

Operating Manual

Translation of the Original Instructions



Cube

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1 Basic Safety Instructions

Intended Use

The Cube is exclusively intended for laser power measurements in the optical path of high power lasers. Please mind and adhere to the specifications and limit values given in chapter „15 Technical Data“ on page 26. 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 in this operating manual.

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 Cube itself does not emit any laser radiation. During the measurement, however, the laser beam is guided on the device which causes scattered radiation (**laser class 4**). 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 Cube 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 Cube 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 symbol to indicate requirements:



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 Cube 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 Cube. This also applies to high environmental dust exposure.

In industrial environments erroneous measurements may be triggered by strong electromagnetic fields. In this case we recommend EMC compliant shielding of the interlock cable.

4 System Description

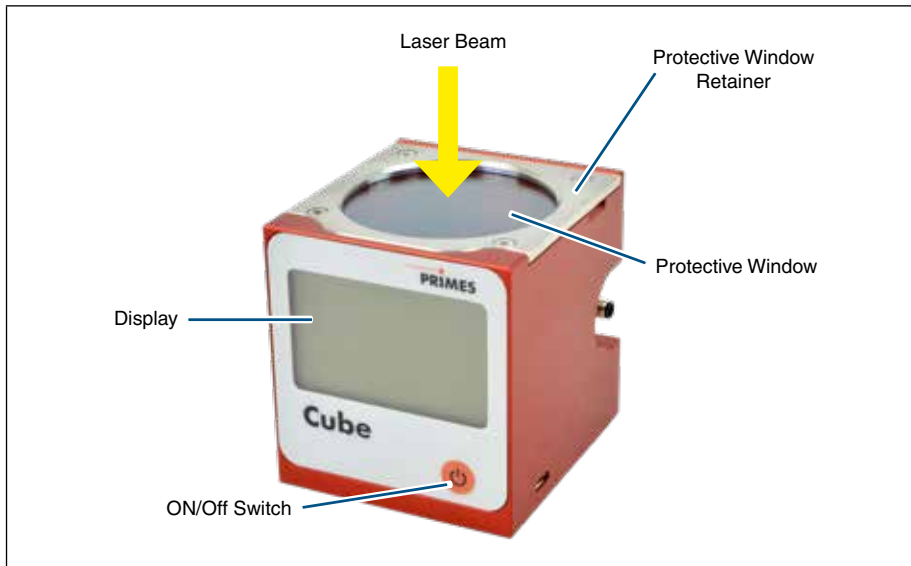


Fig. 4.1: Mechanical assembly of the Cube, cross section

4.1 Measuring Principles

The Cube 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 physical properties 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! Only transport the Cube in its original packaging.**
-

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. By means of, for example, a pilot laser the Cube has to be aligned in the beam path of the laser in a way that ensures that the laser hits the aperture centrally.
4. Fasten the Cube in this position and ensure that it is immovable (see chapter 6.5 on page 13).
5. Connect the interlock connection with the laser control.

6.2 Mounting Position

The Cube is designed for both a horizontal and vertical beam incidence. Please observe the dimensions of the beam diameter and power density depicted in Fig. 6.1 on page 11.

Normally, the Cube is positioned underneath the focus position of the beam path for power measurement (divergent laser radiation). If this is not possible, the cube 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).

6.3 Alignment to the Laser Beam

Depending on the mounting position, the laser beam should hit the absorber vertically/ horizontally and centrally. Please observe that the limit values for the beam diameter, the power and the power density given in the technical data (see chapter 15 on page 26) must not be exceeded.

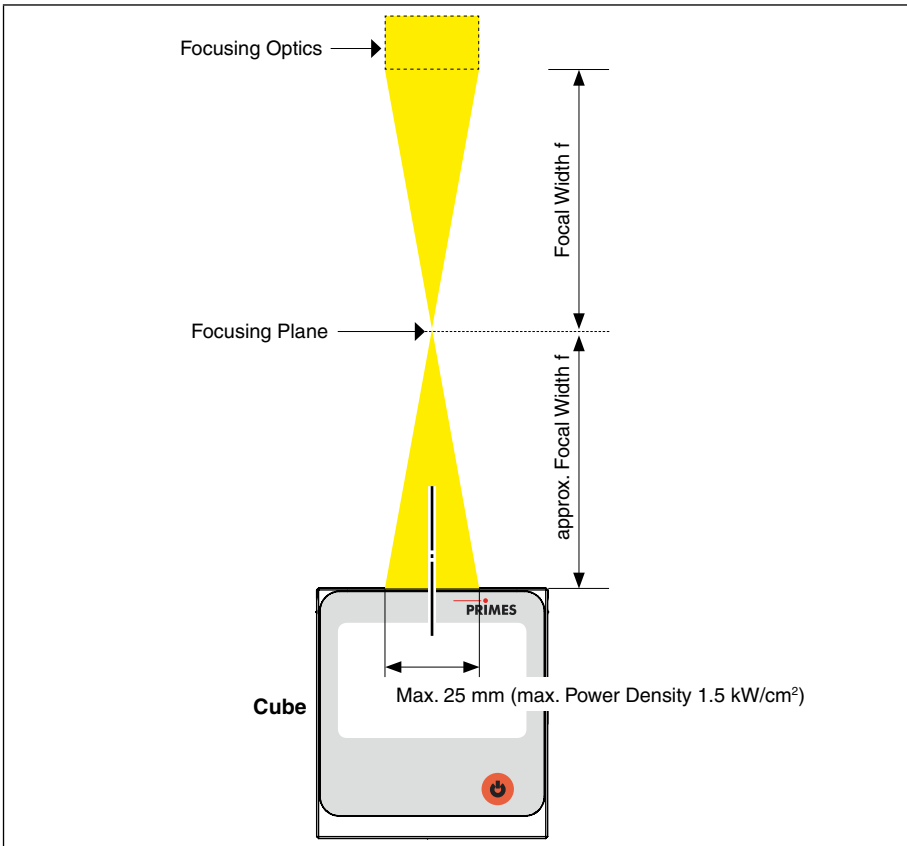


Fig. 6.1: Alignment to the laser beam (example for an optics with an aperture $\varnothing = 50$ mm)

6.4 Laser Parameter Setting

The applicable measurement time is between 0.1 s and 2.0 s, which has to be transferred to the laser controller as pulse on time. The maximum laser rise time for the power measurement is $< 100 \mu\text{s}$. This limit has to be adhered to in order to avoid incorrect results of the power measurement.

Some laser beam sources are factory set with power ramps of up to a few 100 ms to switch on the laser beam. To achieve the correct power values the shortest possible rise time ($< 100 \mu\text{s}$) has to be set.

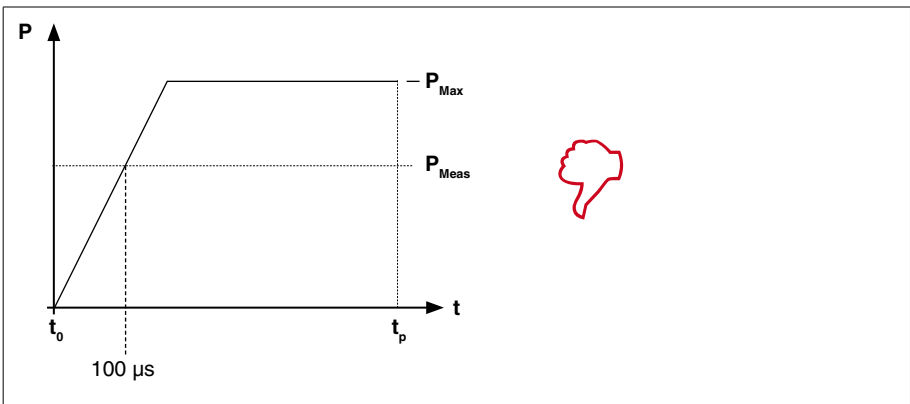


Fig. 6.2: Laser rise time $> 100 \mu\text{s}$

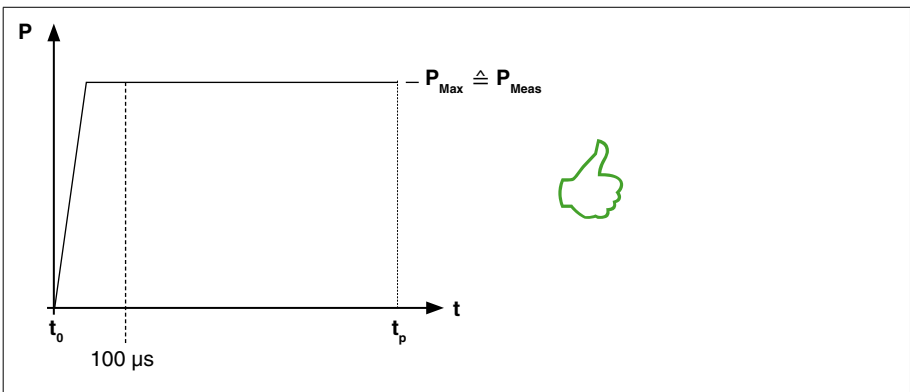


Fig. 6.3: Laser rise time $< 100 \mu\text{s}$

Cube

6.5 Fastening



WARNING

Danger to eyes and skin due to laser radiation

If the stability of the device is not ensured, reflections can cause directional laser radiation.

- ▶ **Fasten the Cube in a way that ensures, that the device can not shift or fall over during the measuring operation.**

The Cube has to be safely retained after the alignment to the laser beam. For this purpose there are three threaded holes in the housing (see Fig. 6.4).

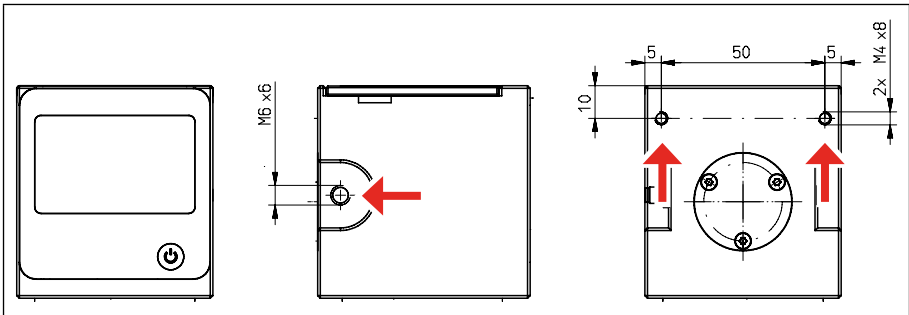


Fig. 6.4: Mounting threads in the Cube housing

6.6 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 and remove the device.
4. Place the **cooled down** Cube in the included transportation bag and close it.

7 Connections

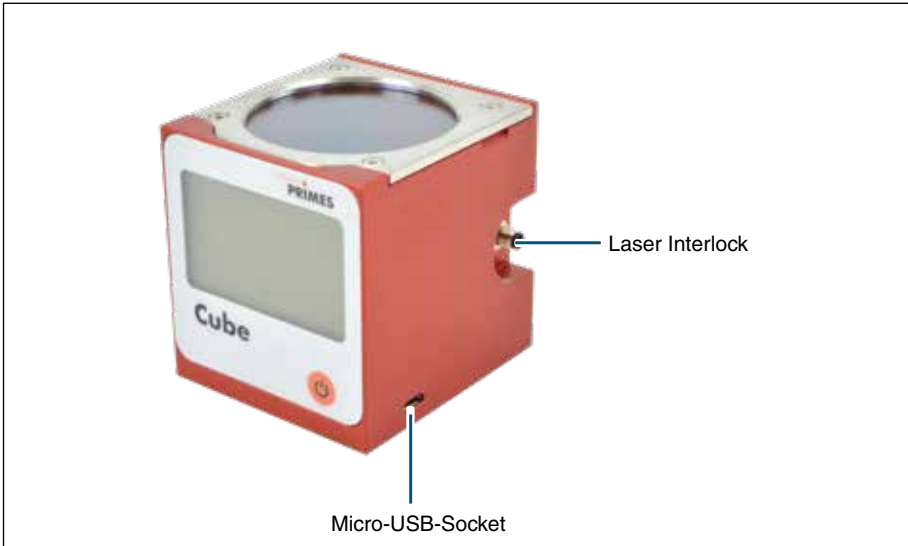


Fig. 7.1: Connections of the Cube

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.

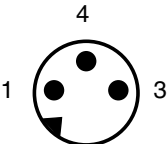
NOTICE

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.**

Cube

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)

Tab. 7.1: Pin assignment interlock plug

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 also be charged at the PC by means of the micro-USB socket. A suitable cable is included in the scope of delivery.

7.3 Bluetooth


A class 1 Bluetooth interface was integrated in the Cube. This enables a wireless connection with the PC or the smart phone. In case of a connection with a PC with a Bluetooth stick class 1 the reach is approximately 250 m. After switching on the device, the Bluetooth connection is permanently active.

The Cube can be controlled entirely via the Bluetooth connection, and it is also possible to transmit the measuring values. When the Bluetooth connection is activated, the USB interface is deactivated.

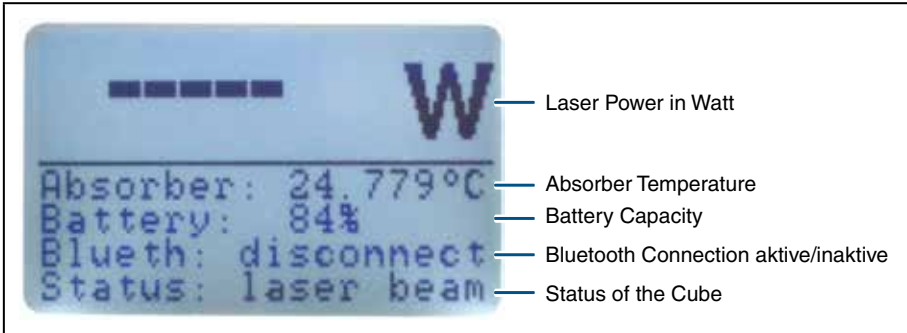
8 Control Elements

8.1 On-/Off Button

The on-/off button has two 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 Cube 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. 6 hours. When using all power saving functions (see Tab. 10.1) approx. 15 hours.

10 Software

The software “PRIMES Cube App” for Android mobile devices is available in the Google Play Store/Tools. The cube is operated with this App via the Bluetooth interface. An operation- and evaluation software for PCs (LaserDiagnosticsSoftware, LDS) is currently being prepared and will be optionally available.

The following functions can be executed via the PRIMES Cube App:

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 the PRIMES Cube App

11 Measurement**NOTICE****Danger of Damage**

The maximum admissible energy per laser pulse is 3000 J. If this limit value is exceeded, the device can be destroyed.

- ▶ Please mind the limit values and dependencies given in chapter 15 on page 26.
-

**CAUTION**

Risk of injury from broken glass.



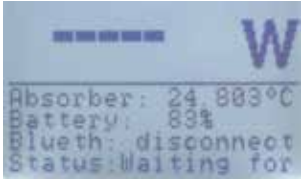
A contaminated protective window can be destroyed during measurement.

- ▶ **Regularly check the condition of the protective window and exchange it in case of pollution (see chapter 12.1 on page 22).**
-



When it comes to pulsed laser radiation a correct exposure time measurement up to a pulse frequency of 1 kHz and a duty cycle of 50 % is possible. In case of on/off times shorter than 500 μ s a correct exposure time measurement is not possible. However, the irradiated energy is still measured correctly.

11.1 Single Measurement

<p>▶ Press the on/off button.</p>	
<p>👁 The start menu appears.</p> <p>After approx. 5 seconds, the Cube is ready for operation.</p>	 
<p>▶ Turn on the laser.</p>	<p>For a high measurement accuracy, we recommend an energy input of 400 J per measurement.</p> <p>Example: With a laser power of 2 kW and an irradiation time of 200 ms, 400 J are absorbed.</p> <p>$E = P \cdot t = 2000 \text{ W} \cdot 0.2 \text{ s} = 400 \text{ J}$</p> <p>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.</p>

👁 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. The shutdown time can be set using the LDS or the Cube App. The preset value is 4 minutes.

You can also turn off the device manually by keeping the on-/off button pressed for approx. 5 seconds.

11.2 Several Measurements in a Row



Always start a measurement series with the smallest power and increase it gradually. Small amounts of energy should be measured with absorber temperatures that are close to the ambient temperature.

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	Max. Energy per Subsequent Pulse in J
< 80	400
< 60	1000
< 40	1000 ... 3000

Tab. 11.1: Absorber limit temperatures for subsequent measurements

Cube

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.

In general: The minimum amount of irradiated energy should approximately equal twenty times the difference between the absorber temperature and the ambient temperature. However, 20 Joule can be considered the absolute minimum.

See also the diagram in the appendix (chapter 17 on page 30).

11.3 Measurement Storage

The Cube automatically saves the previous 63 measurements, which can be read out using the PRIMES Cube App for Android mobile devices. 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 and Service

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

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 from the with alcohol (please observe the manufacturer's safety instructions) when the device is cooled down. In case of heavy, non-removable contamination or damage, the protective window must be replaced with a new one.



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 retainer of the protective window is held by four screws (Torx T8) in the housing.

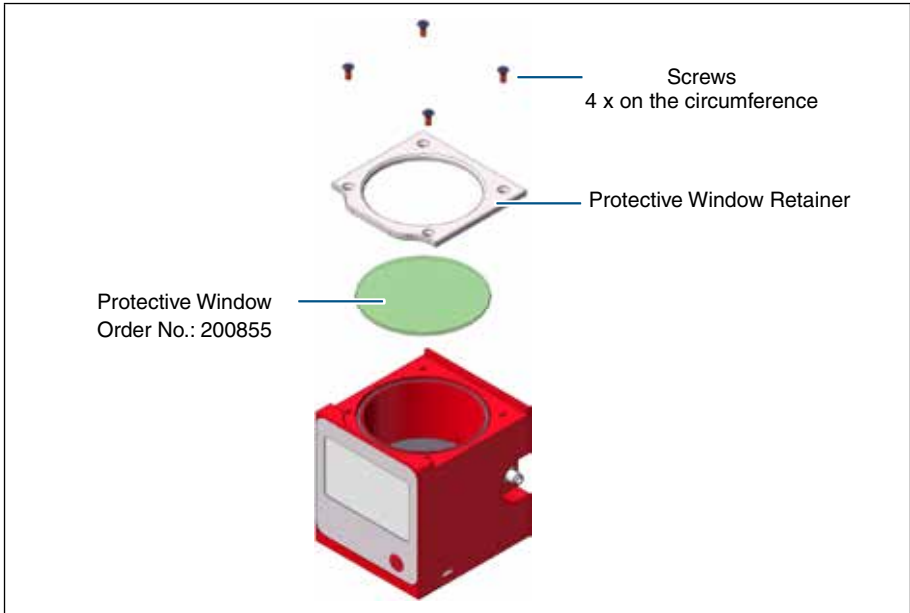


Fig. 12.1: Removing the protective window retainer

1. Keep the Cube horizontally so that the protective window does not fall out.
2. Remove the screws of the protective window retainer.
3. Take off the protective window retainer.
4. Exchange the protective window. Ensure that the new protective window is not polluted in any way.



WARNING

Danger to eyes and skin due to laser radiation.

If the protective window is not correctly positioned, reflections can cause directional laser radiation.

- ▶ **Ensure that the new protective window is positioned evenly in the indentation on the sealing ring.**

5. Put the protective window retainer back on, make sure that it is positioned correctly, insert the screws and tighten them.

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:

Cube

Types: Cube; Cube M

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

A handwritten signature in blue ink, appearing to read "RK 5", written over a horizontal line.

Dr. Reinhard Kramer, CEO

15 Technical Data

Measurement Parameters			
Max. beam diameter	mm	30	
Typical beam diameter	mm	15 ... 25	
Absorber diameter	mm	49	
Wavelength range	nm	900 ... 1090	
Power range	W	25 ... 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 ... 2 ¹⁾	
Irradiation and calculation	s	< 15	
Nominal measuring frequency at 300 J	Cycle/min	1	
Nominal measuring frequency at 3000 J	Cycle/15 min	1	
Absolute accuracy	%	±3	
Relative accuracy	%	±1	
Beam incidence perpendicular to the inlet aperture	Degrees	±10	
Limit Values			
Max. absorber temperature	°C	120	
Min. energy per pulse	J	50	
Max. energy per pulse	J	3000	
Recommended energy per pulse	J	300 ... 500	
Max. power density at the absorber	kW/cm ²	1.5	
Max. laser rise time	µs	100	
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	

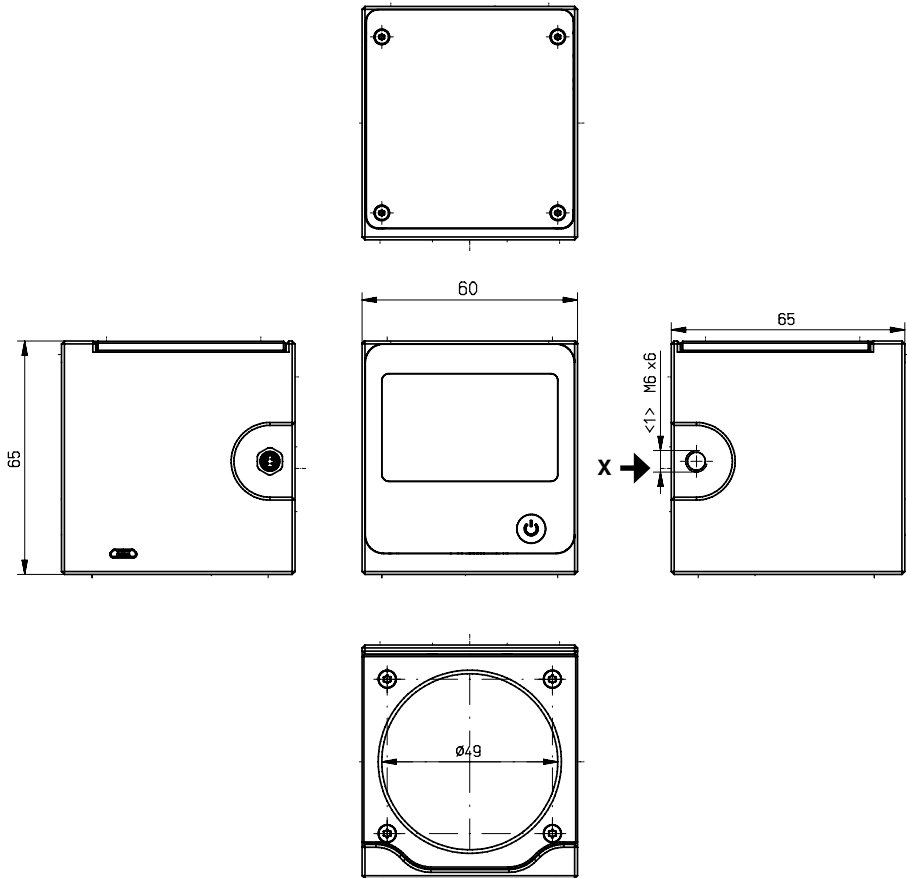
¹⁾ The given limit values must not be exceeded.

Cube

Technical Data (continued)

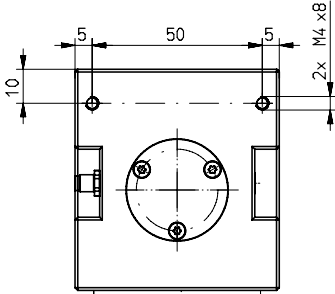
Dimensions and Weights		
L x W x H (without cables and connectors)	mm	60 x 65 x 65
Weight, approx.	g	400

16 Dimensions

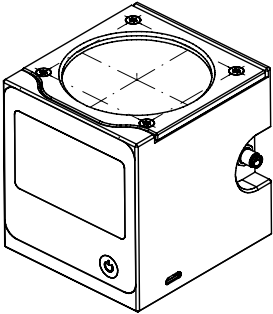


All dimensions given in mm.

View X



3 D-View



17 Appendix

Cube Measuring Range as a Function of the Absorber Temperature

