THORLABS

PM5020

Dual-Channel Optical Power and Energy Meter

User Guide



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Chapter 1 Safety

Attention

The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

All statements regarding safety of operation and specifications in this instruction manual will only apply when the unit is operated correctly as it was designed for.

The PM5020 must not be operated in explosion endangered environments!

Do not obstruct the air ventilation slots in the housing!

Do not remove covers!

Do not open the cabinet. There are no user-serviceable parts inside!

This precision device is only serviceable if returned and properly packed into the complete original packaging including the cardboard inserts. If necessary, ask for replacement packaging.

Refer servicing to qualified personnel!

Changes to this device cannot be made nor may components not supplied by Thorlabs be used without written consent from Thorlabs.

Attention

Prior to applying power to the PM5020, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet! Improper grounding can cause electric shock resulting in damage to your health or even death!

Make sure that the line voltage range marked on the power supply agrees with your local supply.

All modules must only be operated with duly shielded connection cables.

Attention

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

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

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

Note

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.

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- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/T.V. technician for help.

Users that change or modify the product described in this manual in a way not expressly approved by Thorlabs (party responsible for compliance) could void the user's authority to operate the equipment.

Thorlabs is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and equipment other than those specified by Thorlabs. The correction of interference caused by such unauthorized modification, substitution or attachment will be the responsibility of the user.

The use of shielded I/O cables is required when connecting this equipment to any and all optional peripheral or host devices. Failure to do so may violate FCC and ICES rules.

Chapter 2 General Information

The PM5020 Dual-Channel Benchtop Optical Power and Energy Meter Console measures and displays the optical power of laser light or other monochromatic or near monochromatic light and the energy of pulsed light sources, detected by one or two connected sensors simultaneously. The PM5020 power meter also processes and displays positional information from the S44xC Thermal Position Sensors.

The PM5020 power meter is compatible with all Thorlabs "C-Series" Photodiodes, Thermal Power Sensors, including Thermal Position & Power Sensors, Pyroelectric Sensors, and respective custom sensors.

The high-resolution, backlit color touchscreen can be configured for various single and dual channel measurement, visualization, and data acquisition views in a flat menu structure. Operating aids, a laser and unit calculator, multi-language support, as well as the control of all useful additional features round off the range of functions.

The fast boot time of approximately 3 seconds, including the calibration data read out from the connected sensors have the device ready for operation at any time.

Modulated Light Measurements Including Fast Data Acquisition

Time-stamped long-term data acquisition up to 1 kS/s to internal memory or via remote control are available as well as a 100 kS/s scope data acquisition mode. Special modes for photodiode sensors can be used to measure the peak power of modulated signals or pulses down to 10 µs pulse width, independent of the repetition rate. Pulse energy measurements with pyroelectric sensors are supported up to a repetition rate of 80 kHz.

Free Configurable Analog Outputs

For each channel, the PM5020 power meter has a widely configurable, wavelength and offset corrected, analog output, achieved by an analog multiplier without sacrificing the full bandwidth of the analog circuit.

Two additional digital-to-analog (D/A) converter controlled 1 kS/s analog outputs for each channel can be configured to power or energy level, beam position in x and y direction (for thermal power and position sensors only), mathematical operation between the two channels, or as an analog temperature monitor.

Optical Shutters

The meter allows the direct connection of Thorlabs SH05R(/M) or SH1(/M) optical shutters when the interlock is closed. The shutters can be controlled and monitored via the user interface, per TTL input or remote interface.

NTC Connectors

Two external Negative Temperature Coefficient (NTC) thermistors like the Thorlabs TSP-TH, can be connected and their reading can be displayed or logged via the touchscreen.

User Accessible Digital I/O Port and Fan Control

There are two positions to connect to fans up to 12 V. The fans can be controlled by voltage, revolution per minute (rpm), or temperature. These can be used as power supply for fan-controlled power sensors.

The user accessible digital port provides 5 V tolerant TTL logic and contains:

- Four general I/O pins that can also be used for additional functions like a pass/fail test
- A trigger input and output for synchronized measurements
- A I2C bus, that supports specific humidity and temperature sensors

An additional front BNC connector can be configured for digital I/O or trigger control.

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Versatile Remote Operation Capabilities and Power Meter Software Compatibility

The PM5020 power meter can be remote controlled via three different interfaces: the high-speed USB interface, the built in Ethernet, or the serial RS232 interface.

The Thorlabs Optical Power Meter fully supports the PM5020 power meter. The software can handle multiple Thorlabs power meters simultaneously and additionally contains features like the "user calibration wizard" or the "firmware update tool".

The PM5020 power meter remote operation can be integrated into custom made systems with the help of the provided SCPI commands and drivers. For PM5020 drivers, please either use NI-Visa drivers possibly already installed on the PC, or use the Thorlabs TLP drivers which are installed with the Optical Power Monitor. The Thorlabs TLP drivers are compatible with all other Thorlabs power meter drivers. Please see the manual for OPM Software for more information.

In addition, the PM5020 power meter has a built in webserver that enables monitoring of the most interesting functions within a local area network.

Attention

Please find all safety information and warnings concerning this product in the chapter Safety.

2.1 Ordering Codes and Accessories

PM5020	Dual-Channel Benchtop Optical Power and Energy Meter Console

Optional Accessories:

SH1(/M) or SH05R(/M)	Optical Beam Shutter
HR10CAB1 Hirose Cable	Cable to connect the PM5020 power meter with SH05R(/M) or SH1(/M)
TSP-TH	External Temperature Probe

Replacement Terminal Block to Digital I/O and NTC Control.
Printed-Circuit Board Connectors - FMC1.5/10-STF-3.5: by Phoenix Contact (https://www.phoenixcontact.com Item Number: 1966172). Please purchase the sensor connectors directly at Phoenix Contact or contact Thorlabs.

2.2 Requirements

The following are the requirements for the PC intended to be used for remote operation of the PM5020 power meter via the Optical Power Monitor Software (OPM).

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 PM5020 software is compatible with the following operating systems:

- Windows® 8.1 (32 bit, 64 bit)
- Windows® 10 (32 bit, 64 bit)
- Windows® 11 (64 bit)

Chapter 3 Getting Started

3.1 Parts List

Please inspect the shipping container for damage. Please do not cut through the cardboard, as the box might be needed for storage or returns.

If the shipping container appears to be damaged, keep it until you have inspected the contents for completeness and tested the PM5020 mechanically and electrically.

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

1. PM5020 Dual-Channel Optical Power and Energy Meter
2. USB 2.0 Cable, 2 m
3. Two Printed-Circuit Board Connectors - FMC1.5/10-STF-3.5
4. Power Cord, Country Specific
5. Quick Reference
6. Certificate of Calibration

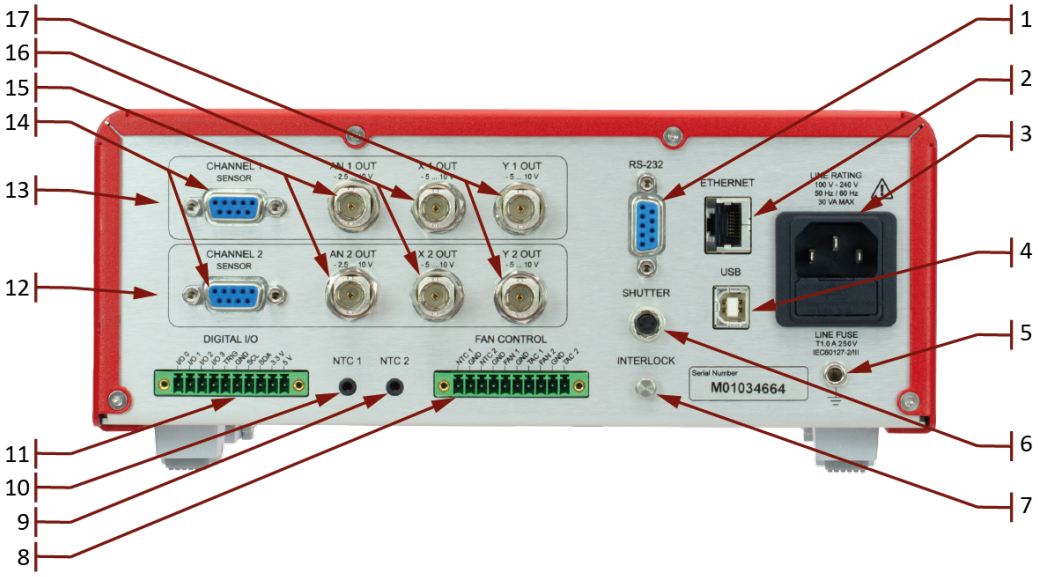
Chapter 4 Operating Instructions

4.1 Operating Elements

Front Panel



Rear Panel



PM5020 Rear Panel Features	
1	DE-9 RS232 Connector
2	RJ45 Ethernet Connector
3	IEC-60320 C14 Power Inlet
4	Type B USB Connector
5	4 mm Banana Socket Ground Terminal
6	Hirose HR10A-7R-6S Shutter Connector
7	2.5mm mono Audio Interlock Connector
8	10-PIN PCB Connector Fan & NTC Control
9	2.5mm Stereo Audio NTC Connector
10	2.5mm Stereo Audio NTC Connector
11	10-PIN PCB Connector Digital I/O
12	Channel 2 Connectors
13	Channel 1 Connectors
14	DE-9 Sensor Input Connector
15	Analog Output Connector
16	X Output Connector
17	Y Output Connector

4.2 Installing Software

The Optical Power Meter (OPM) Software 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 start the Install Shield Wizard.
- Read and accept the End-User License Agreement and the GNU Lesser General Public License.
- After installing the OPM Software, connect the power meter(s) to the PC.

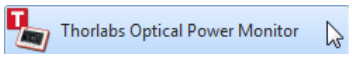
Note Up to 8 sensors can be connected via power meters and monitored in parallel in a single software instance. If your PC does not provide a sufficient number of USB-ports, use a powered USB-HUB to ensure that enough power is supplied to the power meters.

Start Application

There are two ways to open the Optical Power Meter Software:



Click the Desktop Icon

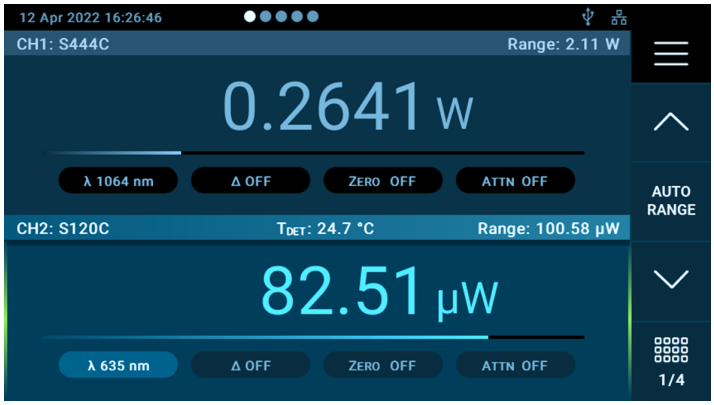


Via the Microsoft Windows START Menu

4.3 Setup

Direct Operation

1. Place the PM5020 power meter such that the power cord can be easily connected and disconnected.
2. Connect the PM5020 power meter to the power network using the supplied power cord.
3. Connect supported sensors. The sensors may also be connected or exchanged at a later point.
4. Short press the power button (<3 seconds). The device powers up, recognizes connected sensors and is ready for operation within 3 seconds. The power button is illuminated when the device is powered up. The following screen will appear on the display:



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5. If not already done in (2), connect one or two suitable sensors to the PM5020 power meter or exchange the sensors connected previously.
6. Configure the PM5020 power meter in the Settings Menu according to the used setup including sensors and light sources. Please follow the guidelines in the chapter Settings Menu.

Remote Operation of the PM5020 Power Meter with the OPM Software

1. Download and install the OPM Software on the device that will be used to control the power meter (PC, laptop).

   Note Install the software prior to connecting the power meter to the PC.
2. Connect the PM5020 power meter to the power network using the supplied power cord.
3. Connect supported sensors. The sensors may also be connected or exchanged at a later point.
4. Short press the power button (<3 seconds). The device powers up, recognizes connected sensors and is ready for operation within 3 seconds. The power button is illuminated when the device is powered up.
5. Connect the PM5020 power meter to the remote controlling instrument (PC/Laptop) using the included USB 2.0 cable.
6. The PM5020 power meter is now ready for operation and is recognized by the OPM Software.
7. If not already done in (3), Connect one or two suitable sensors to the PM5020 power meter or exchange the sensors connected previously.
8. Configure the PM5020 power meter in the Thorlabs software Optical Power Monitor according to the setup used, including sensors and light sources. Alternatively, configure the PM5020 via the Settings Menu on the device. For this, please follow the guidelines in the chapter Settings Menu. Configuration through the OPM Software or on the PM5020 directly are mirrored.

Note

For detailed instructions on controlling the PM5020 through the OPM Software, please download the OPM manual.

Note In addition to using the Thorlabs software Optical Power Monitor, the user can build custom made software with the help of the SCPI commands saved inside the PM5020 power meter and accessible via a browser. Please see the chapter Remote Operation for further instructions.

4.3.1 Switch Off PM5020

To turn off the PM5020 power meter, long press the power button for approximately 1 second until the display briefly shows “Shutting down...". The measurement and device settings will be stored in the device.

Emergency Shut Down

Pressing the button for more than 3 seconds will perform an emergency shutdown in case of a device hang up. In an emergency shut off, settings will not be stored.

4.3.2 Connecting Sensors

The PM5020 power meter supports all Thorlabs C-Series photodiode sensors, thermal sensors, thermal position & power sensors, and pyroelectric sensors that can be identified by the red connector-housing of the DE-9 connector, compared to older versions of Thorlabs power sensors. Sensor type and calibration data are saved in the non-volatile memory of the DE-9 connector. Upon connection, this information is

automatically sent to the PM5020 power meter and software, if used remotely. The PM5020 power meter will automatically recognize the sensor.

To plug-in or remove a sensor, slightly press on the two bolts in the connector housing that fix it by tension.



DE-9 connector

Sensors can be hot-swapped to the power meter interface. After recognizing a new valid sensor, the type and calibration data will be downloaded to the power meter interface and the unit is ready to operate with the new sensor.

Note

Older Thorlabs Sensors Without a red "C-Series" Connector

The PM5020 power meter will **NOT** automatically recognize sensors lacking a red "C-Series" connector, as for the case of the 'A' and 'B' series. Please contact Thorlabs for an upgrade of old sensors with DE-9 connectors.

Note

Custom Sensors

To use sensors without a DE-9 connector, manufactured by Thorlabs or else, the user may provide an appropriate adapter. To build the adapter, refer to the Pin-out of the DE-9 connector shown in the chapter Pin Sensor Connectors. The adapter will per default automatically be recognized as "Photodiode adapter". The sensor type can then be adjusted in the Settings Menu under "Channel" on the touchscreen.

4.4 Analog Output

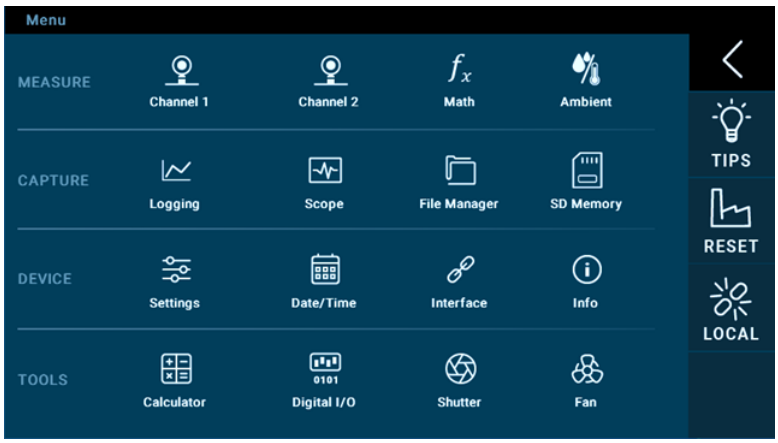
The PM5020 power meter offers several analog output ports and settings to monitor the measurement values by a connected oscilloscope or digital volt meter (DVM), processing the signals by an external digital-to-analog-converter (DAC) card, or using the signals for control loops.

The analog output ports AN1 and AN2, X1 and X2, as well as Y1 and Y2, for sensors 1 or 2, respectively, can be configured in the Settings Menu.

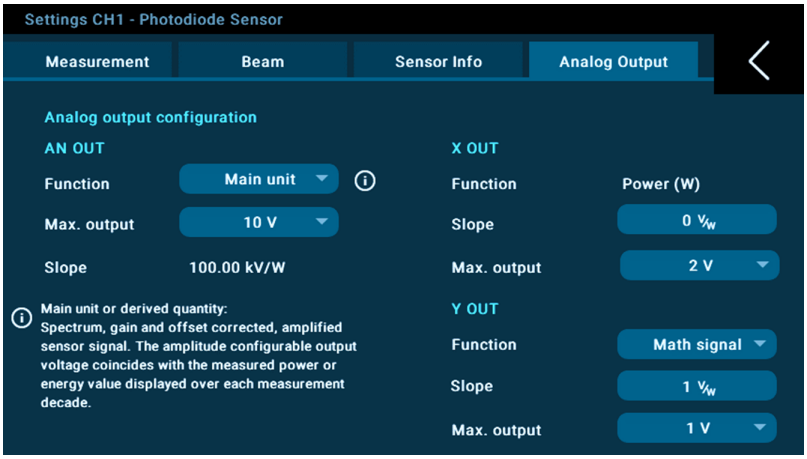
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To go to the interface:

1. Open the setting menu with the top icon in the side menu. 
2. Select the channel of interest in the top row.



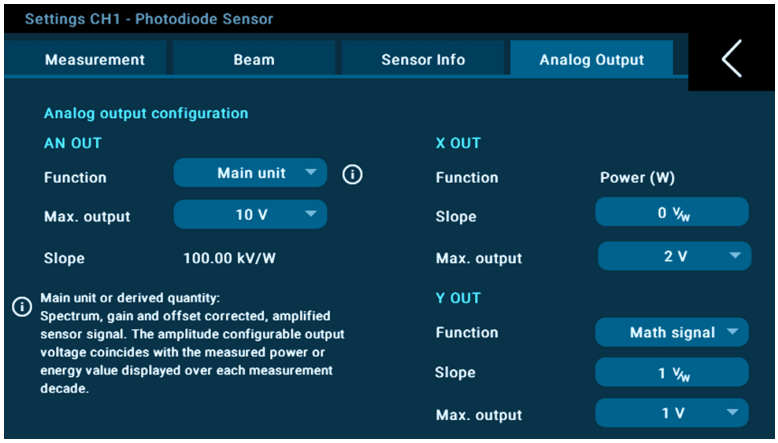
3. Select "Analog Output" in the top panel to adjust the settings.



The settings are described in the below chapters for each output port.

4.4.1 AN1/2 Out

The analog output ports AN1 and AN2 on the rear panel for channels 1 and 2, respectively, provide the raw signal or signal processed in the following way, depending on the configuration set in the touchscreen Settings Menu shown below.



The function of the kind of signal to be exported on the AN1 or AN2 port can be selected as Main Unit, Base Unit or Raw Signal under "Function":

1. Main Unit: This mode takes the amplified raw signal and multiplies it with a fixed factor, calculated based on the offset, the sensitivity of the sensor for the set wavelength, and all user defined attenuation or gain factors.

   The amplitude configurable output voltage coincides with the measured power (W) or energy (J) value displayed over each measurement decade. The output can be set to 10 V, 4 V, 2 V, and 1 V full scale for each decade.

2. Base Unit: This mode supplies the amplified raw signal multiplied with a fixed factor, calculated based on the offset, the sensitivity of the sensor for the set wavelength, and all user defined attenuation or gain factors. This is the offset corrected, amplified sensor signal. In contrast to the setting "Main Unit", the amplitude configurable output voltage is proportional to the displayed reading in A or V for each full-scale range. The output is configurable to 10 V, 4 V, 2 V, and 1 V full scale range for each measurement range.

3. Raw Signal: This is the uncorrected, amplified sensor signal. That means the signal prior to processing, digitizing or calculation. The output voltage is proportional to the displayed reading in A or V for each full-scale range. The maximum output voltage is 2.5 V and not configurable.

4.4.2 X1/2 Out

The analog output ports X1 and X2 on the rear panel for channels 1 and 2, respectively, export DA converted analog output with a 1 kHz update rate and provide a sensor dependent signal from power sensors and energy sensors.

For thermal position and power sensors, the X1 and X2 output ports provide the analog output signal for the X position. The Y-position is provided by the Y1 and Y2 output ports.

Signal for Power or Energy Sensors

A voltage that is proportional to the displayed power (W) or energy (J) level, independent of the measurement range, is exported. In this case a slope in V/W or J/W must be entered. The output supports auto-ranging and can be configured to 10 V, 4 V, 2 V and 1 V full scale.

Signal for Thermal Position and Power Sensors

A voltage that is proportional to the beam position in the X-direction is exported. The slope can be set in mV/µm. The output can be configured to a +/- 5 V full scale, or to +/- 2 V full scale.

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4.4.3 Y1/2 Out

The analog output ports Y1 and Y2 for channels 1 and 2, respectively export DA converted analog output with a 1 kHz update rate and provide a sensor dependent signal.

In contrast to the channels X1 and X2, the exported signal is the selected channel signal calculated based on the mathematical formula entered in the settings menu. As for the X-channels, a slope must be entered. Further, signal from two connected NTCs can be exported.

The Y1 and Y2 output ports provide the analog output signal for the Y position for thermal position and power sensors. The X-position is provided by the X1 and X2 output ports.

Signal for Power or Energy Sensors

A voltage that is proportional to the math signal, calculated from the entered formula, is exported. A slope must be entered. The output supports auto-ranging and can be configured to 10 V, 4 V, 2 V and 1 V full scale.

For NTCs connected to ports NTC1 or NTC2, a voltage proportional to the temperature reading of the NTC can be exported via this port. A slope can be given in mV/°C or mV/K. The output can be configured to 10 V, 4 V, 2 V, or 1 V full scale.

Signal for Thermal Position and Power Sensors

A voltage that is proportional to the beam position in the Y-direction is exported. The slope can be set in mV/µm, The output can be configured to a 0 V +/- 5 V full scale, or to 5 V +/- 10 V full scale.

4.5 Digital I/O

The digital ports are located in the left 10-PIN PCB Connector, Digital I/O, on the rear panel. Aside from the four I/O pins, ground terminal and 3.3 V or 5 V supplies are provided. Additional SCL and SDA pins can be utilized together with the ground and power supply pin to integrate specific humidity and temperature sensors from Texas Instruments (Texas Instrument HDC1080, or the newer HDC3020). The ports can be conveniently accessed with the supplied push-in terminal block.

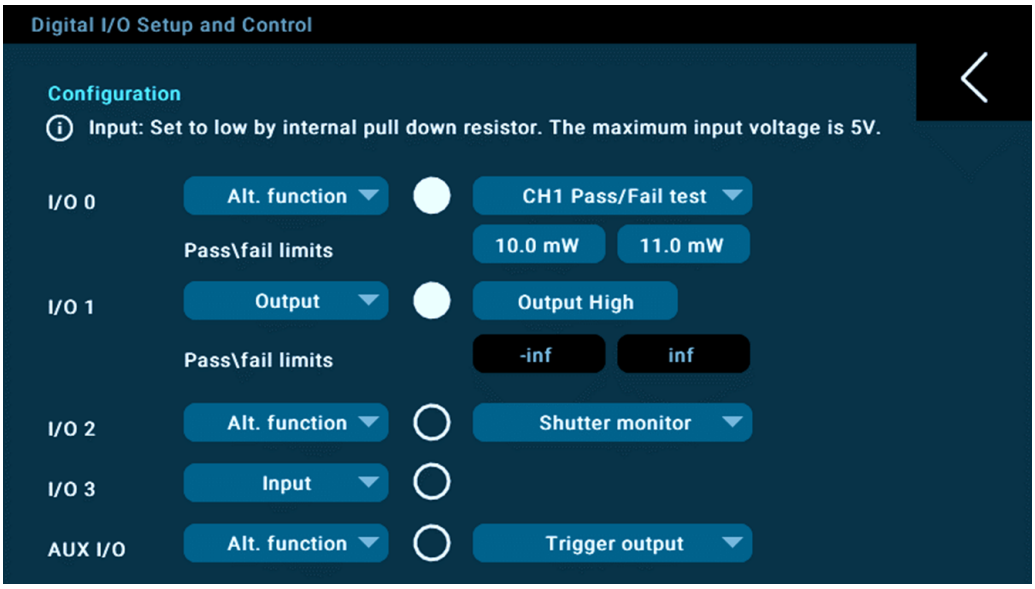
Please see the PIN diagram for the P10p Digital I/O Terminal.

Note The front BNC Auxiliary I/O port can be configured as input/output as well. Please see the chapter BNC I/O and TTL port for more information.

The digital I/O parameters can be configured in the Setting Menu on the touchscreen by selecting the Digital I/O icon:



The following interface will appear:



The I/O pins can be assigned with the following options:

1. **Input:** The input is set to default low level by an internal pull-down resistor. Set input to high level by applying a voltage between 2.4 V and 5 V.

   Note Do not exceed the maximum input voltage of 5 V.

2. **Output:** High level is 3.3 V; the maximum source current is 10 mA per pin.
3. **Alt function:**
   a. **I/O 0: CHx disable AN OUT (Input)**: Internally pulled up to high level by resistor to 3.3 V. Connect the pin to ground to activate the function. This function disables the analog outputs when set to low level. If the input is left open, the analog output works normally.
   b. **I/O 1: CHx Pass/Fail test (Output)**: High level 3.3 V. Maximum current is 10 mA per pin. This function can be used for pass/fail testing. The high and low limits can be entered in two input fields. The output turns low when the measured power level is within the pass/fail window. A range for the pass/fail test can be set by the user.
4. **I/O 2:** Choose between Shutter monitoring and Shutter control. Shutter control allows to connect an external shutter to I/O2, provided the Interlock is closed.
5. **I/O 3:** Choose between Logging Monitoring and Logging Control.

   Logging monitor: An output signal gives information on when logging is started on the PM5020 (signal above 3.3 V) or stopped (below 3.3 V).

   Logging control: A high incoming signal (2.4 V - 5 V) to the PM5020 triggers logging and stops it whenever the signal is low.

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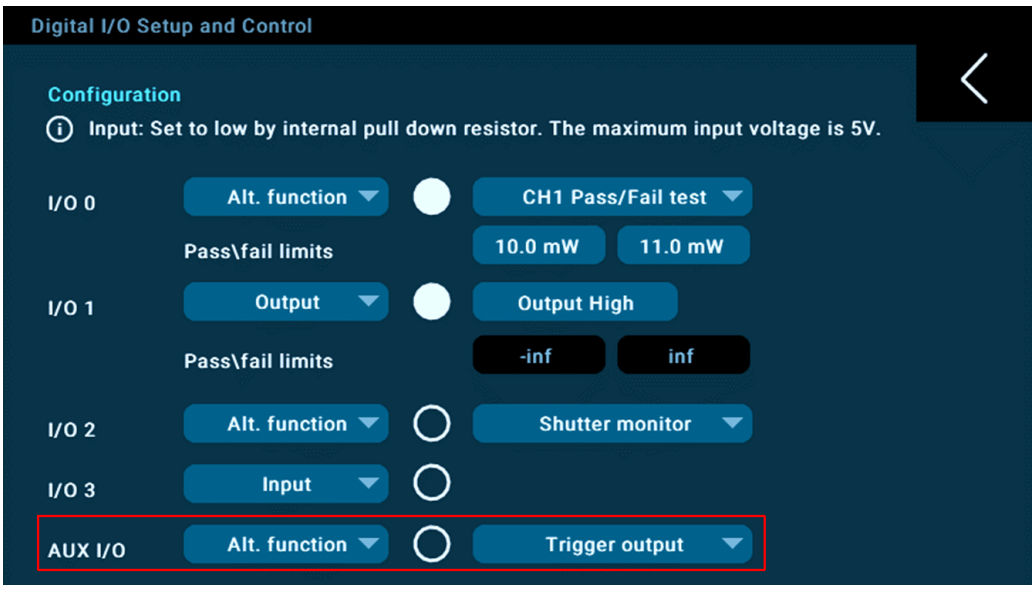
4.6 BNC I/O and TTL port

The front BNC Auxiliary In/Output can be configured as input, output or alternative function with additional functionality like logging and shutter control or monitor via the settings menu on the touchscreen.

Select the icon 

to configure the port.

The following screen appears with the Auxiliary output port configuration panel on the bottom. The screen also shows the Digital I/O configuration above.



Settings for the AUX I/O port can be selected as follows:

Input: The input is set to default low level by an internal pull-down resistor. Set input to high level by applying a voltage between 2.4 V and 5 V. **Note** Do not exceed the maximum input voltage of 5 V.

Output: High level is 3.3 V; the maximum source current is 10 mA per pin.

Alt function:

a. **CH1/2 disable AN OUT**: Internally pulled up to high level by resistor to 3.3 V. Connect the pin to ground to activate the function. This function disables the analog outputs when set to low level. If the input is left open, the analog output works normally.

b. **Trigger Out**: A trigger can be sent to the PM5020. Please see chapter External Trigger

c. **Shutter control**: To send a signal to a connected shutter.

d. **Shutter monitor**: To monitor the state of the shutter and coordinate a signal.

e. **Logging control**: To start/stop logging upon an incoming signal.

f. **Logging monitor**: To monitor logging and send a signal to an outside device.

4.7 Trigger

Measurements can be triggered either as an internal trigger with the trigger signal set in the touchscreen, or as an external trigger via the auxiliary port on the PM5020 power meter front side or the Digital I/O connector.

4.7.1 Internal Trigger

Measurements can be triggered with the internal trigger function for signal above a level set in the touchscreen.

This internal trigger function is useful when, for example, using a pulsed laser to only acquire signal above a set trigger level. Whenever that level is reached, only the signal to be used will be in the displayed measurement result.

Set the internal trigger signal by changing from the icon 

to the icons:



"Top-Mode": A measurement is activated and upon reaching the set trigger level, the PM5020 awaits the signal plateau. The displayed measurement value represents the roof of a laser pulse and is the best choice for square signal modulated laser sources. A valid trigger condition is indicated by the yellow marked "T" in the sensor header. When the signal returns to below the trigger level, this lower signal will not be displayed.

or



"Peak-Mode": A measurement is activated and upon exceeding the set trigger level, the PM5020 power meter awaits a peak. When the maximum is reached, this signal will be displayed. When the signal returns to below the trigger level, this lower signal will not be displayed. The peak mode should be used for short pulses, sinusoidal modulated signals, or when wanting to detect overshoots. A valid trigger condition is indicated by the yellow marked "T" in the sensor header.

Once "TOP" or "PEAK" have been selected, the trigger level can be set directly via the side panel under the icon 

or via the Settings Menu - MEASURE - Channel X - Trigger.

Once this is set, a "T" with white background will appear in the top panel. This white background will turn yellow whenever acquisition is triggered.

This internal trigger can be used in all measurement screens except the Logging screen.

4.7.2 External Trigger

Measurements can be triggered externally via the auxiliary BNC port on the PM5020 power meter front side or the Digital I/O connector in the read side.

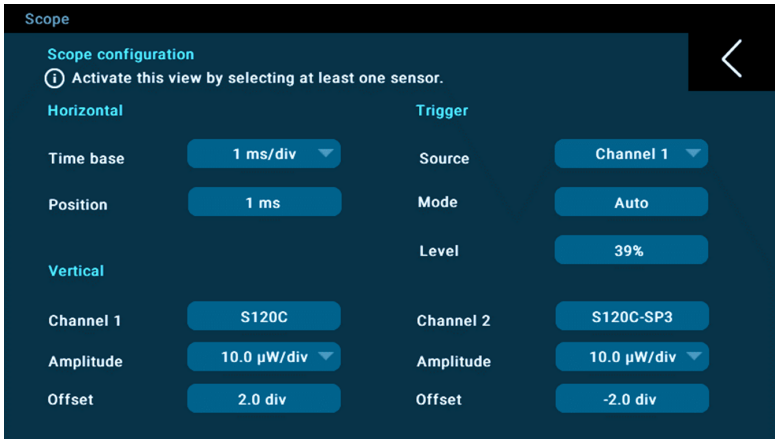
For both, front BNC I/O and rear Digital I/O, set an external Low Voltage TTL (LVTTL) or TTL signal to high to trigger acquisition and to low to stop it. The external signal triggers the start of a measurement on the rising edge of an external LVTTL or TTL signal.

Configure the connector using the PM5020 touchscreen Digital I/O and Control in the Settings Menu.

The logging and scope measurement screens can be used to acquire signal upon an external trigger.

After connecting the trigger sources via either the Digital I/O or the BNC I/O, go to the Settings Menu, subpanel Scope and configure the external trigger:

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Here, also a signal from another channel can be used to trigger acquisition.

Trigger Signal Output:

Whenever a trigger is manually executed on the PM5020, a high TTL signal is sent to the I/O port.

4.8 Environment Setup

In addition to monitoring the temperature of the light sensors from their built in NTCs, two external NTC temperature probes can be connected either at the 2.5 mm audio sockets (compatible to the Thorlabs TSP-TH probes) or at the 10-PIN PCB Connector for Fan Control.

The temperature read from the connected light sensors, from the NTCs on the audio sockets, and the FAN I/O is displayed in the top row of the measurement screen.

NTC configuration

The NTCs can be configured through the touchscreen interface. To open the screen below, touch the icon 

in the Settings Menu.



The NTCs are configurable according their nominal resistance at 25°C and their B value. The factory setting of the PM5020 automatically prepares the NTC inputs for the TSP-TH probes with 10 kOhm and 3988 K.

Humidity and Temperature Sensors

Optionally, specific integrated humidity and temperature sensors, the Texas Instruments HDC1080 or HDC3020, can be connected via the provided I2C bus in the 10-PIN PCB Connector Phoenix for Digital I/O with four wires to SCL (I2C Bus Clock), SDA (I2C Bus Data), 3.3 V and GND. Please see the chapter Pin Assignment Digital I/O connector.

The relative humidity and temperature reading is displayed in the settings menu under Environment setup. For the sensor technical data, please refer to the manufacturer's data sheets.



4.9 Shutter

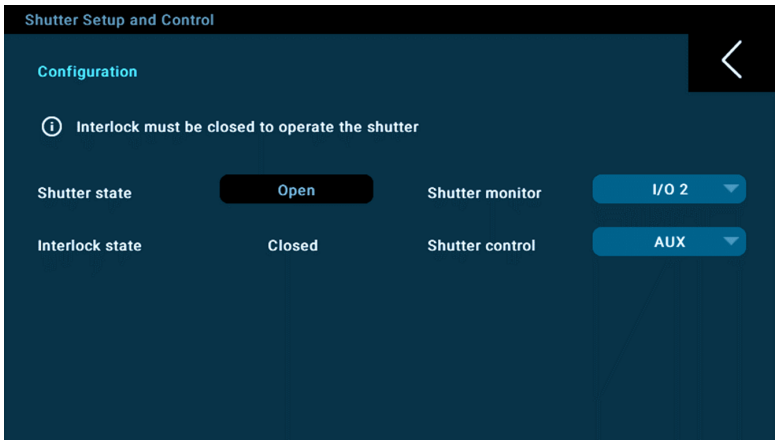
A shutter can be connected to the PM5020 power meter at the rear panel (Hirose HR10A-7R-6S connector) and controlled through the touchscreen, without the need for a separated shutter controller. This feature is convenient in free beam laser applications in closed systems which require safety measures when the system is opened. In combination with the interlock, this can be easily implemented.

Shutter Settings

A shutter control icon 

automatically appears in the side menus of any measurement screen when a SH05R(/M) or SH1(/M) Thorlabs optical beam shutter is connected to the Hirose HR10A-7R-6S connector. Operating the shutter requires an interlock to be connected to the 2.5 mm mono audio interlock connector in the rear panel. The position state of the shutter is monitored and displayed on the touchscreen.

The settings menu provides the following interface:



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The shutter, in addition to manual control in the GUI, can be monitored and controlled by the Digital I/O2 or the front AUX I/O BNC connector using a TTL signal.

4.10 Fan Control

The PM5020 power meter allows the connection and control of up to two 12 VDC fans with adjustable supply voltage or by adjustable number of revolutions per minute (rpm) for 3-wire fans with tacho input.

This feature reserves an extra power supply for fan-cooled sensors, such as the S322C, or can be used to run other cooling fans in the optical setup.

The fans can be operated by:

- Setting of the DC voltage up to 12 V.
- Setting a fan speed, depending on the temperature detected by either the built-in sensor temperature sensor or a connected external NTC. Set a start temperature and a maximum temperature where the fan runs at full speed. The speed will increase with rising temperature.
- Setting of the rpm when the fan provides a tacho signal. In this case please set the maximum rpm and the desired rpm.

Open the Fan Setup Control menu in the Settings Menu to adjust the fan control settings.



The PM5020 power meter uses the configured settings as follows:

1. The fan starts running with the set "Minimum voltage" when exceeding the set "Minimum temperature".
2. The speed is regulated up to the "Maximum voltage" when the sensor reaches the set "Maximum temperature".
3. When exceeding the set "Maximum temperature", the fan will continue running with the set "Maximum voltage".
4. Below the "Minimum temperature", the fan will stop running.

4.11 Operation

The PM5020 power meter can be operated directly or remotely via the OPM Software or custom made software.

Please see the respective chapters on further instructions.

Regardless of whether a measurement is performed in Direct or Remote Operation, please apply appropriate sensor and measurement settings on the screen in the Settings Menu for direct operation or via the OPM Software. This includes sensor settings like wavelength for the incident light, beam settings.

4.11.1 Direct Operation

The PM5020 power meter can be operated directly on the device without the need for external software.

To power up the PM5020 power meter, please follow the instructions in the chapter Setup.

The touchscreen and the physical control buttons on the PM5020 power meter control the device. These controls are redundant and can be mixed as the functions are mirrored within the PM5020 power meter.

Data can be displayed only or acquired and saved via the Logging or Scope measurement screens and saved to the internal 8 GB memory of the PM5020 power meter. The saved data can be exported to the connected PC via USB or the Ethernet connection. Please find more information in the chapters Logging and Scope.

4.11.1.1 Physical Controls

For direct control, the PM5020 power meter has 5 dynamic side menu buttons, a channel button to quickly switch the display between sensor 1 and sensor 2, as well as a rotary knob, aside from the touchscreen.

Dynamic Side Menu Buttons

The five buttons refer to the touchscreen elements shown immediately to their left. Pressing the Dynamic Side Menu Button mirrors touching the icon on the touchscreen. The Dynamic Side Menu Button can be configured to beep when pressed via the subscreen Settings in the Settings Menu.

The functions of the Dynamic Side Menu Buttons are usually the following (top to bottom).

No. 1:  Enter or quit the Settings Menu. Press long to unfold the Side Menu.

No. 2 - 4: Function buttons with a dynamic arrangement, depending on the connected sensor. Set the active view of the column of 3 options to the next set of three option by pushing the the 5th button on the icon .

No. 5:  Opens the next set of functions in the side menu or quits the pop-out menu. 

Channel Button

The Channel Button is used to switch between channel one and channel two, referring to the two connected sensors. When the Single Channel screen is chosen, the Channel button switches between sensor channels and the Math View. The channel button has a back light and a color code indicates which channel is selected:

- Blue: Channel one: CH1
- Green: Channel two: CH2
- Pink: in Scope measurement screen: view: CH1 & CH2 in scope mode simultaneously
- Orange: Math channel: ƒx/*gx* in Math View, Logging measurement screen.

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Low Light Environment - Dark Screen

The Dynamic Side Menu Buttons are illuminated and dim together with the display after the duration selected in the Setting Menu and Settings Subscreen.

To maximally dim the light for sensitive applications, the button illumination will shut off at a display back-light level of less than 3%.

Rotary Knob

Turning the rotary knob will set the focus through all interactive elements on the touchscreen.

Short press the rotary knob to select a focused interactive element. Select the desired setting using the appearing options:

- **Button**: This toggles between the on and off state of the selected field. 



- **Drop-down list**: Turn the rotary knob to the desired drop-down element and Press again to select and activate the selected element. The drop-down list closes with the activated element.



- **Selection**: A white line will show around the selected interactive element. Turn the rotary knob to toggle between the selected indicators. For example, to change a view in the scope mode screen or to increase/decrease a number. Leave the selection by pressing the button.
- **Menu**: A sub menu opens. Turn the rotary knob now to move through the options and press the rotary knob for selection select an option and leave the menu.

Special Functions

1. Screenshot

Press the rotary knob + Next Button: The CH button will change to green during image capture and image conversion. The screenshot is then saved under File manager in the settings menu.

2. GUI-Lock

Press the top and bottom knobs (No. 1 and No. 5) simultaneously to lock the GUI and prevent accidental operation. A LOCK Icon will appear in the header bar.

Unlock the GUI by pressing the top and bottom buttons again.

4.11.1.2 Touchscreen Operation

The PM5020 power meter can be operated via the touchscreen with fingers, with the physical control buttons, or by both combined.

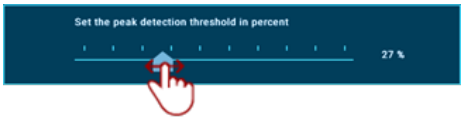
This chapter describes the kinds of active elements on the screen and how to operate them.

The active elements allow easy setting selection from dialog boxes, switches between states, drop-down lists, slider elements and tab leading to different screens.

Supported Touchscreen Gestures

The touchscreen allows gestures in all directions to move sliders, scroll through drop-down lists, change view by swiping horizontally, as illustrated below:

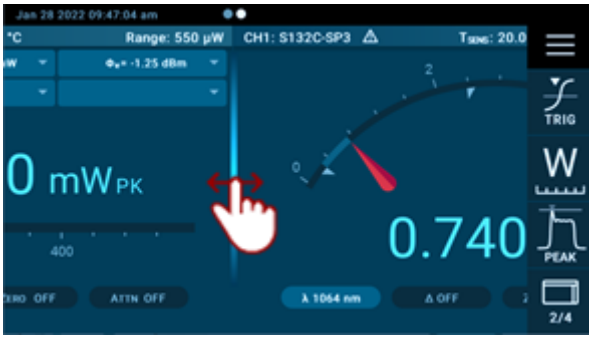
Slider Control: Pick and move the slider



Slider Control: Pick and move the slider



Drop-down list: Scroll though a list



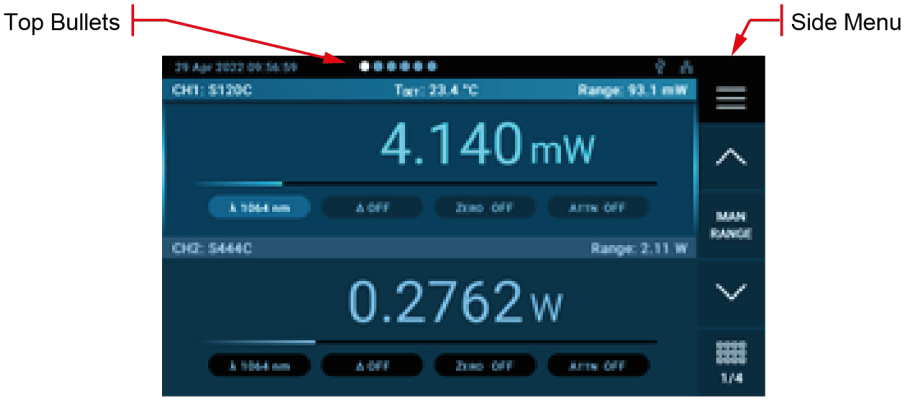
Swipe horizontally to change display views



Swipe vertically to change channels, or scroll measurement screens

4.11.1.3 Touch Screen Options and Menus

The touchscreen opens with the screen used last upon power-up. The operating regions "Top Bullets" and "Side Menu" lead to different displays and measurement settings respectively. Shown here is the Dual/Single measurement screen.



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When starting the PM5020 power meter without sensors connected, the screen displays "NO SENSOR CONNECTED".

Top Bullets

The top bullets indicated how many measurement screens are activated and available for the configured settings. These are from the left bullet to the right:

1. Dual or Single Channel: Displays units of one or two channels, depending on the number of connected sensors
2. Single Channel: Display shows single channel measurement results. Access the Math View to observe calculation results through this main screen.
   a. Math View displays the results of a user defined calculation on live measurements. To access this view, connected two sensors of the same kind to the PM5020 and define the equation in the Settings Menu. Following this, the option appears within the Singe Channel Screen.
3. Analogue Needle display
4. Logging display to set and execute measurement logging: This screen is only activated when a Channel is selected in the Settings Menu.
5. Statistics: To view the measurement statistics: This screen is only visible when the Logging or Scope displays are activated.
6. Scope display: This screen is only activated when a channel is selected in the Settings Menu.

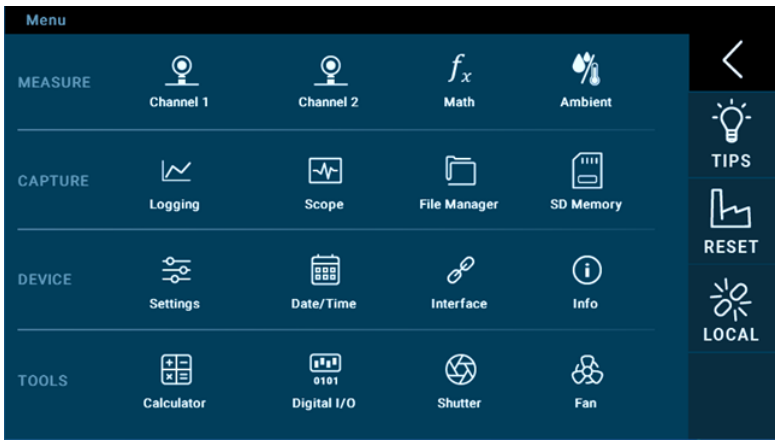
Each measurement screens will have different options. Please find more explanations in the section "measurement screens" or via the links above.

Side Menu

Before starting a measurement, please select the measurement settings for the selected measurement mode.

A subset of the measurement setting is accessible though the four pages of the side menu. These are described in the individual measurement screen sections. All measurement settings are accessible through the menu icon in the top right corner .

The following Settings Menu appears:



Alternatively, settings can be set within the measurement screen visible via the side menu. Swipe left from the right side to open the most useful subset of setting options appropriate for this measurement screen. The setting options depend on the selected measurement screen.



The expanded side menu consists of several columns of 3 options each. To move though the columns with a full view of the measurement screen to monitor the measurements, tip on the pages icon 

The measurement settings are mirrored between the full settings menu and the side menu.

4.11.1.3.1 Measurement Screens

Six different main measurement screens for different display modes can be activated and then selected. Inactive screens are labeled with a crossed out eye in the Settings Menu.

The bullet bar on top of the display indicates how may measurement screens are available. Logging, graph /scope and statistics screen are only available when a channel was selecting in the Settings Menu.

To move through the panels either swipe horizontally, touch the dots panel, or navigate the dots with the rotary knob: Select dot field (thin frame) turn the rotary knob to the desired measurement screen and press the rotary knob (thick frame) to activate the measurement screen.



Not Selected



Thin Frame



Thick Frame

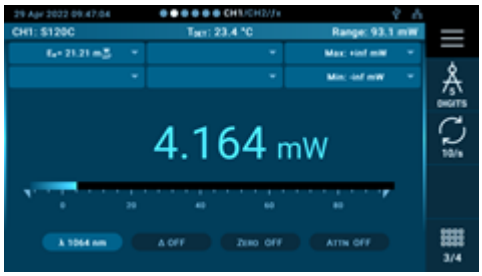
1) Dual/Single Channel



In dual channel view, the side menu as set for the selected channel is displayed and activated. In case only one sensor is connected, this will change to a view of a single channel.

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2) Single Channel



2.1) Math View

When sensors of the same kind, two photo sensors, two thermal sensors or two pyroelectric sensors, are connected, the Math View can be opened from within the Single Channel screen to view calculation results. To activate the display of calculation results, enter a formula in the Setting Menu under "Math".

3) Analog Needle and Thermal Position Sensor Display



Analog needle display

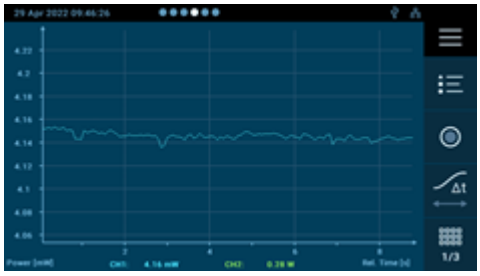


Thermal Pos Sensor

Note

To have the measurement screens Logging, Statistics and Scope appear and accessible in the top bullets, select at least one channel in the Setting Menu.

4) Logging



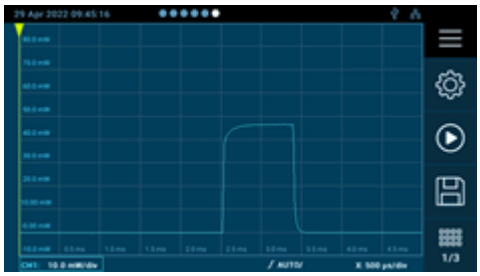
This interface allows to record measurement with one or two channels.

5) Statistics



This interface displays statistics on the measurement logged in the measurement screen "Logging" and is only accessible when the Logging screen is activated.

6) Scope



Scope mode

The scope measurement screen is a convenient way to acquire signal measurements from alternating or CW power signals. With a sampling rate of up to 100 kS/s a resolution of 10 µs can be achieved. The recording and display can be flexibly configured, also with a trigger signal.

Switching Channels

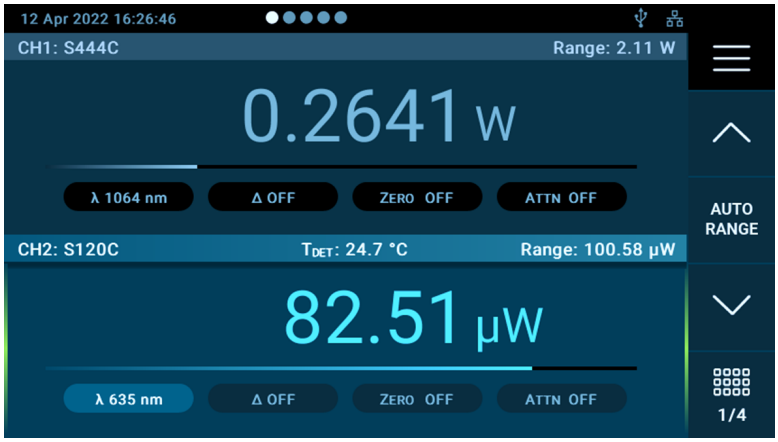
To Toggle between Channel 1, Channel 2 or math display, either

1. Swipe vertically
2. Touch the indicator right to the dots
3. Navigate using the rotary knob until the display shows a thin frame around the field, press button to select a display setting (CH1, CH2, bot, math etc). This results in the thick frame.
4. Press the Channel Button on the front panel of the PM5020

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4.11.1.3.1.1 Dual or Single Channel

The Dual or Single Channel measurement screen displays the main measurement parameter of two or one sensor, respectively.



Each channels header bar contains information about sensor type and temperature, actual measurement range and specific warnings and information.

The numerical value is supported by a simple bar graph below, which shows the utilization of the full-scale measuring range. The activated channel can be identified by the blue or green indicators to the right. The Side Menu refers to the activated channel and is described below.
Four Quick Set buttons below the bar graph give the following options:

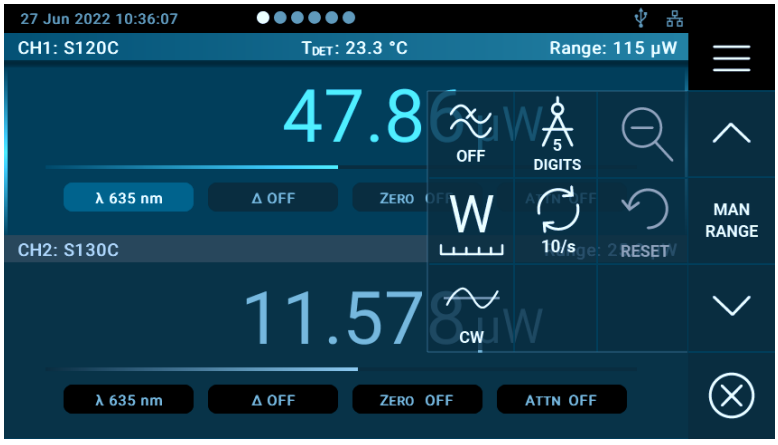
- Change the wavelength of measured light
- Perform a relative Measurement
- Perform Zeroing to set and subtract background
- Attenuation: Apply additional optical filter correction.

Please make sure to configure the settings for this measurement in the comprehensive Settings Menu prior to performing a measurement.

Inside the measurement screen, the Side Menu can be used to directly access the most frequently used settings with simultaneously monitoring the measurement. The Side Menu refers to the selected channel. Switch channels by using the below described ways.

The icons shown here next to the screen are the options provided by the Side Menu.

Note Click on the screen icons in this manual to get to the explanations.



Internal Trigger

In the Dual/Single measurement screen, a trigger level based on the signal can be set as describe in the chapter Internal Trigger.

4.11.1.3.1.2 Single Channel

The Single Channel measurement screen displays the numerical main measurement value recorded in the activated measurement channel. The shown main measurement value is supported by a bar graph display with range dependent scale, showing the utilization of the full-scale measuring range. The two markers indicate the minimum and the maximum measured level. Reset them by touching the bar-graph or via the side menu.

The channel header bar contains information about sensor type and temperature, actual measurement range and specific warnings and information.

Below the channel header bar, the view includes up to six individually configurable small additional readings. Touch the Zoom icon in the Side Menu to have the six readings disappear.

Switch between displayed channels by swiping the touchscreen vertically, by pushing the channel button, or by navigating to the CH1/CH2 indicator in the top bar using the rotary knob.
As in the Dual or Single Channel display, four Quick Set Buttons below the bar graph give the following options:

- Change the wavelength of measured light
- Perform a relative Measurement
- Perform Zeroing to set and subtract background
- Attenuation: Apply additional optical filter correction

Note Click on the screen icons in this manual to get to the explanations.



The measurement can be enlarged for best readability by omitting the extra displays. The zooming function is also available for the math view.

All setting are saved and restored after a reboot.

Internal Trigger

In the Single measurement screen, a trigger level based on the signal can be set as describe in the chapter Internal Trigger.

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Note The measurement screen displaying results of a user defined mathematical function to evaluate, for example, relative measurement results, can be reached though the Single measurement screen only. Please see the chapter Math View for more explanations.

4.11.1.3.1.3 Math View

The Math View shows the calculated numerical value and the numerical value of the two independent measurements. The Math View can be accessed by selecting the Single measurement screen and after providing a mathematical formula to the PM5020 power meter. The underlying mathematical formula is set by the user in the Setting Menu under Math. This requires that both channels are connected to the same kind of sensor.



Choose between formula one or two by touching the formula buttons.

Long pressing the buttons enters the math menu for editing the formula.

The math view is vertically arranged in the channel 1 and channel 2 numerical views. The small windows in the bottom show the actual measurement values of each channel.

4.11.1.3.1.4 Analog Needle

This analog needle view shows the main measurement parameter, supported by a needle gauge display with range dependent scale, which shows the utilization of the full-scale measuring range. It further bears two markers, indicating the minimum and the maximum measured level. These can be reset by touching the bar-graph or via the Reset icon in the Side Menu shown to the right below. A power level dependent audio signal can be activated via the settings menu to support tuning.

To switch the display between the two channels of the connected sensors, swipe the touchscreen vertically, or push the channel button, or by navigating to the CH1/CH2 indicator in the top bar using the rotary knob.

The channel header bar contains information about sensor type and temperature, actual measurement range, and specific warnings and information.

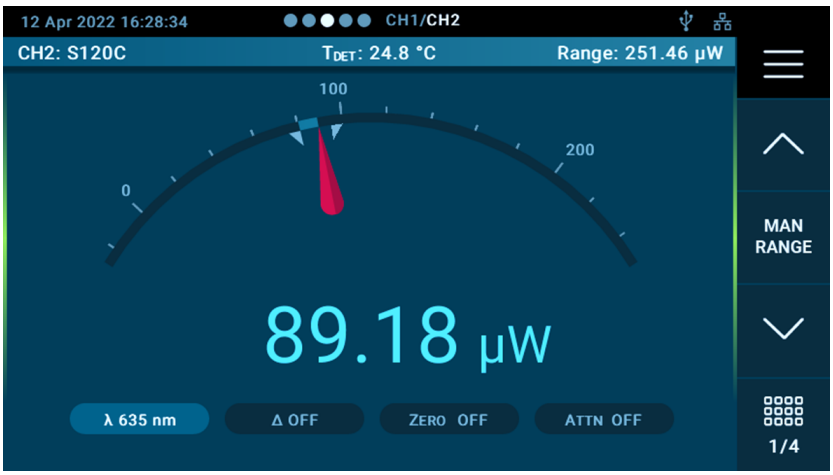
Touch the Zoom icon in the Side Menu to zoom into the measuring range.

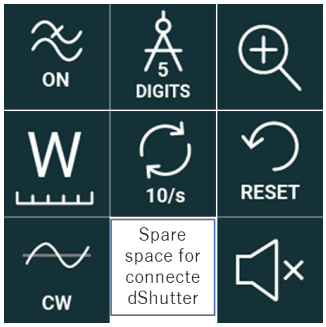
As in other displays, four Quick Set Buttons below the bar graph give the following options:

- Change the wavelength of measured light
- Perform a relative Measurement
- Perform Zeroing to set and subtract background

- Attenuation: Apply additional optical filter correction

Note Click on the screen icons in this manual to get to the explanations.





Internal Trigger

In the Dual/Single measurement screen, a trigger level based on the signal can be set as describe in the chapter Internal Trigger.

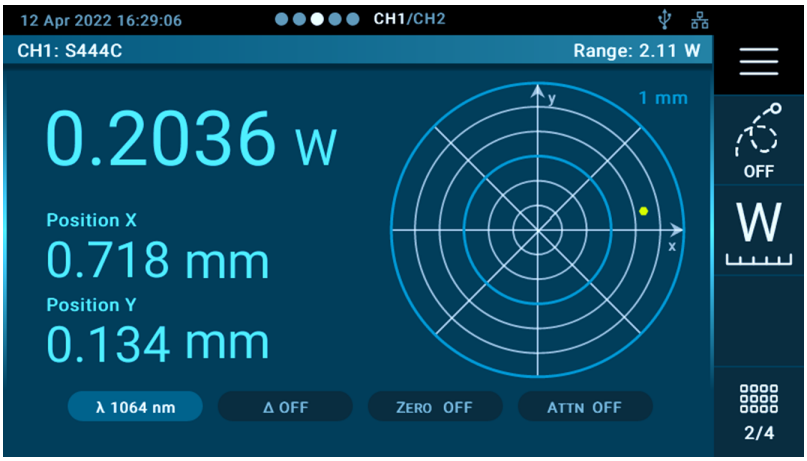
4.11.1.3.1.5 Thermal Position Display

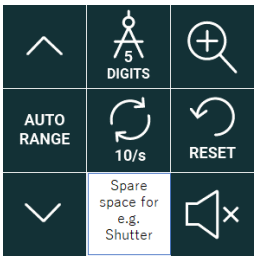
When a Thorlabs Thermal Position and Power Sensor is connected to the PM5020 power meter, the display can be set to show the position target information which represents the light beam on the sensor and displays the numerical measurement value.

Access the Thermal Position Display by selecting the Analog Needle measurement screen when the respective sensor(s) are connected.

The trace function allows convenient beam alignment. This can be refined with a zooming function with a factor of six, by clicking into the target.

Note Click on the screen icons in this manual to get to the explanations.





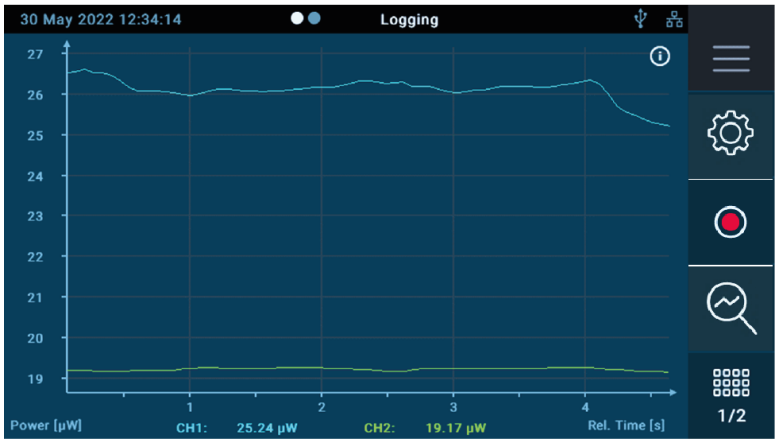
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4.11.1.3.1.6 Logging

Data can be acquired and saved or viewed after saving via the Logging or Scope displays. Logging control can be done manually, by time, by samples or by external TTL signal. The interval is settable from 1 ms. The settings for logging are adjusted in the dialog Logging Setting, described in the chapter Setting Menu under Logging.

Measurements recorded via the Logging function are saved to the internal 8 GB memory of the PM5020 power meter. The saved data can be exported to the connected PC via USB or the Ethernet Connection as described under Interface. Please find more information in the chapters Logging and Scope.

Note Click on the screen icons in this manual to get to the explanations.



The following Side menus appear for the Logging display.

Starting Side Menu	Side Menu Logging	Side Menu to View Logged Data
Page 1 and 2	Go to the recording menu via the red RECORD icon	Enter the submenu to view recordings via the Zoom icon







4.11.1.3.1.7 Statistics

The Statistics measurement screen shows the statistics of the entire currently running measurement as shown in the logging screen.

The following statistics values are given:

- Mean Power/Irradiance (units as set)
- Standard Deviation
- Ratio between CH1 and CH2
- A boxplot showing the measured maximum, median and minimum values for each channel. Q1 and Q3 refer to the median of the lower half and upper half of the dataset.

Side Menu

The settings icon shows the setting of the measurement which the statistics refer to.

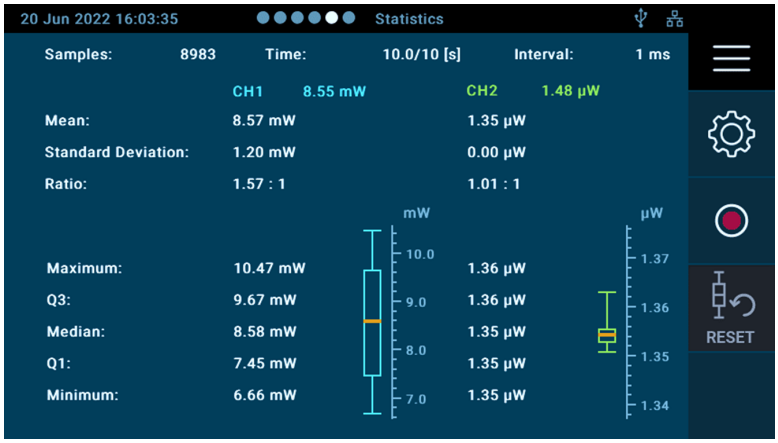
The recording icon updates the statistics of a currently running measurement.

Touching the RESET icon resets the boxplot values in running measurements.

During logging, it is only possible to swap between the graph view and the statistics view.

Please note that the statistics screen is an instrument for data evaluation during active measurements, not for analysis of saved measurements.

Note Click on the screen icons in this manual to get to the explanations.



4.11.1.3.1.8 Scope

The scope measurement screen is a convenient way to acquire signal measurements from alternating or CW power signals. With a sampling rate of up to 100 kS/s a resolution of 10 µs can be achieved.

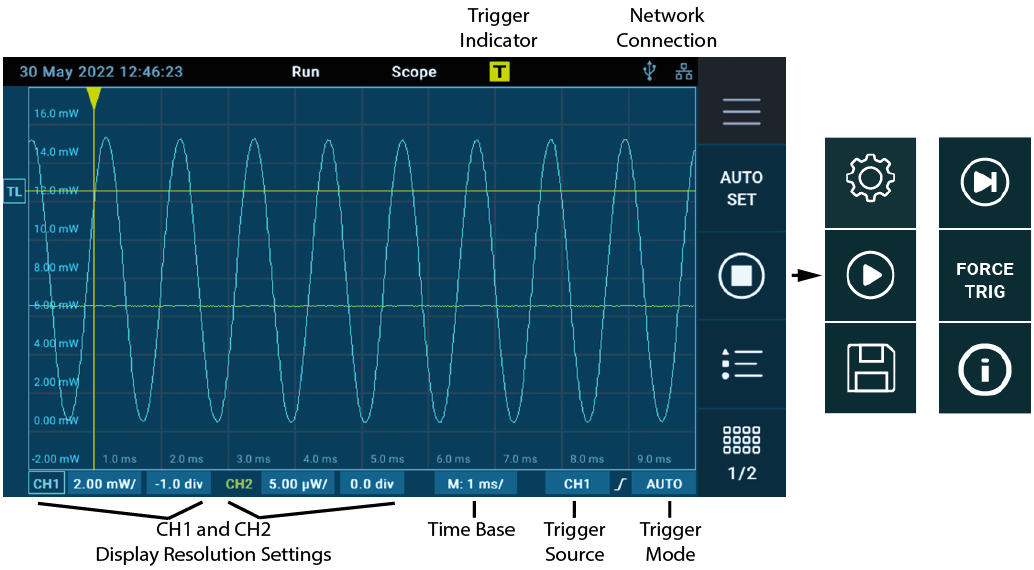
Shown below is the Scope measurement screen as it appears while running a measurement. This is indicated in the top row labeled "RUN". Other measurement screens are only accessible when the measurement is stopped.

Aside from the side panel, the following settings on the bottom of the screen can be adjusted: Display resolution settings, Time Base, Trigger Source, and Trigger Mode. When touching the box, its set value appears in a yellow box. Adjust it and the new setting is implemented.

In scope mode, either an internal or an external trigger through the BNC TTL Input/Output connector or the Digital I/O connector can be used in the measurements. Use the settings on the bottom of the display to select the trigger source and the trigger mode. Please see the respective chapters for more information.

Note Click on the screen icons in this manual to get to the explanations.

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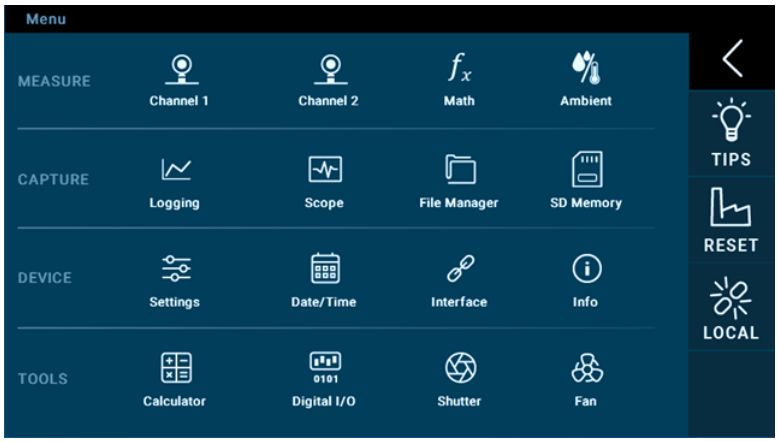


Data can be displayed only or acquired and saved via the Logging or Scope displays and saved to the internal 8 GB memory of the PM5020 power meter. The saved data can be exported to the connected PC via USB or the Ethernet Connection as described under Interface. Please find more information in the chapters Logging and Scope.

4.11.1.3.2 Measurement Settings

Measurement settings can be changed via either of two panels, the full Settings Menu or the Side Panel Menu.

Full Settings Menu:



The Settings Menu is best used when initially setting up the measurement as it includes all possible settings. The full settings menu is opened by touching the following menu icon or by briefly pressing the soft button next to it or via the pop-out side menu. 

Side Panel Menu



The side panel menu allows to change setting quickly during measurements while simultaneously monitoring the measurement.
To pop out the side panel menu, swipe over it as illustrated below or press the top soft button for more than 2 seconds.



To use the side menu without popping it out, change the side panel display by touching the pages icon on the bottom right corner. 

Short touch: move forward.

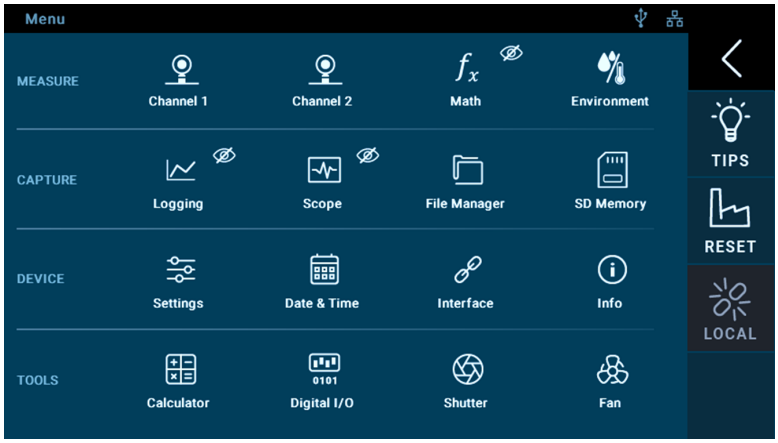
Long touch: move backward.

Note All visible touchscreen buttons can be activated when popped out from the left side. The physical soft buttons only address the right column closest to the screen edge.

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4.11.1.3.2.1 Settings Menu

The settings menu shown below leads to all possible settings for a measurement. The following chapter describes these settings.

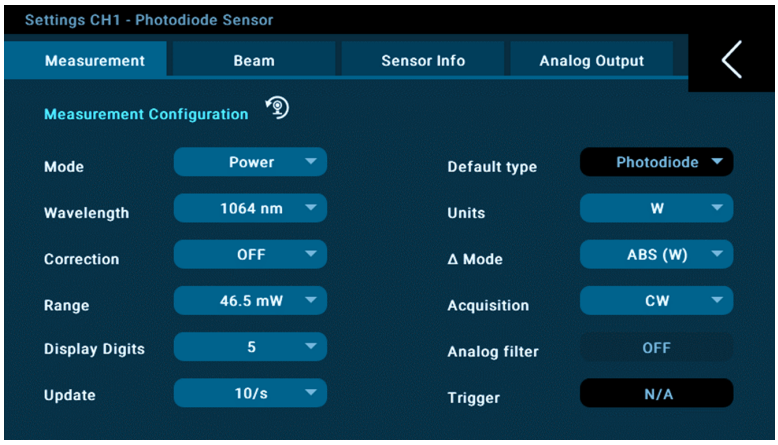


Math view, logging view, statistics or scope views are only activated and visible in the top bullets after configuration. The crossed eye symbol means, that the view is not configured.

MEASURE: This line leads to the settings for

- Sensor channels in Channel 1 and Channel 2 (connected sensors and Analog Output settings)
- Mathematical functions
- Environment sensors

Channel1/Channel2



Please adjust the following settings prior to a measurement:

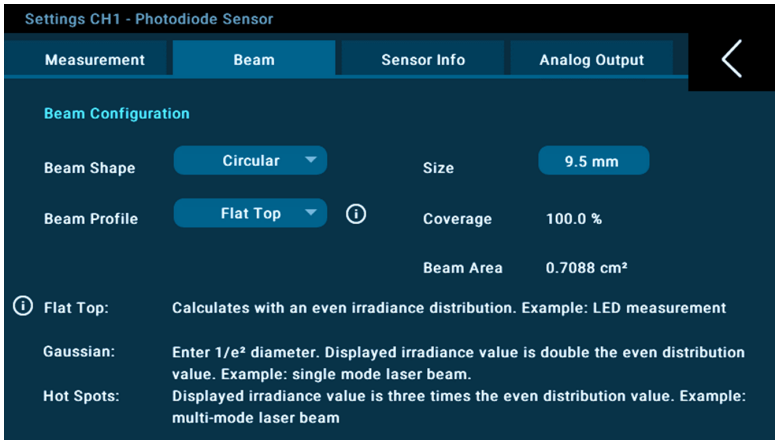
- Set Mode: Power or Irradiance
- Wavelength of measured light to correct for. Set a peak wavelength or load a spectrum.
- Correction: This refers to attenuation in %, dB, off, or times x. Set a value or load a curve.
- Range of the measurements: This can be set to automatic (auto) or numerical in W or W/cm^2.
- Display digits
- Update rate
- Sensor Type, if not imported from EEPROM of a Thorlabs sensor

- Units
- Delta Mode: This allows zeroing to an absolute given value.
- CW or Pulsed
- Analog Filter (or bandwidth)
- Trigger

Beam

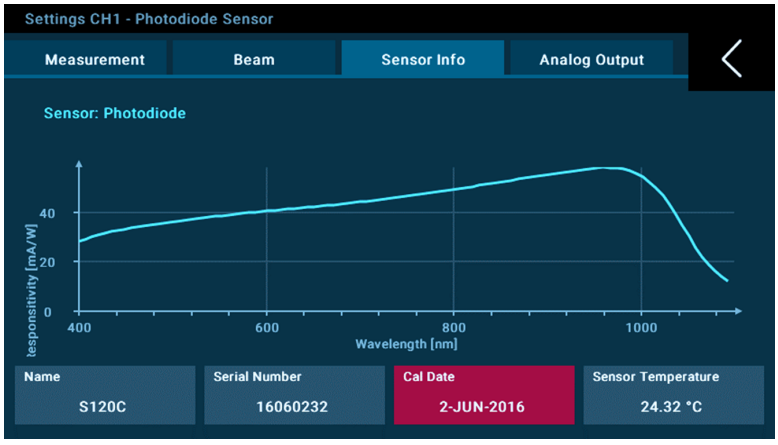
Please adjust the following settings for the excitation source prior to a measurement:

- Beam Shape
- Beam Profile
- Beam Size/Beam Area



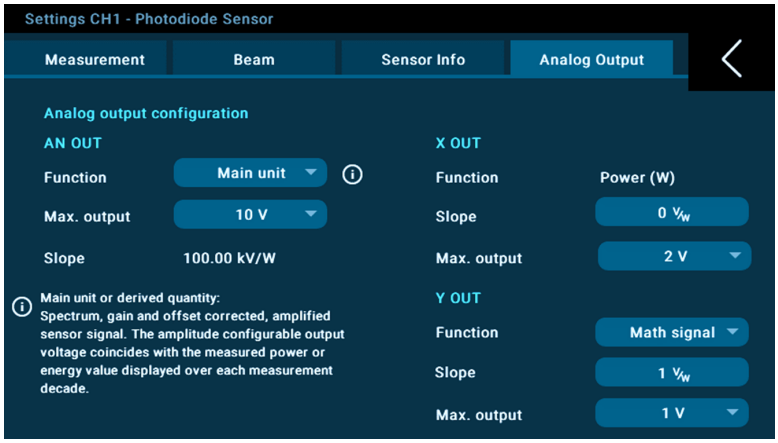
Entering the actual beam diameter, shape and profile is used to calculate the beam area. This enables the calculation and display of measurement values in irradiance or fluence.

Sensor Info: Information about the sensor, imported from the EEPROM of the sensor, is displayed.

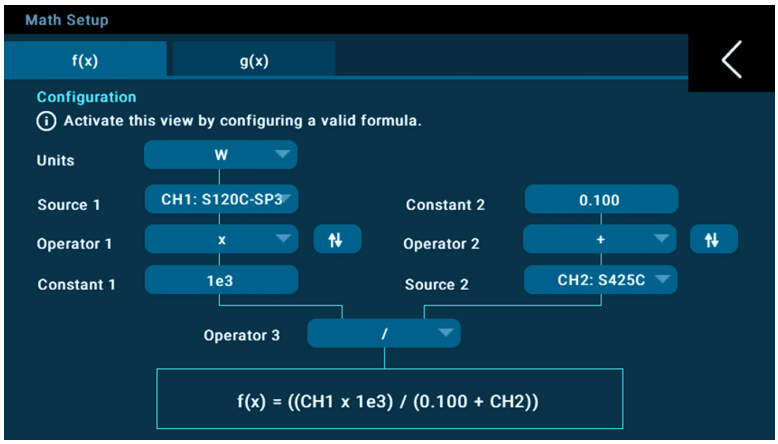


Analog Output: Configured the output port for signal analysis via an external device.

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Math: Perform two independent calculations between both channels or on just one of both channels and one constant for each channel in the PM5020 power meter interface.



The drop down lists are interactively filled with each previously set action.

The compared measurement values between two channels can also be displayed in percent.

Please find the possible functions in the table below:

(CH x <operation 1> Constant 1) <operation 3> (CH y <operation 2> Constant 2) = [Units]

The number has, depending on the operation, the same unit as CHx or no unit.

Source 1: CH1 | CH2	Operation 1	Constant 1	Operation 3	Source 2: CH1 | CH2	Operation 2	Constant 2	Result Units
Power [W] [1)]	+ | - | x | /	0 | number	+	Power [W] | 0	+ | - | x | /	0 | number	Watt
Power [W]	+ | - | x | /	0 | number	-	Power [W] | 0	+ | - | x | /	0 | number	Watt
Power [W]	+ | -	0 | number	/	Power [W] | 1	+ | -	0 | number	NA (x1 or %)
Power [dBm]	+ | -	0 | number	+	Power [dBm] | 0	+ | -	0 | number	dBm
Power [dBm]	+ | - | x | /	0 | number	-	Power [dBm] | 0	+ | - | x | /	0 | number	dB
Energy [J]	+ | - | x | /	0 | number	+	Energy [J] | 0	+ | - | x | /	0 | number	Joule
Energy [J]	+ | - | x | /	0 | number	-	Energy [J] | 0	+ | - | x | /	0 | number	Joule
Energy [J]	+ | - | x | /	0 | number	/	Energy [J] | 0	+ | - | x | /	0 | number	NA (x1 or %)

[1)] W/cm² is treated like W

Environment

This allows configuration of settings for the detection of the surrounding environment.

Capture

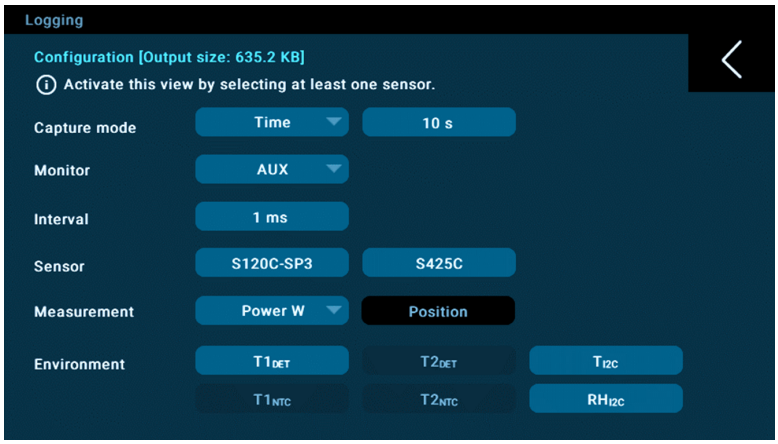
This line leads to the settings for:

- Capturing and recording of measurements: Logging and Scope measurement screens.
- File handling via the File Manager.
- SD memory: the settings to choose the remote access connections

Logging

Shown below are the settings options for measurement logging. Both, the Logging Icon 

in the Settings Menu and the Setting icon  in the measurement screen "Logging" will lead to this menu.



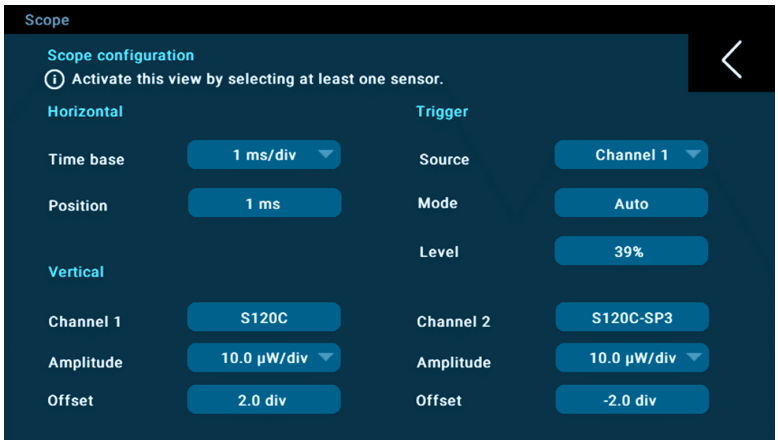
In order to give access to the Logging measurement screen, please activate at least one channel in the channel setup menu

Please adjust here the following:

- Capture mode: mode of measurement duration
- Monitor: output channel for the recording
- Interval: measurement resolution, connected sensor(s)
- Measurement: Units of data or "position" when using Thermal Position Sensors
- Environment parameters

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Scope



In order to give access to the Scope measurement screen, please activate at least one channel in the channel setup menu

Please adjust here the following setting for the screen display:

- Horizontal: X-axis configuration
- Trigger
- Vertical: Y-axis configuration for both channels

File Manager

The file manager shows the folders where respective files are saved. This File manager is also mirrored when the PM5020 power meter memory is accessed via the connected PC.



SD Memory

Pressing the memory card menu button maps the SD card file system to a connected PC. This requires USB connection.

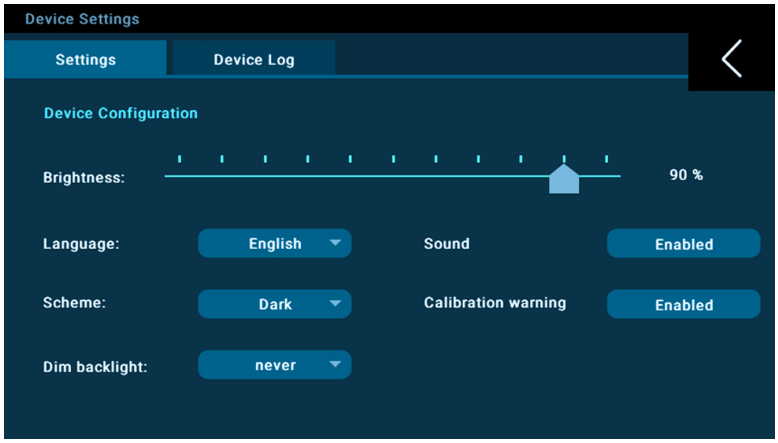
Device

This line leads to:

- Settings of the device itself
- Date and Time settings
- Configuration of the device interface via USA, Ethernet or RS232

- Information on this PM5020 power meter

Settings



This panel gives access to the setting language, display appearance (3 color schemes) and backlight level, key sound and whether a warning should be displayed when the connected sensor exceeds the recommended calibration interval.

Date/Time

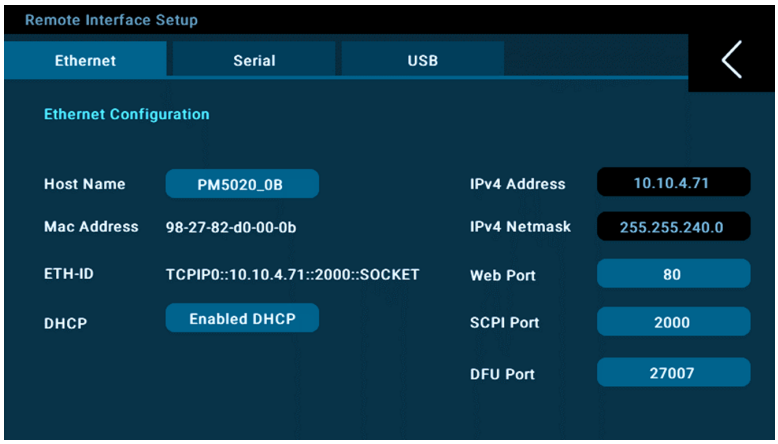
Set date and time as saved in the instrument measurements.

Interface



This screen provides information on establishing a connection via either the Ethernet connection, Serial RS232 connection or USB.

Ethernet

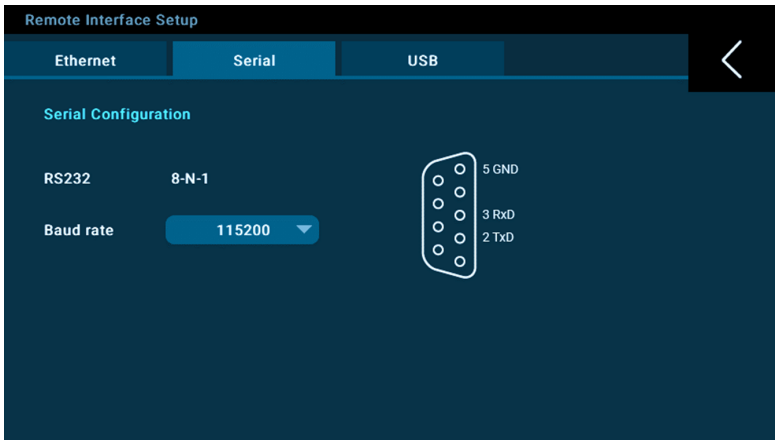


The device comes with a preconfigured host name that can be changed by user. The Ethernet ID must be used in external programs to establish the device connection.

Set ports to 0 to disable the access within a network.

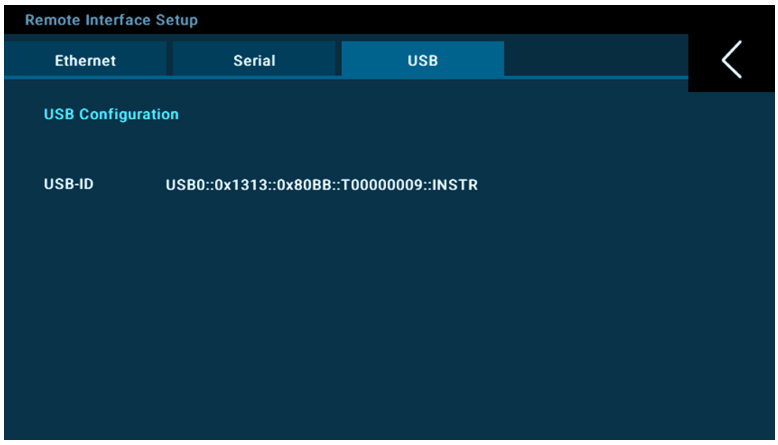
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Serial RS232



Baud rates can be set from 9 600 baud up to 921 600 baud (115 200 baud is the default that can be handled by most PCs with a sufficient performance). To connect to the instrument via serial interface, the PC serial port number must be known. Please see the Pin Assignment of the serial port.

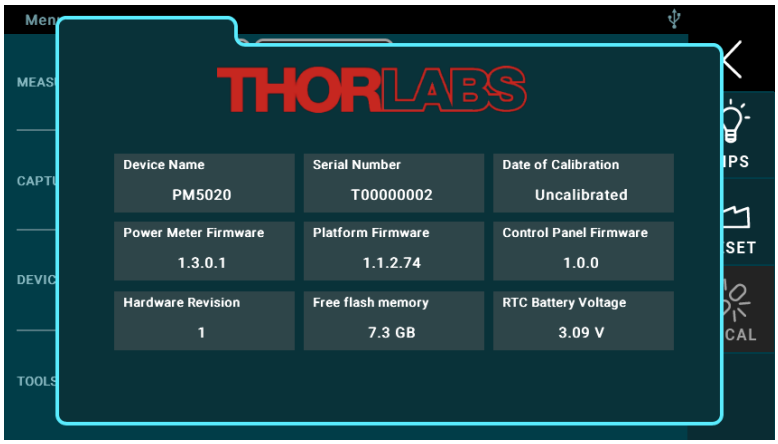
USB



This panel shows the resource string information that must be used in external programs to establish the device connection.

"0345" is the Thorlabs vendor ID, "8709" is the PM5020 product ID, followed by the device serial number.

Info



The info screen shows all relevant device parameters, including firmware versions of all built-in pcbs as well as the back up battery voltage of the real time clock and the free flash memory for the data storage.

Tools

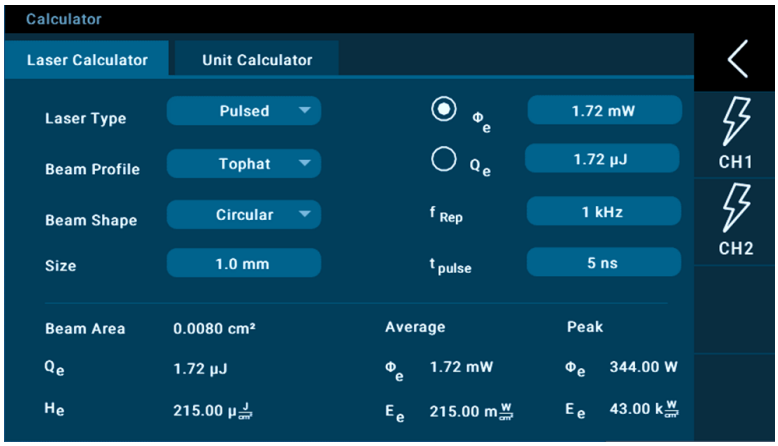
This line leads to:

- the calculator for convenient peak and average power estimations of your laser beam and conversions between the commonly used units
- Settings for the digital I/O connections
- Shutter Settings
- Fan settings

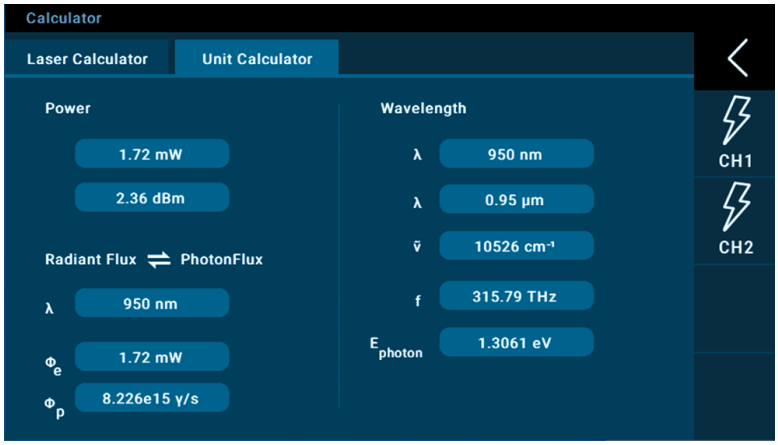
Calculator

The laser and unit calculators allow convenient peak and average power estimations of your laser beam and conversions between the commonly used units.

There are two channel wizard buttons that take the actual measurement and set values from channel 1 or 2 for your calculations.



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Digital I/O

This leads to the menu as described in the chapters Digital I/O and BNC I/O and TTL port.

Shutter

This leads to the menu as described in the chapter Shutter.

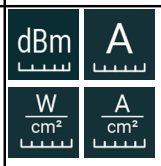
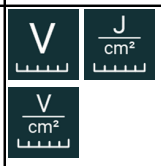
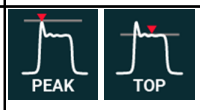
Fan

This leads to the menu as described in the chapter Fan Control.

4.11.1.3.2.2 Side Menu

This chapter describes the functions of the side menu settings which can be adjusted in the different measurement screens.

Main Icon	Toggle Icon(s)	Description
		Short press to open the Setting Menu which includes all Setting Long press to unfold the Measurement Screen specific Side Menu. To reduce the Side Menu, press the fifth button or touch 
		Increase/Decrease Selected Parameter
		Sets the Measurement Range to Automatic or manual.
		Go through different panel options
		Analog low pass filter for photodiode sensors on / off (toggling)

Main Icon	Toggle Icon(s)	Description
		Sets the number of displayed digits. (rotating)
		Magnification Numerical Dispaly: Enlarges display by using the space for the supplementary displays (setting will be stored) Analog Needle: Zooms in/out the needle gauge by factor 5 Thermal Position Sensor: Zooms in/out the target for position sensors by factor 6
		Selectable units for photodiode power sensors and thermal sensors for derived (main) and basic units and Irradiance units for photodiode sensors
		Selectable units for pyroelectric energy sensors, ("W" is currently not displayed, but average Power can be selected in the dropdown displays. --> P_{AVG} = Energy x Frequency) Fluence units for pyroelectric energy sensors
		Selectable units for photometric sensors (not yet offered in Thorlabs portfolio)
		Sets the display update rate in combination with a digital averaging (rotating)
		Resets the Min/Max/(Ratio) values in the analog representations (bargraph and needle) and in the optional drop-down displays.
		Continuous Wave or Pulsed Light Setting. For Pulsed Light: Choose between monitoring of the base or the peaks. Rotates between the acquisition functions for the photodiode sensors: - CW is used for average power measurements, the measurement value follows the incident power level. Additional averaging and filtering is possible - TOP is best setting for square shaped pulses. Analog filtering is switched off. Short overshoots will be filtered out. - PEAK(+) detects the peak level of the incident light. Analog filtering is switched off. Use this setting for triangular, sinusoidal signals or for short pulses
		Tuning sound off / on (toggling). A power level dependent audio signal is activated here or via the settings menu to support

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Main Icon	Toggle Icon(s)	Description
		tuning.
		Open the Logging setting dialog for recordings. The settings are only available when Logging is stopped. The icon leads to the same display as the Logging settings in the main settings menu.
		Start Logging and Stop Logging
		Investigate graph(s)/View recorded graphs after recording Return to start logging with the top arrow.
	 	In Logging view: • Show power graph • Show temperature graph • Show position graph
		• Open file to display • Close file
		When viewing graphs, pan or zoom into the graph with rotary knob or fingers on touchscreen. The icon to the right zooms out.
		Show strip chart or (2) show the complete chart, toggling between (1) and (2)
		Show legend, with possibility to display or hide channels in the graph plot (this does not influence the recording)
		Controls here show shutter operation, toggling between open and closed.
		Shows the position trace in the target for the position sensors, toggling between ON and OFF
		Set an internal trigger level at which a measurement is acquired for photodiodes or pyroelectric sensors in peak mode. Pressing the button opens a dialogue to adjust the trigger level.

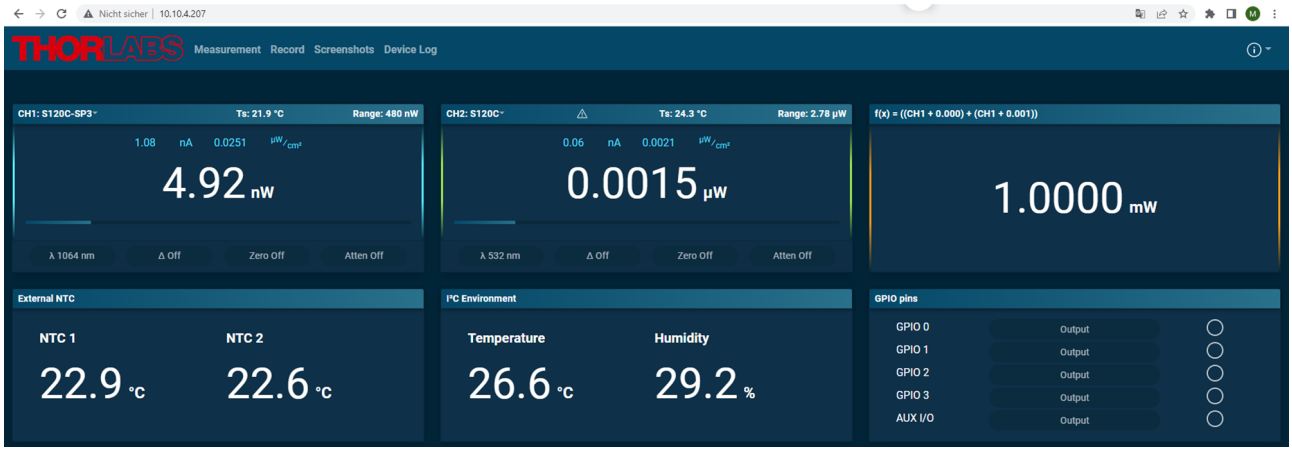
4.11.2 Web Viewer

As an alternative to observing the measurement on the PM5020 power meter display, measurement can also be viewed remotely via a web browser when the PM5020 meter is connected via Ethernet or USB.
For this, connect the PM5020 to a network, and enter the IP address shown in the interface settings to any web browser.

The website displays the status of the measurement of both channels, math channel, connected temperature or humidity sensors as well as the GPIO settings and shutter control.

In addition, recorded data can be easily downloaded via the browser, screen-shots can be made, or the device log can be monitored.

Note For safety reasons, it is not possible to control the instrument via the web viewer! All settings need to be adjusted on the PM5020 power meter directly.



4.11.3 Remote Operation

The PM5020 power meter can be remote controlled via three different interfaces: the high-speed USB interface, the built in Ethernet, or the serial RS232 interface.

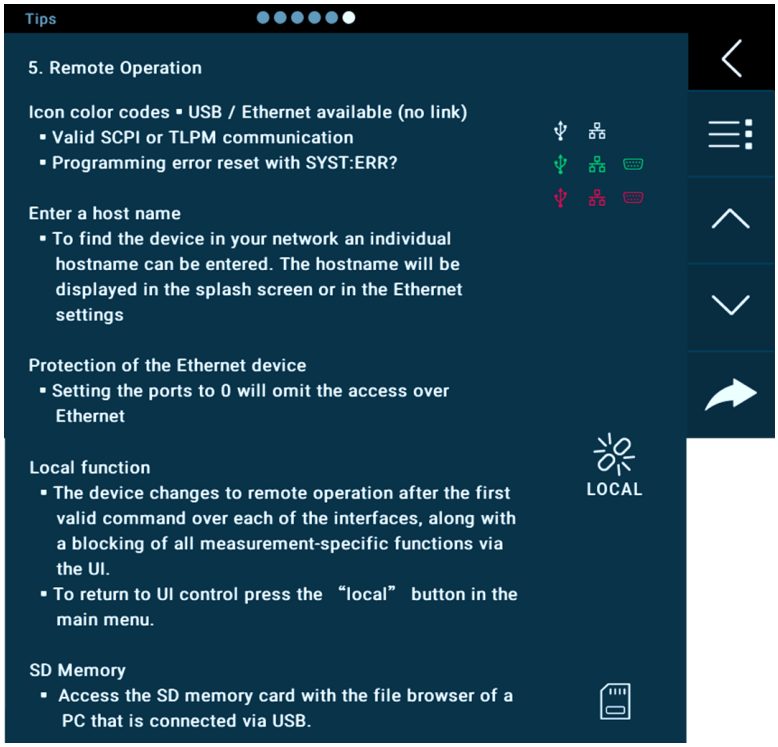
The Thorlabs Optical Power Meter (OPM) Software fully supports the PM5020 power meter and can be used via the USB or Ethernet connection. . The software can handle multiple Thorlabs power meters simultaneously and additionally contains features like the “user calibration wizard” or the “firmware update tool”. Please find more information in the chapter "Software Optical Power Monitor".

The PM5020 power meter remote operation can be integrated into custom made systems with the help of the provided SCPI commands and drivers via the RS232 or USB ports. For PM5020 drivers, please either use NI-Visa drivers possibly already installed on the PC, or use the Thorlabs TLP drivers which are installed with the Optical Power Monitor (OPM) Software. The Thorlabs TLP drivers are compatible with all other Thorlabs power meter drivers. Please see the manual for OPM Software for more information.

In addition, the PM5020 power meter has a built in Webserver such that measurements can be monitored via the USB or Ethernet connection in the web viewer.

Further instructions are also provided in the TIPS icon in the settings menu: Remote Operation.

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4.11.3.1 Software Optical Power Monitor

The Thorlabs Optical Power Monitor (OPM) Software provides a Graphical User Interface to view, log, and analyze measurement data and can be use when the PM5020 power meter is connected via USB or the Ethernet connection. Download the OPM Software package from the Thorlabs website via this link, through the software tab on the product website, or through searching for the product name within the Thorlabs software website.

All information on software installation, device control and data management software can be found in the software manual directly downloaded here.

Note

Do not connect the PM5020 prior to software installation!

Attention

Exit all running applications on your PC as the installer may require a reboot of your PC during installation!

Software Requirements

The software Optical Power Monitor (OPM) for remote operation of the PM5020 power meter requires a PC hardware and software environment as specified on the software website. The PC can be connected wither via USB or the Ethernet connection on the PM5020 power meter.

4.11.3.2 Interfaces

The PM5020 power meter can be connected to a PC or network using the Ethernet connection, a Serial RS323 connection or a USB connection.

Use the Ethernet connection to view the measurement via a web browser on a remote PC.

Use RS232 or USB for remote control of the PM5020 power meter.

The USB and Ethernet connection can be used to connect the PM5020 power meter to the software Optical Power Monitor, and to transfer files such as screen shots to a PC:

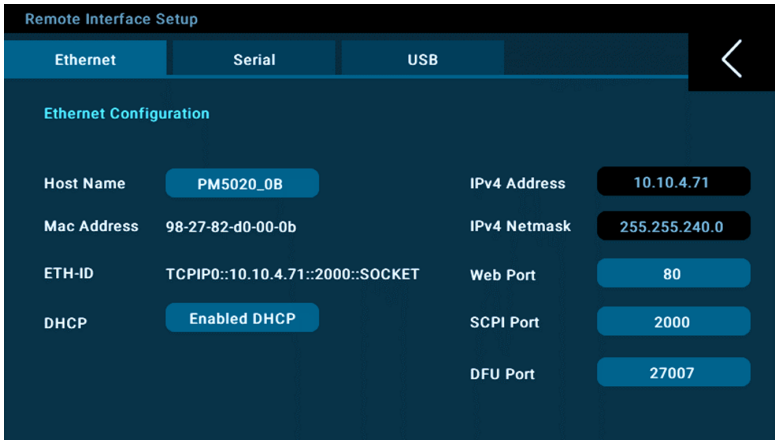
4.11.3.2.1 Ethernet Operation

Connect the PM5020 power meter using the RJ45 Ethernet connector on the rear panel.

Go to the Settings Menu and open the submenu Interface 

The below screen "Ethernet" provides the information to connect the PM5020 to the network.

The device comes with a pre-configured host name that can be changed by user. The Ethernet ID must be used in external programs to establish the device connection.



Set ports to 0 to disable the access within a network.

Once this connection is established, the user can access the web viewer as described in the respective chapter, or control the PM5020 via the OPM Software or custom made software (link).

4.11.3.2.2 RS232 Operation

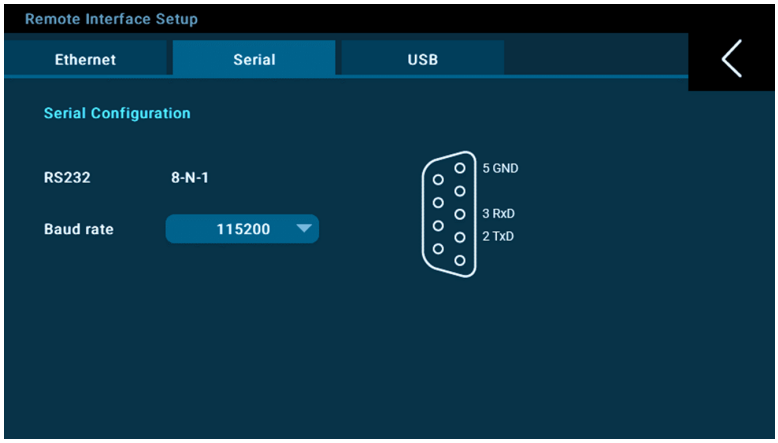
The power meter PM5020 can be operated with serial communication via RS232.

Connect the PM5020 power meter using an appropriate connector cable.

Go to the Settings Menu and open the submenu Interface 

The below screen "Serial" provides the information to connect the PM5020 to the network.

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Please use a RS232 standard protocol for RS232 communications. For questions, please contact our engineers at Thorlabs.

Please set up the port as follows:

Parameter	Setting
Baud Rate	115 200 baud (default) Supported range of Baud Rate: 9 600 and 230 400 baud
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None
Termination Character	LF (x0A; \n). The termination character needs to be enabled.

Access to Driver the SCPI commands to establish remote control software can be found in the chapter Custom Software.

4.11.3.3 Data Export

Data can be accessed via connection to a PC via the USB connection.

Spec curves, screen shots, Data acquired in the Scope measurement screen or recorded via the Logging feature, attenuation curved and the SCPI commands to write a custom made application are saved on the PM5020 internal memory and can be conveniently viewed in a web browser.

1. Connect the PM5020 to a PC using the supplied USB cable.
2. Touch the icon SD Card in the Settings Menu 

.

   This connects the PM5020 power meter to the PC.
3. A new removable disk will appear on the connected PC.
4. Open the subfolder of interest to access the data.

4.11.3.4 Custom Software

The PM5020 power meter remote operation can be integrated into custom made systems with the help of the provided SCPI commands and drivers.

The SCPI commands are saved on the PM5020 internal memory and can be conveniently viewed in a web browser.

1. Connect the PM5020 to a PC using the supplied USB cable.
2. Touch the SD Card icon in the Settings Menu 

.

   This connects the PM5020 power meter to the PC.
3. A new removable disk will appear on the connected PC.
4. Open the subfolder "support_docs" in a web browser (for example Edge, Firefox). This .html file contains all information required to write a custom made applications.

For PM5020 drivers, please either use NI-Visa drivers possibly already installed on the PC, or use the Thorlabs TLP drivers which are installed with the Optical Power Monitor (OPM) Software. The Thorlabs TLP drivers are compatible with all other Thorlabs power meter drivers. Please see the manual for OPM Software for more information.

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Chapter 5 Specifications

Item #	PM5020
Sensor Compatibility	
Compatible Sensor Types	Photodiode Sensors S100C Series Thermal Sensors S300C/S400C Series Thermal Position Sensors S400C Series Pyroelectric Sensors ES100C/ES200C/ES300C/ES400C Series Photodiodes (Max 10 mA) Thermopiles incl 4Q (Max 1 V) Pyroelectric Sensors (Max 100 V)
Sensor Connector	DE-9 Female, Rear
Photodiode Sensor Current Input (CH1 and CH2)	
Units	W, dBm, W/cm², lx, A
Measurement Range	21 Ranges: 2 nA to 10 mA Ranges Selectable in W or A, Sensor Dependent
Display Resolution	0.1 pA / Responsivity Value (A/W)
Measurement Uncertainty	±0.2% Full Scale (1 µA to 10 mA Ranges) ±0.5% Full Scale (2 nA to 400 nA Ranges)
Analog Bandwidth	DC - 250 kHz, Dependent on Sensor and Settings
Wavelength Correction	nm [A/W], Sensor Dependent
Thermopile Sensor Voltage Input (CH1 and CH2)	
Units	W, dBm, W/cm², V
Measurement Range	9 Ranges: 2 mV to 1 V Ranges Selectable in W or V, Sensor Dependent
Display Resolution	0.1 µV / Responsivity Value (V/W)
Measurement Uncertainty	± 0.5% Full Scale
Analog Bandwidth	DC - 1 kHz Dependent on Sensor and Settings
Wavelength Correction	nm [V/W] Sensor Dependent
Pyro Sensor Voltage Input (CH1 and CH2)	
Units	J, J/cm², W, W/cm²
Measurement Range	12 Ranges: 20 mV to 100 V Ranges Selectable in J or V, Sensor Dependent
Display Resolution	1 µV / Responsitivity Value (V/J)
Measurement Uncertainty	±0.5% Full Scale
Max Repetition Rate	80 kHz
Wavelength Correction	nm [V/J] Sensor Dependent
External Trigger	

Item #	PM5020
Connector	BNC (Front), 10-PIN PCB Connector Digital I/O (Rear) (TTL 5V Max)
Analog Outputs	
Connector	2 x BNC, Rear
Signal	CH1, CH2 Amplified, Corrected Input Signal
Voltage Range	-2.5 V to 10 V
Bandwidth	Up to 250 kHz Dependent on Sensor and Settings
Programmable Analog Output	
Connector	4 x BNC, Rear
Signal	Selectable: CH1, CH2, CH1-CH2, CH1/CH2, Position X, Y
Voltage Range	-5 to 10 V; Programmable Gain and Offset
Bandwidth	Up to 1 kHz Dependent on Sensor and Settings
Shutter Control	
Type	Support for SH05R(/M)/SH1(/M) with Interlock Input
Connector	Hirose HR10-7R-6S, 2.5 mm Mono Audio
Power Rating	15 V, 0.5 A
Temperature Control	
Type	NTC
Connector	2 Channels 2.5 mm Stereo Audio & 10-PIN PCB Connector Fan Control (Rear)
Digital I/O	
Type	4 Configurable I/O Channels: 1 Trigger Input/Output, I2C (LVTTL / TTL)
Connector	10-PIN PCB Connector Digital I/O (Rear)
Fan Control	
Type	2 Channels, Voltage or rpm Control (12 V, 0.25 A)
Connector	10-PIN PCB Connector Fan Control (Rear)
Power Rating	12 V, 0.25 A
Interface	
Type 1	USB 2.0
Connector	USB B, Rear
Type 2	Ethernet
Connector	RJ45, Rear
Type 3	Serial RS232
Connector	DE-9 Female, Rear
Power Supply	
Line Voltage	100 - 240 V
Line Frequency	50 to 60 Hz
Maximum Power Consumption	30 W
Mains Supply Overvoltage	Category II (Cat II)
General	
Display Type	Graphical IPS LCD w. Touch 854 x 480 Pixels

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Item #	PM5020
Display Size	5.0" (4.32" x 2.43", 109.7 x 61.6 mm)
Display Update Rate	25 Hz
Display Format	Numerical, Bargraph, Needle, Graph Power/Position/Temperature, Statistics
Operating Temperature Range [1)]	0 °C to 40 °C
Storage Temperature Range	-40 °C to 70 °C
Relative Humidity	Max. 80% up to 31 °C, Decreasing to 50% at 40 °C
Pollution Degree (Indoor Use Only)	2
Operation Altitude	<2000 m asl
Dimensions (W x H x D)	253.2 mm x 110.6 mm x 293.6 mm (9.97" x 4.35" x 11.56")
Weight [2)]	2.6 kg (5.7 lbs)

[1)] Non-condensing.

[2)] Weight of the PM5020 power meter, excluding all shipped accessories.

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

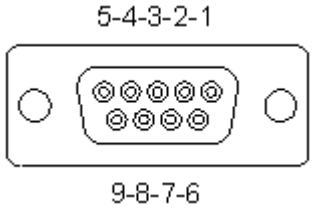
5.1 Pin Sensor Connectors

The sensor connector allows the access of all Thorlabs “C-type" photodiode, thermal, and pyroelectric sensors. The power meter interface uses the sensor calibration data, stored in the sensor connector, to calculate the corresponding actual power levels.

Additionally, the PM5020 is capable to support custom made detectors. Please read the following instruction prior to connecting a self made sensor.

Warning

Pin 2 is uniquely used for the EEPROM Digital I/O (memory in Thorlabs sensor heads) and MUST NOT be used. Connecting this Pin may cause malfunction of the PM5020.

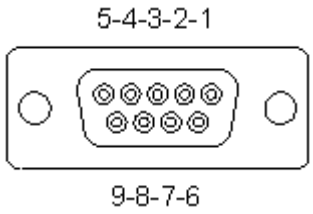


Pin	Function	Description
1	Power Supply	+5 V; Max Current 50 mA from this Pin
2	EEPROM	Sensor Memory for the Calibration Data
3	AGND	Analog Ground for Photodiode, Thermal, Pyroelectric Sensor, NTC
4	PD - / TH Q3	Photodiode Cathode Input / Thermal Position Sensor Input Quadrant 3
5	PY + / TH Q4	Pyroelectric Sensor Input / Thermal Position Sensor Input Quadrant 4
6	DGND	Digital Ground for EEPROM and 5V Output
7	PRESENT	Sensor Recognition, NTC Input. For Custom Sensors: Connect via a 1 kΩ - 10 kΩ Resistor to Pin 3 (AGND) to Enable a Custom Sensor

Pin	Function	Description
8	TH+ / TH Q1	Thermal Sensor + / Thermal Position Sensor Input Quadrant 1
9	TH Q2	Thermal Position Sensor Input Quadrant 2

5.2 Pin Output Connector RS232

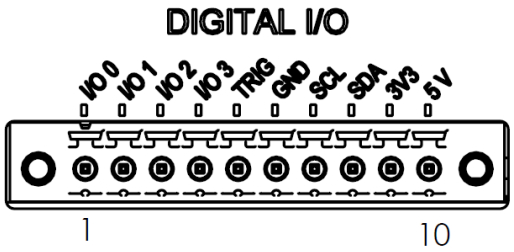
The PM5020 as a RS232 serial DE-9 connector. The Pins are assigned as follows:



Pin	Function	Description
1	N.C.	Not Connected
2	TxD	RS232: Connect to PC Terminal RxD (PC DE-9 Pin2)
3	RxD	RS232: Connect to PC Terminal TxD (PC DE-9 Pin3)
4	N.C.	Not Connected
5	GND	RS232 Signal Ground: Connect to PC Terminal Ground (PC DE-9 Pin5)
6	N.C.	Not Connected
7	N.C.	Not Connected
8	N.C.	Not Connected
9	N.C.	Not Connected

5.3 Pin Digital I/O

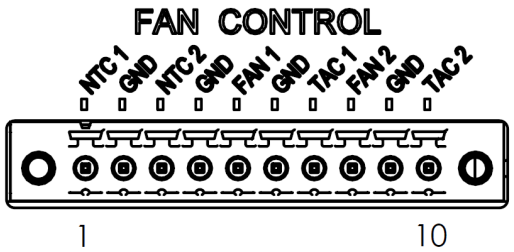
The PM5020 has a Digital I/O Connector. The Pins are assigned as follows:



Pin	Function	Description
1	I/O 0	Input/Output Port or alternative function pass/fail or disable analog port to be set in the settings menu
2	I/O 1	Input/Output Port or alternative function pass/fail or disable analog port to be set in the settings menu
3	I/O 2	Input/Output Port or alternative function shutter control or shutter monitor
4	I/O 3	Input/Output Port or alternative function logging control or logging monitor
5	TRIG	Trigger Input/Output
6	GND	Ground
7	SCL	I2C Bus Clock
8	SDA	I2C Bus Data
9	3V3	Power Supply for Accessories, 3.3 V, 100 mA Max
10	5 V	Power Supply for Accessories, 5 V, 100 mA Max

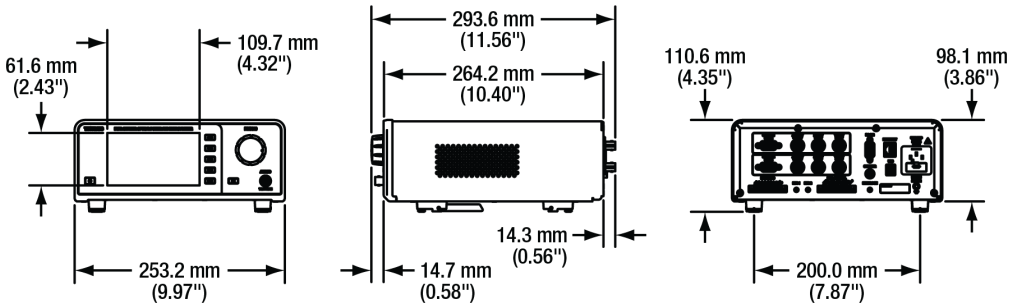
5.4 Pin Fan Control

The PM5020 has a Fan Control Connector. The Pins are assigned as follows:



Pin	Function	Description
1	NTC1	Input External NTC1
2	GND	Ground NTC1
3	NTC2	Input External NTC2
4	GND	Ground NTC2
5	Fan1	Supply Fan1
6	GND	Ground Fan1
7	TAC1	Optional Tacho Signal of Fan1
8	Fan2	Supply Fan2
9	GND	Ground Fan2
10	TAC2	Optional Tacho Signal of Fan2

5.5 Dimensions



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Chapter 6 Maintenance and Service

Protect the PM5020 power meter from adverse weather conditions. The PM5020 is not water resistant.

Attention

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

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

Do not remove covers!

Chapter 7 Certifications and Compliances

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs GmbH

Of: Münchner Weg 1, 85232 Bergkirchen, Deutschland

in accordance with the following Directive(s):

2014/35/EU	Low Voltage Directive (LVD)
2014/30/EU	Electromagnetic Compatibility (EMC) Directive

hereby declare that:

Model: ***PM5020***

Equipment: ***Dual Channel Optical Power and Energy Meter***

is/are in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010 + A1:2019 + AC:2019.
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2021

and which, issued under the sole responsibility of Thorlabs, is/are in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

contains no substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed: *On:* 07 July 2022

Name: Dr. Bruno Gross

Position: General Manager

EDC - PM5020 -2022-07-07

CE

Chapter 8 Warranty

Thorlabs warrants material and production of the PM5020 for a period of 24 months starting with the date of shipment in accordance with and subject to the terms and conditions set forth in Thorlabs' General Terms and Conditions of Sale which can be found at:

General Terms and Conditions:

https://www.thorlabs.com/Images/PDF/LG-PO-001_Thorlabs_terms_and_%20agreements.pdf

and

https://www.thorlabs.com/images/PDF/Terms%20and%20Conditions%20of%20Sales_Thorlabs-GmbH_English.pdf

8.1 Return of Devices

This precision device is only serviceable if returned and properly packed into the complete original packaging including the complete shipment plus the cardboard insert that holds the enclosed devices. If necessary, ask for replacement packaging. Refer servicing to qualified personnel.

8.2 WEEE Policy

Thorlabs 'End of Life' Policy (WEEE)



Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return "end of life" Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out "wheelie bin" logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. "End of life" units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site. It is the users responsibility to delete all private data stored on the device prior to disposal.

Chapter 9 Manufacturer Address

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Chapter 10 Copyright and Exclusion of Liability

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Please refer to the general terms and conditions linked under Warranty.

Chapter 11 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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