM instrument driver: TLPM.dll.

- **Solution:** To revert to the PM100D.dll, use the [Power Meter Driver Switcher](#)^[60] tool supplied with the Optical Power Monitor software package. Read about the different instrument drivers in the section [Instrument Driver for Thorlabs Power Meters](#)^[60].

- **I can not use the software Optical Power Meter Utility**

- **Reason:** The Thorlabs Optical Power Monitor (OPM) uses a different driver for the connected power meters than Thorlabs power meter software application Optical Power Meter Utility. The instrument driver of the power meters was changed to the new driver upon installation of the Optical Power Monitor. That is why a driver may be incompatible.

Former instrument driver: NI-VISA™-based driver PM100D.dll.
OPM instrument driver: TLPM.dll.

- **Solution:** To revert to the PM100D.dll, use the [Power Meter Driver Switcher](#)^[60] tool supplied with the Optical Power Monitor software package. Read about the different instrument drivers in the section [Instrument Driver for Thorlabs Power Meters](#)^[60].

- **I can not use the software Multi Power Meter**

- **Reason:** The Thorlabs Optical Power Monitor (OPM) uses a different driver for the connected power meters than Thorlabs power meter software application Multi Power Meter. The instrument driver of the power meters was changed to the new driver upon installation of the Optical Power Monitor. That is why a driver may be incompatible.

Former instrument driver: NI-VISA™-based driver PM100D.dll.
OPM instrument driver: TLPM.dll.

- **Solution:** To revert to the PM100D.dll, use the [Power Meter Driver Switcher](#)^[60] tool supplied with the Optical Power Monitor software package. Read about the different instrument drivers in the section [Instrument Driver for Thorlabs Power Meters](#)^[60].

- **I can not use my Custom Made Software to steer Thorlabs power meters anymore**

- **Reason:** The Thorlabs Optical Power Monitor (OPM) uses a different driver for the connected power meters than former Thorlabs power meter software applications. The instrument driver of the power meters was changed to the new driver upon installation of the Optical Power Monitor. You may have used the former instrument driver when writing your software and now that the driver is changed, your software no longer recognizes the power meters.

Former instrument driver: NI-VISA™-based driver PM100D.dll.
OPM instrument driver: TLPM.dll.

- **Solution:** You can either [adjust your custom made software](#)^[63] or switch between the PM100D.dll and the TLPM.dll by using the [Power Meter Driver Switcher](#)^[60] tool supplied with the Optical Power Monitor software package. Read about the different instrument drivers in the section [Instrument Driver for Thorlabs Power Meters](#)^[60].

- **The PC freezes/ OPM freezes when logging a long term experiment**

- **Reason:** When logging a long-term measurement, the PC may go into hibernation or sleep mode. This causes the Optical Power Monitor to lose contact to the power meters and results in freezing of the Optical Power Monitor

- **Solution:** Turn off hibernation and sleep settings on your PC for long-term experiments read the section [Logging Configuration](#)^[32].

9 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 being installed to your computer during software installation and cannot be found in the installation package.

In this section the location of drivers and files, required for programming in different environments, are given for installation under Windows® 8.1 and Windows® 10 (32 bit and 64 bit).

In order to fully support 64 bit LabVIEW™ version, the installation offers two installer versions:

- For Windows® 8.x (32/64 bit) and Windows® 10 (32/64 bit): Install "xxxx VXIpn Instrument Driver (32bit)"
- For Windows® 8.x (64 bit) and Windows® 10 (64 bit): Install "xxxx VXIpn Instrument Driver (64 bit)"

In other words, the 32 bit VXIpn driver works with both 32 and 64 bit operating systems, while the 64 bit driver requires a 64 bit operating system.

Note

The Thorlabs Optical Power Meter 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, CVI	*.h (header file) *.lib (static library)
C#	.net wrapper dll
Visual Studio	*.h (header file) *.lib (static library) or .net wrapper dll
LabVIEW™	*.fp (function panel) and VXIpn Instrument Driver. Beside that, LabVIEW™ driver vi's are provided with the *.llb container file
Python	*.py wrapper

Note

All above environments require also the VXIpn Instrument Driver dll!

During 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 environment variable is necessary for installation of the instrument driver software components. In the next sections the locations of above files are described in detail.

9.1 32 bit Operating System

Note

According to the VPP6 (Rev6.1) Standard the installation of the 32 bit VXIpn driver includes both the WINNT and GWINNT frameworks.

VXIpn Instrument Driver:

C:\Program Files\IVI Foundation\VISA\WinNT\Bin\TLPM_32.dll

Note

This instrument driver is required for all development environments!

Header File

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

Static Library

C:\Program Files\IVI Foundation\VISA\WinNT\lib\msc\TLPM_32.lib

Function Panel

C:\Program Files\IVI Foundation\VISA\WinNT\TLPM\TLPM.fp

Online Help for VXIpn Instrument Driver:

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

NI LabVIEW™ Driver

The LabVIEW™ Driver is a 32 bit driver and compatible with 32 bit NI-LabVIEW™ versions 8.5 and higher.

C:\Program Files\National Instruments\LabVIEW xxxx\Instr.lib\TLPM...
...\TLPM.llb

(LabVIEW™ container file with driver vi's and an example. "LabVIEW xxxx" stands for actual LabVIEW™ installation folder.)

In case LabVIEW™ is not installed or if LabVIEW™ versions 2017 and higher are installed, the LabVIEW™ driver will be installed in:

C:\Program Files\Thorlabs\PowerMeters\LabVIEW\LabVIEW
32bit\TLPM\TLPM.llb

.net wrapper dll

C:\Program Files\Microsoft.NET\Primary Interop Assemblies...
...\Thorlabs.TLPM_32.Interop.dll

C:\Program Files\IVI Foundation\VISA\VisaCom\...
...\Primary Interop Assemblies\Thorlabs.TLPM_32.Interop.dll

Python wrapper

C:\Program Files (x86)\IVI Founda-
tion\VISA\WinNT\TLPM\Example\Python\TLPM.py

Example for C

Source file:

```
C:\Program Files\IVI Foundation\VISA\WinNT\TLPM\Example\C\...  
...sample.c
```

Example for C#

Solution file:

```
C:\Program Files\IVI Foundation\VISA\WinNT\TLPM\Example...  
...\MS.NET_CS\Thorlabs.TLPM.Interop.Sample.sln
```

Project file:

```
C:\Program Files\IVI Foundation\VISA\WinNT\TLPM\Examples...  
...\MS.NET_CS\Thorlabs.TLPM.Interop.Sample\ Thorlabs.TLPM.In-  
terop.Sample.csproj
```

Example for LabVIEW™

```
C:\Program Files\National Instruments\LabVIEW xxxx\Instr.lib\TLPM...  
...\TLPM.llb
```

(LabVIEW™ container file with driver vi's and an example. "LabVIEW™ xxxx" stands for actual LabVIEW™ installation folder.)

Example for Python

Solution file:

```
C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLPM\Example...  
...\Python\PowermeterSample.py
```

9.2 64 bit Operating System

Note

According to the VPP6 (Rev6.1) Standard the installation of the 64 bit VXIpnnp driver includes the WINNT, WIN64, GWINNT and GWIN64 frameworks. That means, that the 64 bit driver includes the 32 bit driver as well.

In case of a 64 bit operating system, 64 bit drivers and applications are installed to

```
"C:\Program Files"
```

while the 32 bit files - to

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

Below are listed both installation locations, so far applicable.

VXIpnnp Instrument Driver:

```
C:\Program Files (x86)\IVI Foundation\VISA\WinNT\Bin\TLPM_32.dll
```

```
C:\Program Files\IVI Foundation\VISA\Win64\Bin\TLPM_64.dll
```

Note

This instrument driver is required for all development environments!

Header File

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

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

Static Library

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\lib\msc...
... \TLPM_32.lib

C:\Program Files\IVI Foundation\VISA\Win64\lib\msc\TLPM_32.lib

C:\Program Files\IVI Foundation\VISA\Win64\Lib_x64\msc\TLPM_64.lib

Function Panel

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

Online Help for VXIpnv Instrument Driver:

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLPM\Manual\TLPM.html

NI LabVIEW™ Driver

The LabVIEW™ driver supports 32 bit and 64 bit NI-LabVIEW™ 2009 and higher.

C:\Program Files\National Instruments\LabVIEW xxxx\Instr.lib\TLPM ...
... \TLPM.llb

(LabVIEW™ container file with driver vi's and an example. "LabVIEW xxxx" stands for actual LabVIEW™ installation folder.)

In case LabVIEW™ is not installed or if LabVIEW™ versions 2017 and higher are installed, the LabVIEW™ driver will be installed in:

C:\Program Files\Thorlabs\PowerMeters\LabVIEW\LabVIEW
64bit\TLPM\TLPM.llb

.net wrapper dll

C:\Program Files (x86)\Microsoft.NET\Primary Interop Assemblies...
... \Thorlabs.TLPM_32.Interop.dll

C:\Program Files (x86)\IVI Foundation\VISA\VisaCom\...
... \Primary Interop Assemblies\Thorlabs.TLPM_32.Interop.dll

C:\Program Files\IVI Foundation\VISA\VisaCom64\...
... \Primary Interop Assemblies\Thorlabs.TLPM_64.Interop.dll

Python wrapper

C:\Program Files (x86)\IVI Founda-
tion\VISA\WinNT\TLPM\Example\Python\TLPM.py

Example for C

Source file:

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLPM\Example\C\...
...sample.c

Example for C#

Solution file:

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLPM\Example...
... \MS.NET_CS\Thorlabs.TLPM.Interop.Sample.sln

Project file:

```
C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLPM\Examples...  
...\MS.NET_CS\Thorlabs.TLPM.Interop.Sample\ Thorlabs.TLPM.In-  
terop.Sample.csproj
```

Example for LabVIEW™

```
C:\Program Files (x86)\National Instruments\LabVIEW xxxx\In-  
str.lib\TLPM...  
...\TLPM.llb
```

(LabVIEW™ container file with driver vi's and an example. "LabVIEW xxxx" stands for actual LabVIEW™ installation folder.)

Example for Python

Solution file:

```
C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLPM\Example...  
...\Python\PowermeterSample.py
```


10 Appendix

10.1 Warranty

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.

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10.3 Thorlabs Worldwide Contacts

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



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