

Operating Manual

Translation of the Original Instructions



PowerMeasuringCassette

PMC

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1 Basic Safety Instructions

Intended Use

The PowerMeasuringCassette (PMC) is exclusively intended for laser power measurements which are carried out in or nearby the optical path of high power lasers. Other forms of usage are improper. To ensure a safe operation, the device must only be operated according to the terms stipulated by the manufacturer.

Using the device for unspecified use is prohibited strictly by the manufacturer. By usage other than intended the device can be damaged or destroyed. This poses an increased health hazard up to fatal injuries. When operating the device, it must be ensured that there are no potential hazards to human health.

The device itself does not emit any laser radiation. During the measurement, however, the laser beam is guided on the device which causes scattered radiation. That is why the applying safety regulations are to be observed and necessary protective measures need to be taken.

Observing Applicable Safety Regulations

Personal protection is required when humans are present in a dangerous zone with uncovered visible or invisible laser radiation or particularly uncovered laser beam systems, beam guiding systems or process regions. This holds true for any application of this equipment. During measurement procedures there is always an unavoidable risk of laser radiation through direct or reflected emissions. The applicable safety regulations are stipulated in ISO/CEN/TR standards as well as in the IEC-60825-1 regulation, in ANSI Z 136 "Laser Safety Standards" and ANSI Z 136.1 "Safe Use of Lasers", published by the American National Standards Institute, and additional publications, such as the "Laser Safety Basics", the "LIA Laser Safety Guide", the "Guide for the Selection of Laser Eye Protection" and the "Laser Safety Bulletin", published by the Laser Institute of America, as well as the "Guide of Control of Laser Hazards" by ACGIH.

Taking Necessary Safety Measures

If there are people present within the danger zone of visible or invisible laser radiation, for example near laser systems that are only partly covered, open beam guidance systems or laser processing areas, the following safety measures need to be taken:

- Please wear safety goggles adapted to the laser wave length and operating mode of the laser beam source in use.

- Depending on the laser source, it may be necessary to wear suitable **protective clothing** or **protective gloves**.
- Please protect yourself from direct laser radiation, scattered radiation as well as from beams generated from laser radiation (e.g. by using appropriate shielding walls or by weakening the radiation to a harmless level).
- Please use beam guidance- or beam absorber elements which do not emit any hazardous particles as soon as they get in contact with laser radiation and which resist the beam sufficiently.
- Please install safety switches and/or emergency safety mechanisms which enable an immediate closure of the laser shutter.
- Please ensure a stable mounting of the measuring device in order to prevent a relative motion of the device to the beam axis. This reduces the risk of scattered radiation and is also necessary to ensure an optimal performance for the measurement.

Employing Qualified Personnel

All users of the PMC must have been introduced to the handling of the measuring device and they need to have a basic knowledge about the work with high power lasers, beam guidance systems as well as focussing units.

Modifications

The PMC must not be modified, neither constructional nor safety-related, without our explicit permission. Modifications of any kind will result in the exclusion of our liability for resulting damages.

Liability Disclaimer

The manufacturer and the distributor of the measuring devices do not claim liability for damages or injuries of any kind resulting from an improper use or handling of the devices or the associated software. Neither the manufacturer nor the distributor can be held liable by the buyer or the user for damages to people, material or financial losses due to a direct or indirect use of the measuring devices.

2 Symbol Explanation

The following symbols and signal words (according to ISO 3864) indicate possible residual risks:



DANGER

means that death or serious physical injuries **will** occur if necessary safety precautions are not taken.



WARNING

means that death or serious physical injuries **can** occur if necessary safety precautions are not taken.



CAUTION

means that a slight physical injury **can** occur if necessary safety precautions are not taken.

NOTICE

means that property damages **can** occur if necessary safety precautions are not taken.

The device itself or the packing bears the following symbols to indicate requirements and possible dangers:



Read and observe the operating instructions and safety guidelines before the start-up!

Further symbols that are not safety-relevant:



Here you can find useful information and helpful hints.



With the CE marking the manufacturer guarantees that his product is in conformity with the EC guidelines.



Call for action



Call for observing (visual feedback from the device or the software)

3 Conditions at the Installation Site

The PMC must only be operated in a dry and dust free atmosphere. High levels of humidity can lead to condensation, which can affect the operation of the PMC. This also applies to high environmental dust exposure.

4 System Description

The PowerMeasuringCassette is intended for power measurements of solid-state lasers for a direct integration into the laser processing head. The PMC can also be operated outside the processing head (“stand-alone”).

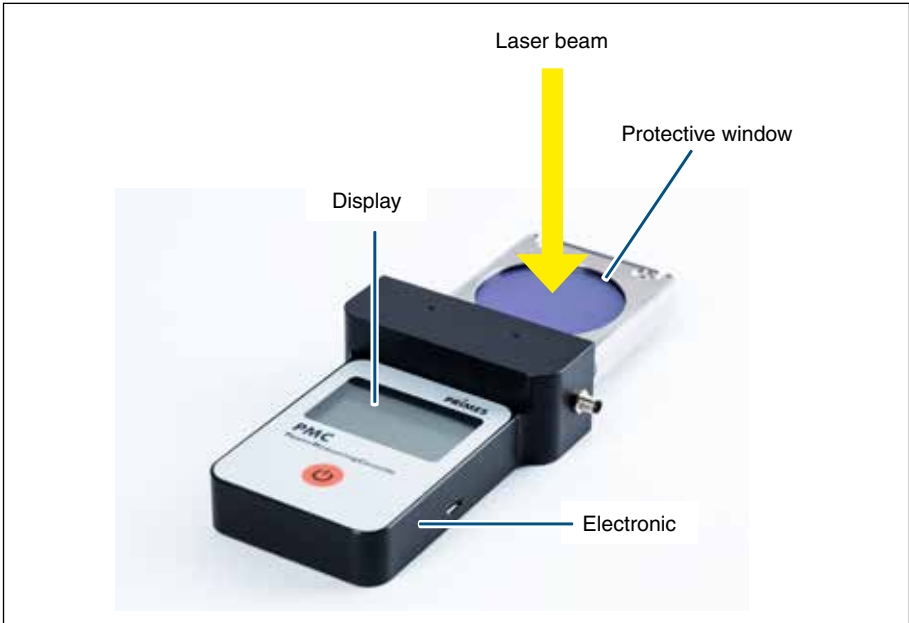


Fig. 4.1: Mechanical assembly of the PMC (BEO version)

4.1 Measuring Principles

The PMC measures the laser power according to the ballistic principle. Here, the absorber is irradiated with laser radiation for a stipulated period of time.

After a thermalization time, the laser power can be determined by means of the temperature rise as well as the known weight of the absorber.

5 Transportation

NOTICE

Danger of damage

Hard impacts and dropping the device can damage electronical components.

- ▶ **Handle the measuring device with care both during transport and assembly!**
-

6 Installation

6.1 Installation into the Laser System

Please mind the following procedure when installing the device:

1. First of all the laser source has to be turned off.
2. Ensure that moving parts, e.g. robot arms, etc. are at a standstill and that they cannot be set in motion unintentionally.
3. Remove the protective foil from the protective window.
4. Insert the PMC into the slot of the processing optics until the locking latch locks in place.
5. Connect the interlock connection with the laser control.

6.2 Mounting Position

The PMC is mainly used in processing optics. Here, the mounting position is stipulated. However, the PMC can also be used for measurements in an open beam path. In this case, please mind the dimensions and distances given in Fig. 6.2 on page 12 as well as the limit values given in chapter 15 on page 24.

6.3 Fastening

- When inserting the PMC into the processing optics, please make sure that the locking latch locks in place in the final position.
- When carrying out measurements outside processing optics, the PMC has to be securely fastened.



WARNING

Danger to eyes and skin by laser radiation.

If the stability of the device is not ensured, directed reflection of the laser radiation can occur.

- ▶ **Fasten the PMC outside of the processing head always by using the fastening threads in the housing.**
- ▶ **Please wear safety goggles adapted to the laser wave length and operating mode of the laser beam source in use and appropriate protective clothing.**

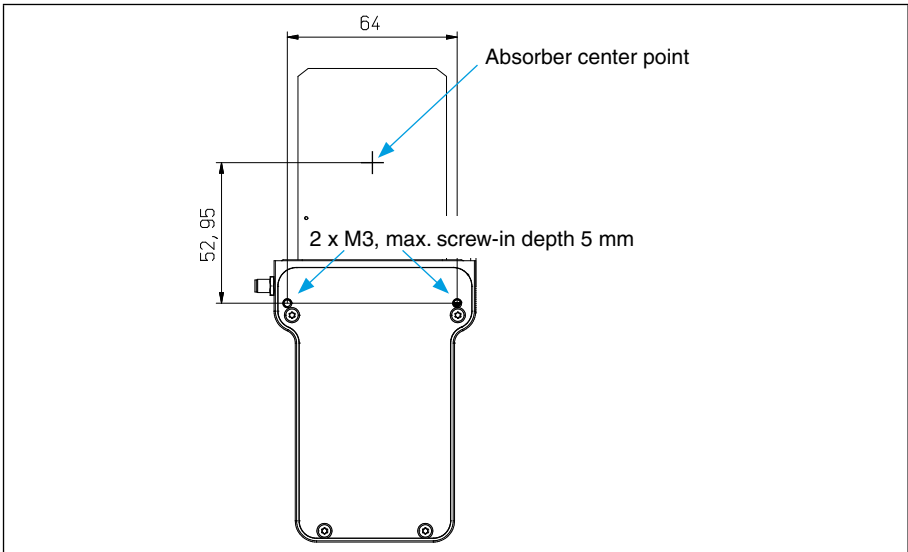


Fig. 6.1: Threads for fastening, view from below

The distance between the absorber center point and the mounting holes as well as the spacing of the holes from one another are the same for all PMC variants.

6.4 Alignment to the Laser Beam

If the PMC is not built into a processing optics, it has to be aligned to the laser beam. The laser should hit the absorber vertically and centrally. Please mind the values for beam diameter and power density given in Fig. 6.2). Normally, the PMC is positioned underneath the focus position of the beam path for power measurement (divergent laser radiation). If this is not possible, the PMC can be positioned above the focus. Please note, that in this case the laser radiation is convergent and the permissible power density on the absorber must not be exceeded (risk of overheating /destruction of the absorber).

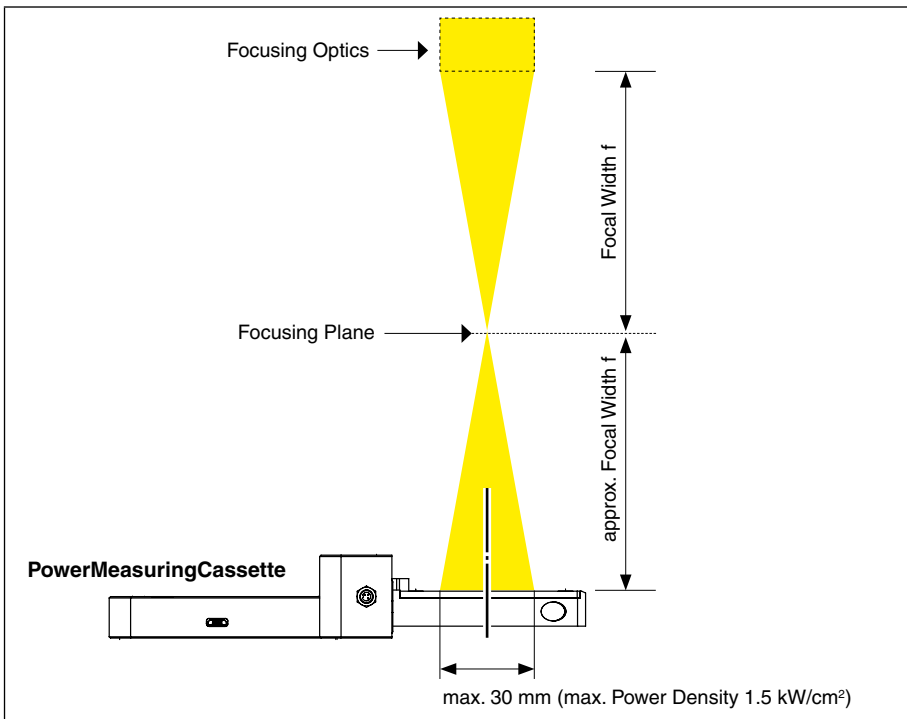


Fig. 6.2: Alignment to the laser beam (example for an BEO optics with an aperture $\varnothing = 50$ mm)

6.5 Removal from the Laser System

1. First of all the laser source has to be turned off.
2. Ensure that moving parts, e.g. robot arms, etc. are at a standstill and that they cannot be set in motion unintentionally.
3. Remove the interlock connection cable, press the locking latch and remove the device.

7 Connections

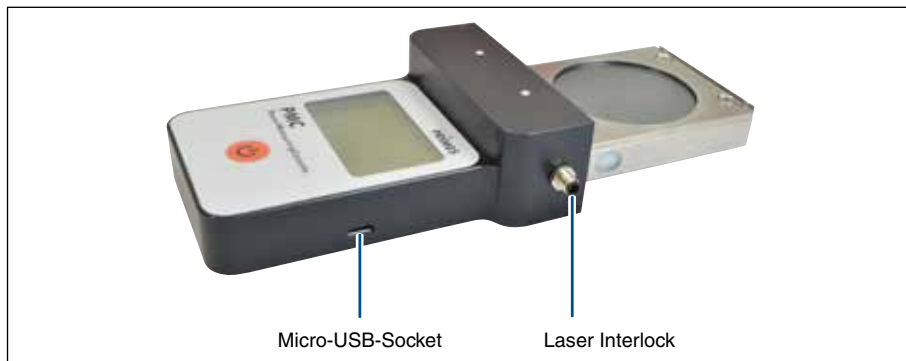


Fig. 7.1: Connections of the PMC

7.1 External Safety Circuit (Laser Interlock)

The external safety circuit protects the measuring device from damages caused by switching of the laser in case of an error.

If the absorber is still too hot, pin 3 and 4 are connected. If the absorber is ready for operation, pin 1 and 4 are connected.

NOTICE

Danger of damage

If the safety circuit is not connected, the device can be damaged or destroyed due to overheating.

- ▶ **When connecting the laser control, please ensure that the laser is turned off in case of an interruption of the connection.**

Pin Diagramm Device Plug (view: connector side)	Pin	Strand Color	Function
	4	Black	Mutual pin
	1	Brown	Connected with pin 4 when ready for operation
	3	Blue	Connected with pin 4 when in interlock mode (absorber too hot)

A suitable cable with a length of 2 m is included in the scope of delivery.


7.2 Micro-USB Socket

The lithium-ion battery of the device can be charged at the PC by means of the micro-USB socket. A suitable cable is included in the scope of delivery.

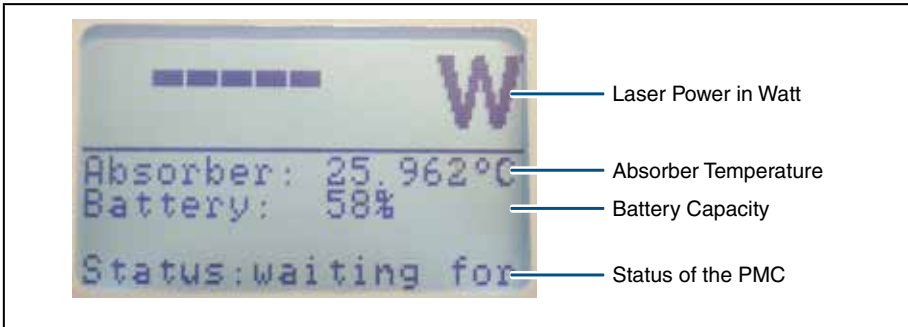
8 Control Elements

8.1 On-/Off Button

The on-/off button have several functions:

	Keystroke	Function
	5 seconds	Turn on/Turn off
	2 seconds	Show measuring values
	Repeated pushing for 2 seconds	Turn over measuring value display

9 Display



9.1 Status Messages

Status Message	Meaning
Waiting for laser beam	The PMC is ready for operation, the laser can be turned on.
Check temp.	Preparation for measurement, the temperature gradient is being checked. If it is too high, the device remains in the test status.
Thermalize	Thermalization is running.
Finished	The measurement is completed.

9.2 Warning Message

Warning Message	Reason
Interlock open	The absorber temperature has exceeded 100 °C. In order to protect the device, the safety circuit is open.



This warning message does not imply an error. The message is automatically reset as soon as the absorber temperature is below 100 °C again. Likewise, the safety circuit is then closed again.

9.3 Battery Capacity

The capacity of the rechargeable lithium-ion battery is displayed in percentage. The accuracy of this display is subject to various factors (such as, for example, the temperature, the battery condition, etc.). We therefore recommend charging the battery when 20 % are displayed. If the battery is fully discharged, the charging can take between 12 and 14 hours.

With a battery capacity of 100 %, the device has an operating time of approx. 10 hours (\triangleq approx. 100 measurements).

10 Software

An operation- and evaluation software for PCs (LDS) is currently being prepared. The following functions then can be executed via the LDS:

Function	Possible Settings
Measuring Mode	Manual / automatic operation (device automatically ensures readiness for operation after a completed measurement)
Power Saving Function	Constant lighting
	Contrast
	Switch off automatically
	Switch off time
	Switch-on only after the termination of a measurement or by at the push of a button
	Deactivate interlock

Tab. 10.1: Functions of the LDS

11 Measurement

NOTICE

Danger of Damage

The maximum permissible energy per laser pulse depends on the absorber mass and is various for the cassette versions. If this limit value is exceeded, the device can be damaged.

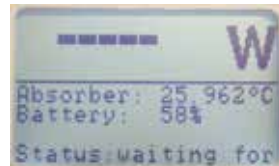
- ▶ Please notice the limit values and dependencies given in chapter 15.

11.1 Single Measurement

- ▶ Press the on/off button.

- 👁 The start menu appears.

After approx. 5 seconds, the PMC is ready for operation.



▶ Turn on the laser.

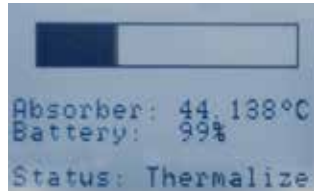
For a high measurement accuracy, we recommend an energy input of 400 J per measurement.

Example: With a laser power of 2 kW and an irradiation time of 200 ms, 400 J are absorbed.

$$E = P \cdot t = 2000 \text{ W} \cdot 0.2 \text{ s} = 400 \text{ J}$$

In this case, further measurements can be carried out. However, before carrying out further measurements, please mind the temperature limits for the absorber given in table Tab. 11.1 on page 20 .

👁 The thermalization is displayed by means of a progress bar (duration approx. 15 seconds).



👁 The measured power, the temperature, and the irradiation time are displayed.



The device turns off automatically after approx. 4 minutes. You can also turn off the device manually by keeping the on-/off button pressed for approx. 4 seconds.

11.2 Several Measurements in a Row

In case of subsequent measurements, the residual capacity of the absorber for another laser pulse has to be considered. The absorber temperature can serve as a good reference point:

Absorber Temperature in °C	Energy per Subsequent Pulse in J
< 80	400
< 60	1000
< 40	> 1000

Tab. 11.1: Absorber limit temperatures for subsequent measurements

If the absorber temperature is higher than 80 °C, no further measurement is possible. In this case, please wait until the temperature has reached the necessary value according to table Tab. 11.1.

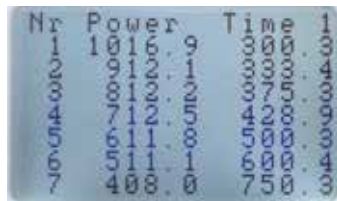
11.3 Measurement Storage

The PMC automatically saves the previous 63 measurements, which can be read out using the PRIMES LDS. The previous 14 measurements can also be displayed directly.

- ▶ Press the on-/off button for approx. 2 seconds.

👁 The measured values and the time are displayed.

- ▶ Press the on-/off button again for 2 seconds to have the remaining measuring values (no. 8-14) displayed.



12 Maintenance

We strongly recommend a regular service carried out by the manufacturer. The typical service interval is 12 to 18 months.

12.1 Exchanging the Protective Window



CAUTION

Risk of burns

After a measurement the absorber below the protective window is hot! Unintentional contact during the protective glass exchange could lead to burns.



Do not exchange the protective window directly after a measurement. Let the device cool down for an adequate period of time. In case of doubt, turn on the device, the current absorber temperature is displayed.

NOTICE

Danger of damage due to burn-in.

Pollution and finger prints on the protective window may lead to burn-in during the measurement operation.



When exchanging the protective window, always wear cotton- or powder-free latex gloves.

The protective window in the beam entrance is a wearing part and can be replaced if necessary. Low levels of contamination of the protective window can be carefully removed with alcohol. In case of heavy, non-removable contamination or damage, the protective window must be replaced with a new one.



When exchanging the protective window, only use original protective windows by PRIMES, as only these products guarantee a reliable operation.

PMC-BEO

Protective glass diameter	55 mm
Glass thickness	1.5 mm
Order number	410-070-021 (1 piece); 410-070-031 (10 pieces)

PMC-YW

Protective glass diameter	50 mm
Glass thickness	1.5 mm
Order number	410-030-002 (1 piece); 410-030-006 (10 pieces)

PMC-ALO

Protective glass diameter	55 mm
Glass thickness	1.0 mm
Order number	410-030-004 (1 piece); 410-030-005 (10 pieces)

13 Measures for the Product Disposal

Due to the Electrical and Electronic Equipment Act (“Elektro-G”) PRIMES is obliged to dispose PRIMES measuring devices manufactured after August, 2005, free of charge. PRIMES is a registered manufacturer in the German “Used Appliances Register“ (Elektro-Altgeräte-Register “EAR“) with the number WEEE-reg.-no. DE65549202.

Provided that you are located in the EU, you are welcome to send your PRIMES devices to the following address, where they will be disposed free of charge (this service does not include shipping costs):

PRIMES GmbH
Max-Planck-Str. 2
64319 Pfungstadt
Germany

14 Declaration of Conformity

Original EG Declaration of Conformity

The manufacturer: PRIMES GmbH, Max-Planck-Straße 2, 64319 Pfungstadt, Germany,
hereby declares that the device with the designation:

PowerMeasuringCassette (PMC)

Types: PMC-C; PMC-BEO; PMC-YW; PMC-ALO

is in conformity with the following relevant EC Directives:

- EMC Directive EMC 2014/30/EU
- Low voltage Directive 2014/35/EU
- Directive 2011/65/EC on the restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment
- Radio Equipment Directive 2014/53/EU

Authorized for the documentation:
PRIMES GmbH, Max-Planck-Straße 2, 64319 Pfungstadt, Germany

The manufacturer obligates himself to provide the national authority in charge with technical documents in response to a duly substantiated request within an adequate period of time.

Pfungstadt, April 26, 2017



Dr. Reinhard Kramer, CEO

15 Technical Data

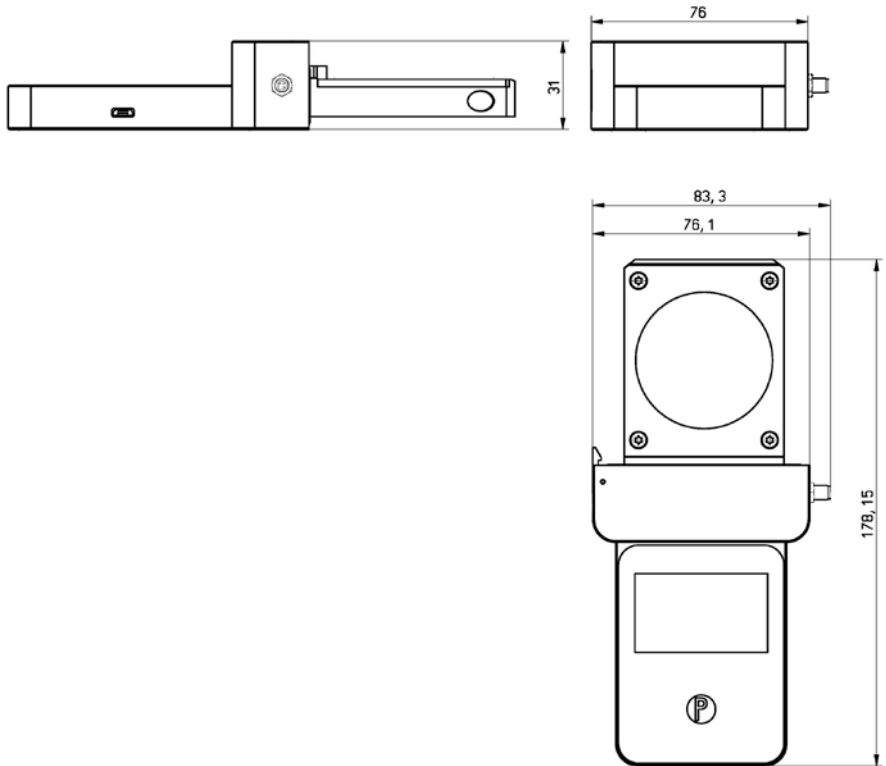
Measurement Parameters			PMC-BEO	PMC-YW	PMC-ALO
Max. beam diameter	mm		30		
Typical beam diameter	mm		15 ... 25		
Absorber diameter	mm		48		
Wavelength range	nm		900 ... 1090		
Power range	W		400 ... 8000 ¹⁾		
Max. power density (peak)					
at beam diameter	> 10 mm	kW/cm ²	1.5		
	10 mm – 3 mm	kW/cm ²	2.5		
	3 mm – 1.5 mm	kW/cm ²	5		
	1.5 mm – 1 mm	kW/cm ²	6		
	< 1 mm	kW/cm ²	8		
Irradiation time	s		0.1 ... 1 ¹⁾		
Irradiation and calculation	s		< 15		
Nominal measuring frequency at 400 J	Cycle/min		1		
Nominal measuring frequency at 3000 J	Cycle/15 min		1		
Absolute accuracy	%		±3		
Relative accuracy	%		±1		
Limit Values					
Max. absorber temperature	°C		120		
Min. energy per pulse	J		50	30	25
Max. energy per pulse	J		3000	2000	1500
Max. power density at the absorber	kW/cm ²		1.5		
Min. laser rise time	µs		100		
Max. incident angle	Degree		±3		
Environmental Conditions					
Operating temperature range	°C		+15 ... +40		
Storage temperature range	°C		+5 ... +50		
Reference temperature	°C		+22		
Permissible relative humidity, non condensing	%		10 ... 80		

¹⁾ The stated limit values are to be understood in correlation with the permitted maximum energy ($E = P \cdot t$).

Dimensions and Weights		PMC-BEO	PMC-YW	PMC-ALO
L x W x H (without cables and connectors)	mm	179 x 84 x 31	171 x 84 x 24	177 x 84 x 24
Weight, approx.	g	460	280	280

16 Dimensions

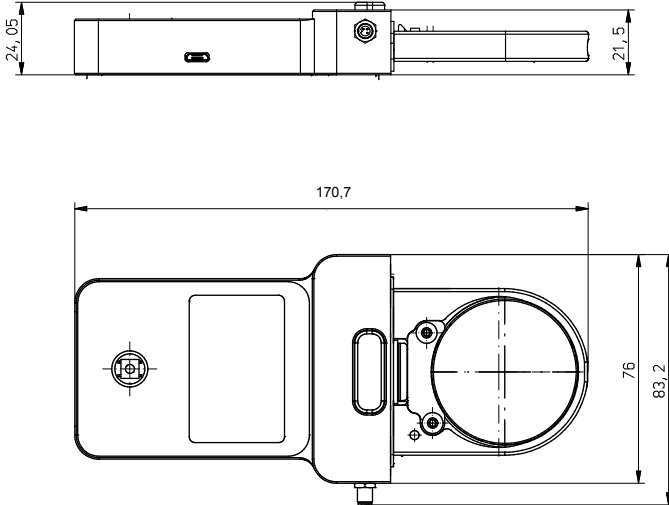
16.1 PMC-BEO



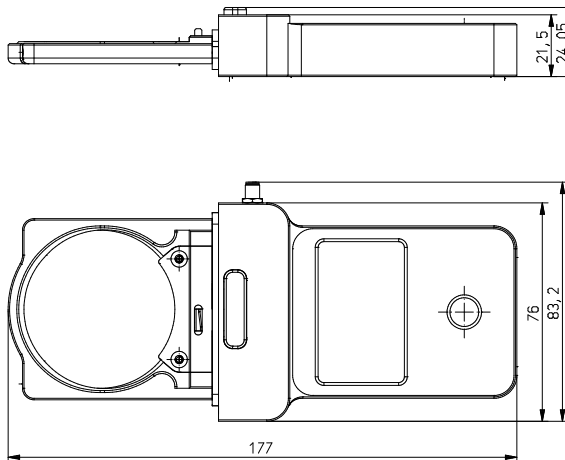
All dimensions given in mm.

PowerMeasuringCassette PMC

16.2 PMC-YW



16.3 PMC-ALO



All dimensions given in mm.

