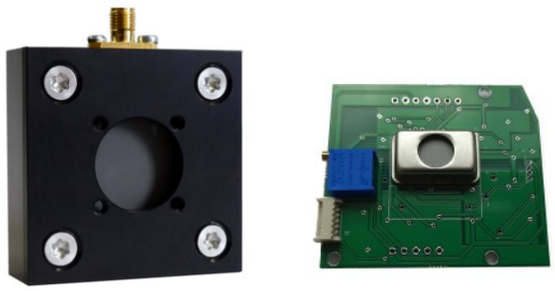
Sensor- und Lasertechnik

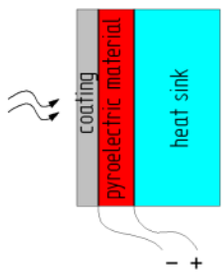
Power and Energy Measurement for Lasers



OEM Products

Pyroelectric Detectors

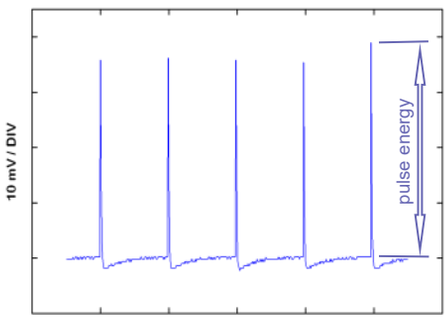
Pyroelectric detectors belong to the class of thermal detectors. Such detectors work independent of wavelength. They consist of an absorber in good thermal contact to the pyroelectric element. Pyroelectric detectors do not need cooling and have the same sensitivity for all wavelengths as long as the absorption process is perfect. The third element in the setup of a pyroelectric detector is the heat sink. It has good thermal contact to the pyroelectric sensor and is responsible for heat transfer to the surroundings.



Pyroelectric sensors are only able to detect modulated or pulsed radiation. Every pyroelectric sensor generates a charge proportional to the temperature change (the laser pulse energy). Dependent on the detection circuit, the charge is detected as a voltage peak, or the deviation of the charge (a current) is detected proportional to the pulse power. For a correct measurement, the pulse duration must be smaller than the thermal time constant so no heat loss occurs during the measurement.

A good pyroelectric material shows linearity between energy and charge for at least 5 orders of magnitude.

Most of the detectors are coaxially arranged and very insensitive against electromagnetic disturbances. A benefit of such detector heads is that they can be directly connected to an oscilloscope and energies from µJ to J can be detected without an amplifier or readout unit.



typical output of an pyroelectric detector

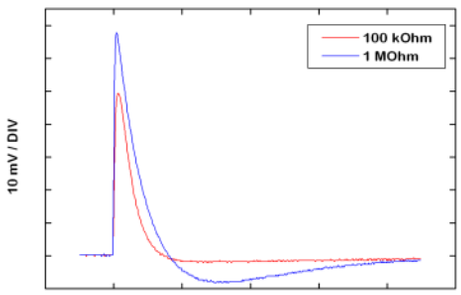
For a measurement of high rep. pulse lasers smaller thermal and electric time constants are desired. Dependent on the construction of the detectors, some types are able to detect pulse energies up to 100 kHz.

Three parameters limit the use of a pyroelectric detector:

- Too high peak power destroys or partially evaporates the absorber
- Too high average power and
- Too high pulse energy is dangerous for the sensor material

The limits depend on the wavelength of the radiation and the pulse duration. High threshold coatings are available for most sensor types.

For all detectors the sensitivity (V/J) is specified for a load of 1MΩ (oscilloscope) and for 100kΩ for enabling higher rep. rates. For both loads the sensitivity is determined at 355nm by a comparison with a master detector calibrated at PTB Braunschweig.



output on dependence of load resistor

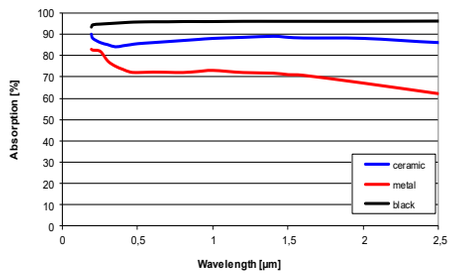
Coatings for Pyroelectric Detectors

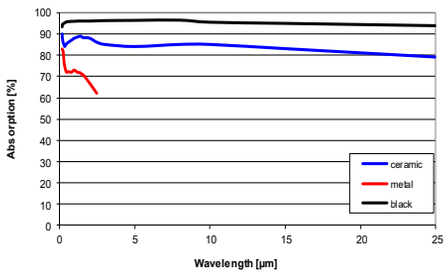
The absorber coating of the detector has to withstand the intense laser power. Its stability determines the lifetime of the detector. Nearly all absorbers are a compromise between wavelength independent absorption and stability.

We use three different coatings:

- Organic black coating with a high and nearly wavelength independent absorption of 97±1 % between 190 nm and 25 µm
- Ceramic based high power absorber, especially for all high peak power lasers (YAG, Excimer, CO_2)
- Metallic absorber with high thermal conductivity for high rep rates

For wavelengths larger than 100 µm, the absorption decreases for all known absorbers , caused by an increasing transparency. This can only be compensated for by a larger thickness of the absorber leading to disadvantages for power and energy sensors.





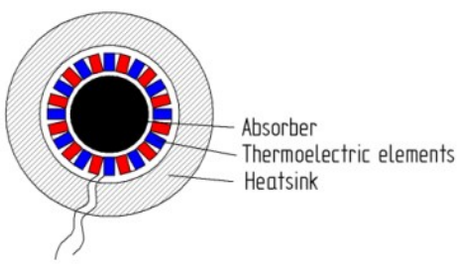
THz - Detectors

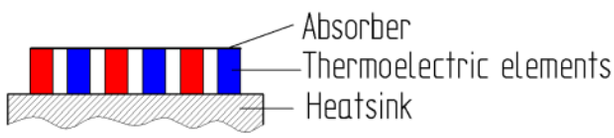
Thermopile Detectors

Such detectors are used for the determination of the average power of cw or repeatedly pulsed lasers. All types of thermopile detectors use the temperature gradient along the heat flow for the determination of the input power. As shown in the next figures the heat flow can proceed in axial or in radial directions. Independent of the setup, it needs a certain time to reach stationary state. Radial heat flux sensors have a shorter time constant and are able to handle higher power, whereas axial heat flow sensors can have higher sensitivities.

In most cases the time constant is larger than 10 seconds. This rise time can be reduced using adequate electronics, but for an evaluation of the fluctuation of pulsed lasers a pyroelectric detector is the better choice.

Similar to joule meters the power meters can have different absorber sheets, optimized for a broadband behaviour and lower power densities or for high peak powers and reduced wavelength independence.





The axial design above has a much higher sensitivity than the radial design, shown on the left side. The radial types are optimal for high power applications, because the area of high temperature is far away from the thermocouples.

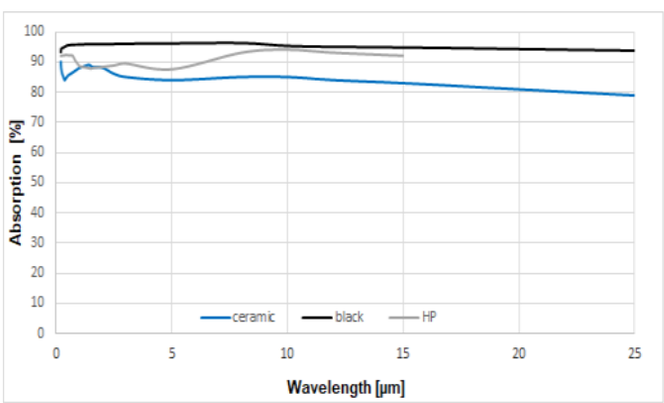
Coatings for Thermopile Detectors

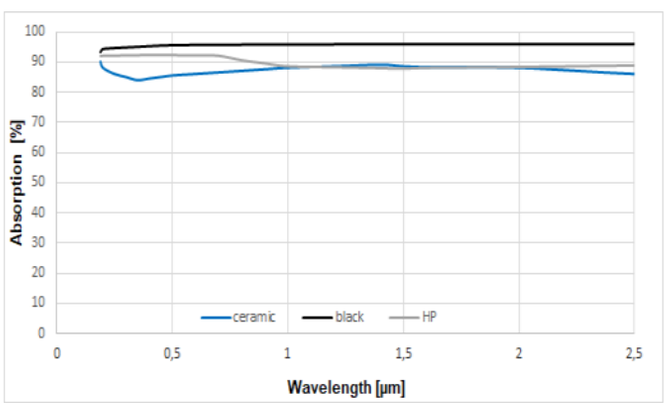
The absorber coating of the detector has to withstand the intense laser power. Its stability determines the lifetime of the detector. Nearly all absorbers are a compromise between wavelength independent absorption and stability.

We use three different coatings for our detectors:

- Our organic black coating offers a very broadband absorption layer for low energy densities and medium power densities. It works with a nearly wavelength independent absorption of 97±1 % between 190 nm and 25 µm, which means that no wavelength correction is necessary.
- Our ceramic based coating works with very high energy densities and low power densities. The absorption depends on the wavelength. It works best for all high peak power lasers (Nd:YAG, Excimer, CO_2)
- Our HP coating is used for high power densities und medium energy densities. Its absorption depends on the wavelength

For wavelengths larger than 100 µm, the absorption decreases for all known absorbers , caused by an increasing transparency. This can only be compensated for by a larger thickness of the absorber leading to disadvantages for power and energy sensors.



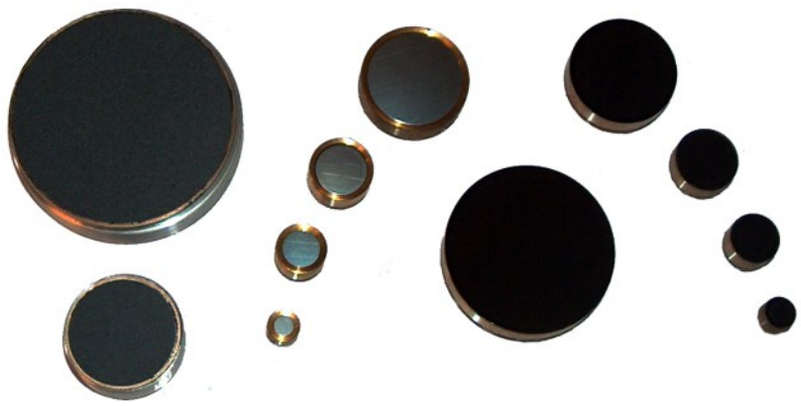


Pyroelectric OEM detectors series PES

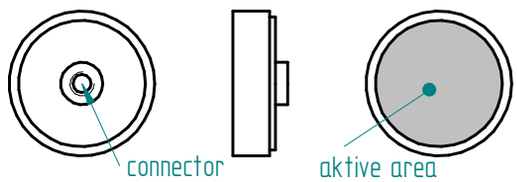
The main application for this type of sensor is energy monitoring of high repetition rate lasers. The co-axially built sensors have a high sensitivity and can be applied in a wide spectral range. Because of the very low noise design and high sensitivity it is possible to monitor low energies, for instance behind beam splitters or semi-transparent mirrors.
Detector diameters between 4 mm and 45 mm are available. The maximum repetition rate depends on the sensor diameter and the load resistor; values up to 3000 pps. are possible. For these sensors 3 absorber coatings are available:

- organic black, flat spectral behaviour
- Metallic coating for high repetition rates
- Ceramic coating for highest peak powers

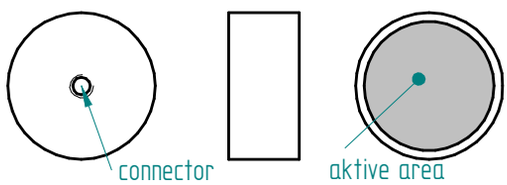
The sensors can easily be combined with own electronics. Additionally we offer our OEM-Pyrobox with RS232 or USB-output.



	PES	PES HR	PES K
Max. energy density:	150 mJ/cm²	100 mJ/cm²	up to 1 J/cm²
Max. power density:	150 mW/cm²	150 mW/cm²	500 mW/cm²
Max. peak power density: (10 ns—pulse)	8 MW/cm²	8 MW/cm²	70 MW/cm²
Temperature range:	0 .. 40°C	0 .. 40°C	0 .. 70°C
Spectral range		190 nm .. 25 µm	
Max. pulse duration		2 ms	
Accuracy		±3%	

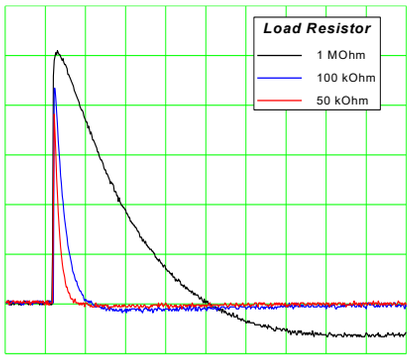


Type PES and PES HR

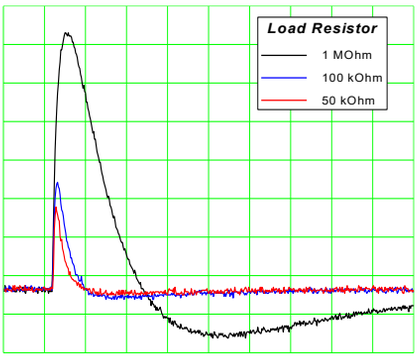


Type PES K and HP

	Aperture	Sensitivity	Rep Rate	Dimension (Dia x length Connector)
PES 4	4 mm	500..1000 V/J at 1 MΩ 130..250 V/J at 100 kΩ	80 Hz at 1 MΩ 120 Hz at 100 kΩ	7 x 9,5 mm² M 3
PES 8	8 mm	200..500 V/J at 1 MΩ 50..200 V/J at 100 kΩ	40 Hz at 1 MΩ 100 Hz at 100 kΩ	11 x 9,5 mm² M 3
PES 11	11 mm	100..400 V/J at 1 MΩ 50..150 V/J at 100 kΩ	40 Hz at 1 MΩ 80 Hz at 100 kΩ	14 x 9,5 mm² M 3
PES 21	21 mm	50..150 V/J at 1 MΩ 30..80 V/J at 100 kΩ	25 Hz at 1 MΩ 50 Hz at 100 kΩ	24 x 9,5 mm² M 4
PES 34	34 mm	40.. 70 V/J at 1 MΩ 10..40 V/J at 100 kΩ	25 Hz at 1 MΩ 80 Hz at 100 kΩ	37 x 10 mm² M 4
PES 20 HP	20 mm	30.. 50 V/J at 1 MΩ 8..20 V/J at 100 kΩ	50 Hz at 1 MΩ 150 Hz at 100 kΩ	25 x 12 mm² M 3
PES 45 HP	45 mm	8.. 15 V/J at 1 MΩ 4..8 V/J at 100 kΩ	25 Hz at 1 MΩ 100 Hz at 100 kΩ	50 x 13 mm² M 4
HR 4	4 mm	1000..1500 V/J at 1 MΩ 900..1200 V/J at 100 kΩ 900..1100 V/J at 50 kΩ	250 Hz at 1 MΩ 2,5 kHz at 100 kΩ 3,3 kHz at 50 kΩ	7 x 9,5 mm² M 3
HR 8	8 mm	700..900 V/J at 1 MΩ 400..500 V/J at 100 kΩ 300..400 V/J at 50 kΩ	150 Hz at 1 MΩ 2 kHz at 100 kΩ 2,5 kHz at 50 kΩ	11 x 9,5 mm² M 3
HR 11	11 mm	400..600 V/J at 1 MΩ 400..500 V/J at 100 kΩ 300..400 V/J at 50 kΩ	250 Hz at 1 MΩ 1,5 kHz at 100 kΩ 2 kHz at 50 kΩ	14 x 9,5 mm² M 3
HR 21	21 mm	150..250 V/J at 1 MΩ 100..250 V/J at 100 kΩ 100..200 V/J at 50 kΩ	50 Hz at 1 MΩ 200 Hz at 100 kΩ 1,4 kHz at 50 kΩ	24 x 9,5 mm² M 4
PES 20 K	20 mm	7..15 V/J at 1 MΩ 1..8 V/J at 100 kΩ	50 Hz at 1 MΩ 50 Hz at 100 kΩ	25 x 12 mm² M 3
PES 45 K	45 mm	1.5..4.5 V/J at 1 MΩ 0.4..1.5 V/J at 100 kΩ	20 Hz at 1 MΩ 50 Hz at 100 kΩ	50 x 13 mm² M 4



HR 11, 500 µs/div; 5 mV/div; 100 µJ



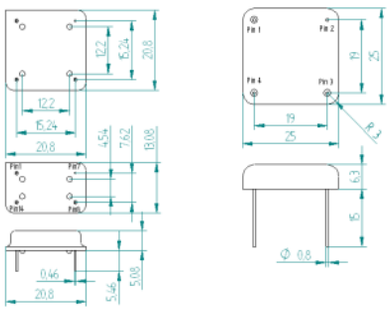
PEM 11, 1 ms/div; 5 mV/div; 100 µJ

Samples of the output signal of different sensors

Pyroelectric OEM detectors series PEO

These sensors are characterised by a high sensitivity and a high repetition rate. Cause of the windowless design and the used metallic absorption coating an usage in the UV-range is also possible. If needed, for example when using the sensor at different wavelengths, we will also supply these sensors with our reliable, broadband black coating. The modular construction set EMK100 can be combined with PEO sensors.
In combination with good adapted amplifiers repetition rates of 30kHz are possible.

max. energy density	50 mJ/cm²
max. average power	1 W
Calibration uncertainly	±3 %
Temperature environment	10°C .. 50°C
Temperature coefficient	+0,1%/K



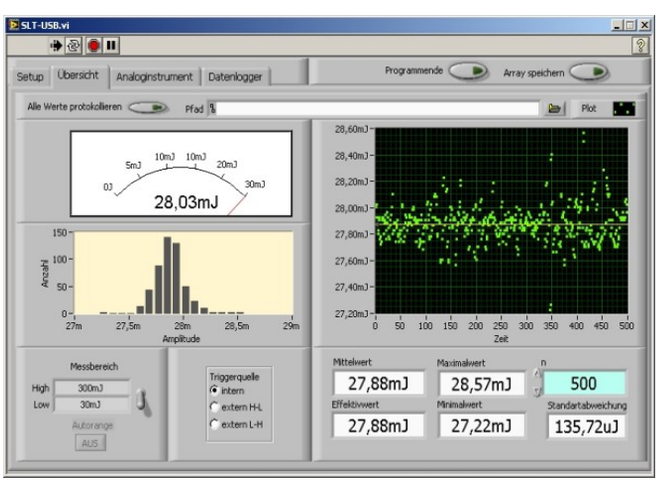
	Aperture	Sensitivity [V/J]	Rep Rate [Hz]
PEO 8	Ø 8 mm	400..500 V/J at 1 MOhm 200..300 V/J at 100 kOhm	1 kHz at 1 MOhm 10 kHz at 100 kOhm
PEO 8 B	Ø 8 mm	300..400 V/J at 1 MOhm 200..300 V/J at 100 kOhm	750 Hz at 1 MOhm 1 kHz at 100 kOhm
PEO 12	Ø 12 mm	300..400 V/J at 1 MOhm 200..300 V/J at 100 kOhm	700 Hz at 1 MOhm 6 kHz at 100 kOhm
PEO 12 B	Ø 12 mm	20..40 V/J at 1 MOhm 10..20 V/J at 100 kOhm	500 Hz at 1 MOhm 750 Hz at 100 kOhm
PEO 20	Ø 20 mm	100..160 V/J at 1 MOhm 70..120 V/J at 100 kOhm	250 Hz at 1 MOhm 2 kHz at 100 kOhm

Pyrobox OEM

This „Pyrobox“ processes the signals of all pyroelectric energy detectors. The output signal will be transferred to a connected PC via USB. The device is powered from the USB-port. The Pyrobox communicates with the computer using ASCII code and is very easy to integrate into your own existing software program or systems.

- For all PEM detectors
- Two different sensitivities
- USB 2.0 connection or RS232
- Power supply from USB
- Max. rep. rate 100 pps
- Additional external trigger input
- Software for different applications available (Analogue and digital display, data logger, statistics,...)
- Data transfer as ASCII code
- Dimensions 90 mm x 62 mm x 30 mm

In addition, we offer the Pyrobox with an integrated sensor. The sensor PES20 or PES20K is used as standard. If necessary, other sensors of the PES series are also possible with adjustments. The compact design and the lack of cables between the sensor and electronics reduce noise and improve accuracy.



OEM-Module EMK

The OEM modules of the EMK series offer laser manufacturers a simple and inexpensive integration of the PEO series sensors into their own laser systems without a great deal of development effort.

The basic model EMK100 delivers a corresponding analog voltage for each laser pulse, which can be easily read in via the laser control unit. Additional header contacts for power supply, measurement and trigger signals offer the option of plugging the circuit board onto your own circuit board and thus reducing the amount of cabling.

Significantly higher repetition rates are possible with the EMK200. The power supply has also been simplified and the output signal has been made available at an SMA socket to reduce interference. Power and trigger signals can be contacted either via a 9-pin D-Sub connection or a simple wire-to-board connector. The trigger signals are decoupled via optocouplers.

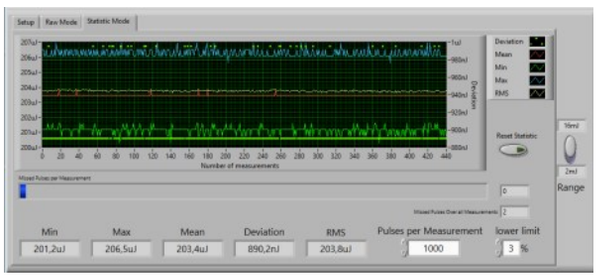
With the EMK200, the measured values reach the laser control via USB without having to take a detour via an analogue signal. Power is also supplied via USB. The communication protocol is kept very simple to facilitate integration into your own software. Labview examples can be supplied. The firmware supports two modes. In "Stream" mode, each recorded energy value is transmitted via the interface. In "Statistics" mode, all relevant statistical values are recorded via an adjustable number of pulses and only these are sent.

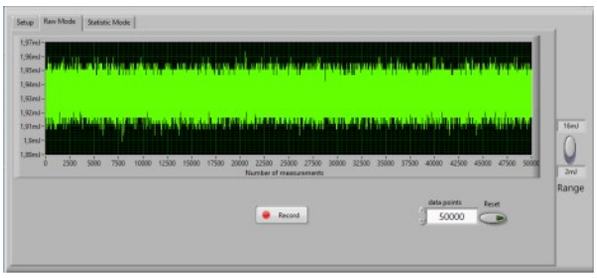
All variants have 2 measuring ranges. With the analogue versions, the switching is done via a 5V signal, with the USB version via software.

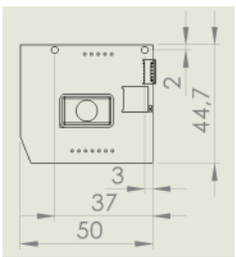
Optional housings are available for all variants. Required mounting holes can be discussed.

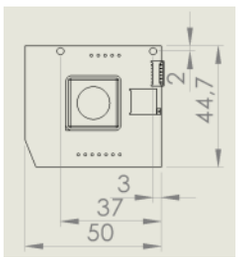
	EMK100	EMK200	EMK200 USB
Dimension PCB	45 mm x 50 mm	44 mm x 77 mm	44 mm x 100 mm
Dimension housing	55 mm x 52 mm x 16 mm	55 mm x 100 mm x 16 mm	50 mm x 100 mm x 16 mm
Ranges *	15µJ - 1mJ 150µJ - 5mJ	5µJ - 100µJ 50µJ - 1mJ	5µJ - 100µJ 50µJ - 1mJ
Rep. rate	up to 5kHz	up to 25kHz	up to 25kHz
Trigger	Internal	External/Internal Selectable by jumper	External/Internal Selectable by jumper
Power supply	±12V .. ±15V	+5V	from USB
In- Output	6-pol. Molex, pitch 1.27	SMA coaxial connector for analog output 6-pol. Molex, pitch 2.54mm or alternatively DSUB for trigger and supply	SMA coaxial connector for trigger input

* Adjustable, also depends on the sensor

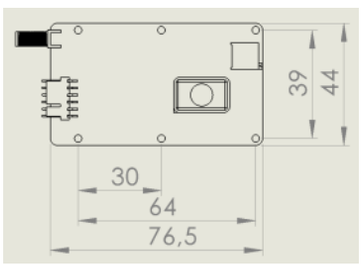


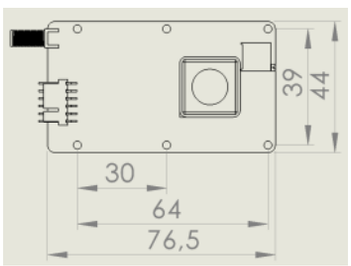




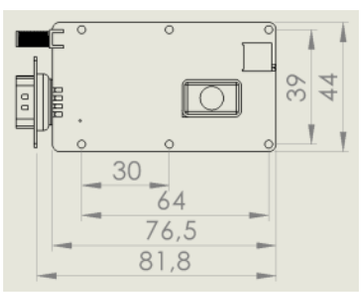


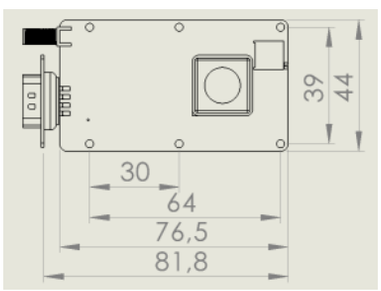
EMK100 with PEO8 sensor

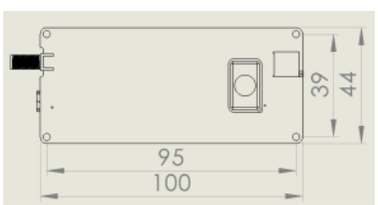


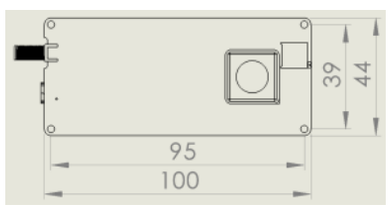


EMK200 with PEO12 sensor,
DSUB9 connector









EMK200USB with PEO12 sensor

EMK100 with PEO12 sensor

EMK200USB with PEO12 sensor

OEM Powermeter

OEM detectors and accessories are typically used within laser systems for online power monitoring or power regulation. Because they are fixed within the laser on baseplates or the laser housing they have only small or no cooling fins. They use the laser as a heatsink.

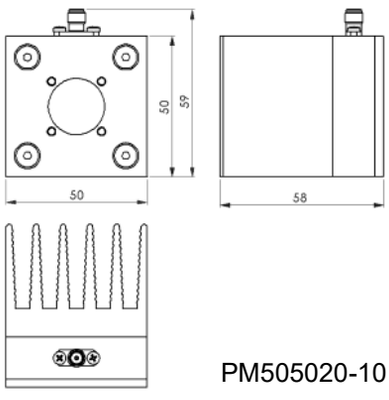
The sensor elements are available in different sizes for different power ranges. The housings have a lot of holes for mounting the detector and for combination with additional optical components like beam splitters, diffuser discs or optical fibre adaptors. Please ask for a solution.

Additionally a preamplifier module with analogue output is available to read the power directly into own applications. For digital interface the OEM Powerbox is available.

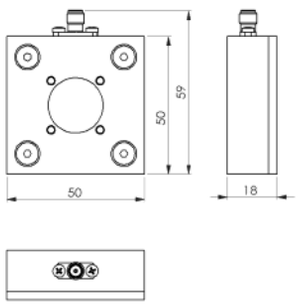
PM505020

Main feature of this family is the high average power density. That's make them ideally for solutions, where it is necessary to measure the whole power of the laser for a short time.

	PM505020-5	PM505020-10
Active diameter	20 mm	
Max. power	5 W	10 W 15 W for 2 minutes
Min power	10 mW	
Response time	< 2 seconds (with electronic)	
Max. power density	10 kW/cm²	
Max. energy density	300 mJ/cm² (at 10 ns) | 1,2 J/cm² (at 10 µs)	
Sensitivity	≈1 mV/W	
Linearity	±1%	
Calibration uncertainty	±3%	
Cooling	convection or additional heatsink	
Spectral range	190 nm - 15 µm	
Connector	SMA	
Dimensions [mm]	50 x 50 x 18	50 x 50 x 58



PM505020-10



PM505020-5

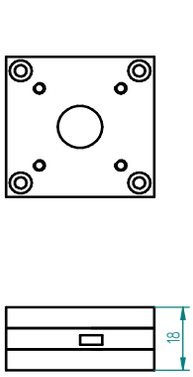
PM404010

These family of high sensitive thermopile sensors and electronics are ideally for online power monitoring.

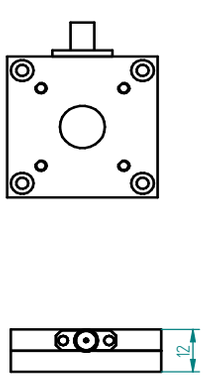
For applications at high repetition rate lasers with high peak power we recommend to order these detectors with our ceramic coating.

For easy integration within the laser, the housings feature numerous threads on various surfaces. Mounting on solid housing parts or base plates allows for high temperature stability and thus stable measurement results.

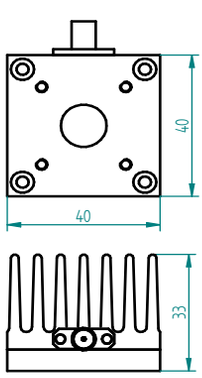
	PM404010-3	PM404010-5	PM404010-3-A	PM404010-5-A
Active diameter	10 mm			
Power range	0.5 mW - 3 W	0.5 mW - 5 W	0.5 mW - 3 W	0.5 mW - 5 W
Max. power density	40 W/cm²			
Max. energy density	80mJ/cm²			
Sensitivity	250 mV/W .. 450 mV/W			
Linearity	±1%			
Calibration uncertainty	±3%			
Spectral range	190 nm - 25 µm		190 nm - 25 µm	
Cooling	Convection or additional heatsink		Convection or additional heatsink	
Connector	SMA		Molex Microblade	
Dimensions [mm]	0.5 mW - 3 W	0.5 mW - 5 W	40 x 40 x 18	40 x 40 x 39



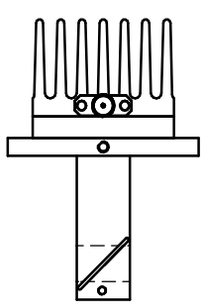
PM404010-3-A



PM404010-3



PM404010-5

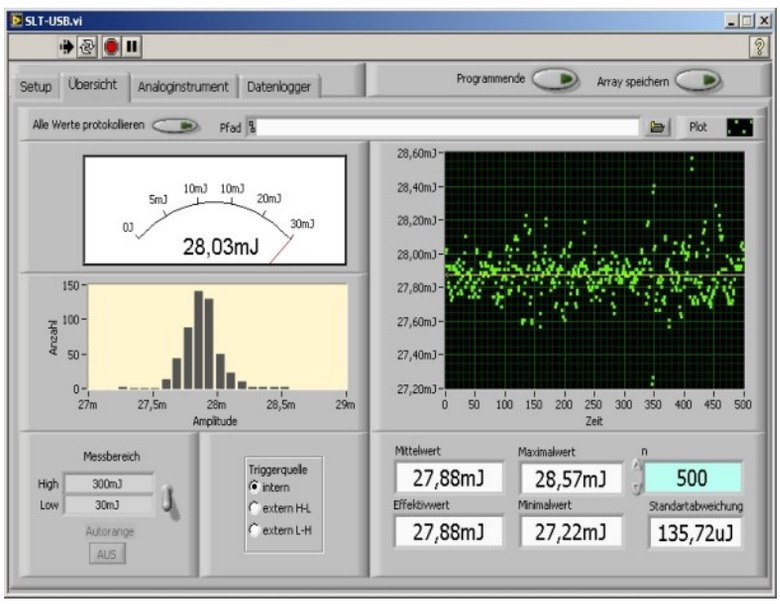


PM404010-5
with additional beam splitter

Powerbox OEM

This „Powerbox“ processes the signals of all thermopile power detectors. The output signal will be transferred to a connected PC via USB. The device is powered from the USB-port. The Powerbox communicates with the computer using ASCII code and is very easy to integrate into your own existing software program or systems.

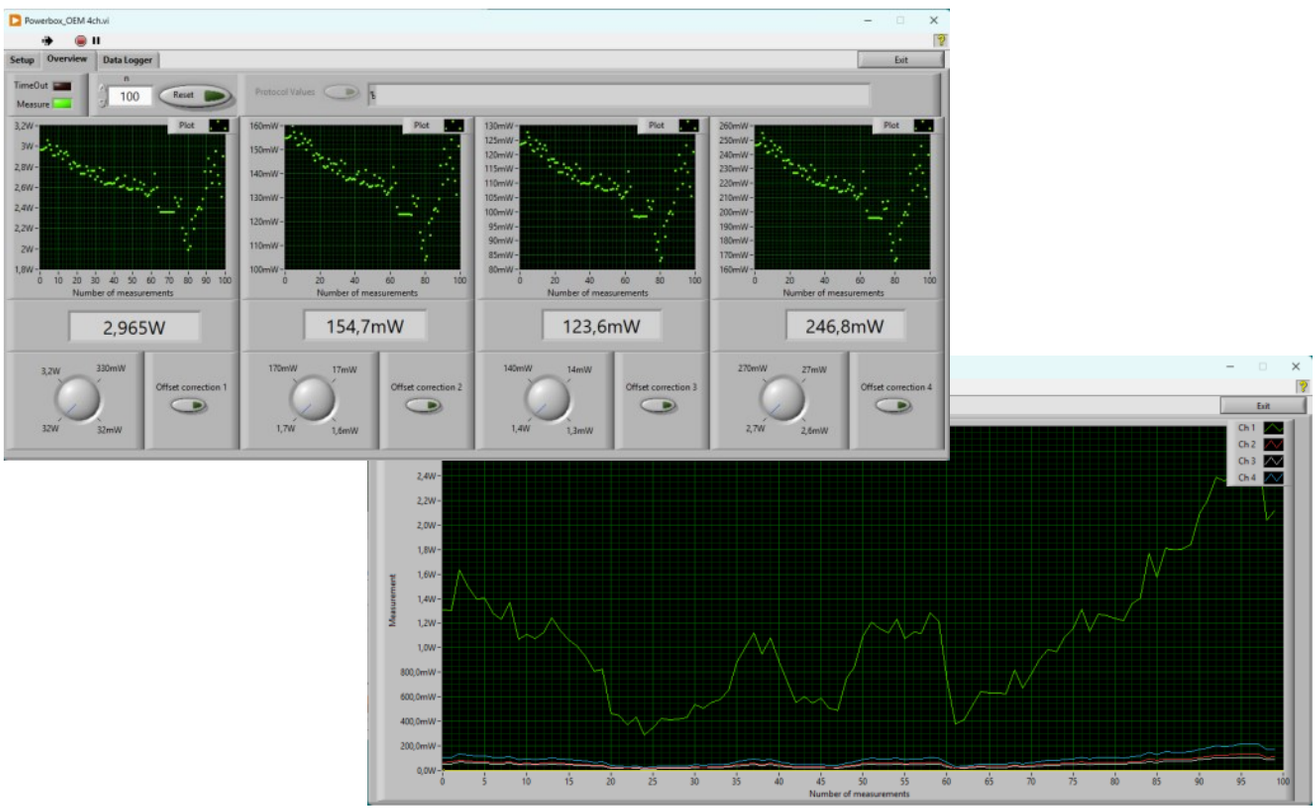
- USB 2.0 connection or RS232
- For all thermopile detectors
- Four ranges
- Power supply from USB
- LabVIEW based software for different applications available (Analogue and digital display, data logger, statistics)
- Data transfer as ASCII code
- Dimensions 100 mm x 41 mm x 24 mm



Powerbox OEM 4-Ch

Based on the Powerbox OEM, we now offer a 4-channel version. A USB and an RS232 version are also available. The range of functions and operation are largely the same as the Powerbox OEM.

- USB 2.0 connection or RS232
- For all thermopile detectors
- Four ranges per channel
- Power supply from USB or external power supply for RS232 version
- LabVIEW based software for different applications available
- Data transfer as ASCII code
- Dimensions 105 mm x 34 mm x 130 mm



SLT Sensor– und Lasertechnik GmbH

Freiheitstr. 124-126
15745 Wildau
Germany

Tel.: +49 3375 5257201
Fax: +49 3375 5257203

www.pyrosensor.de
service@pyrosensor.de