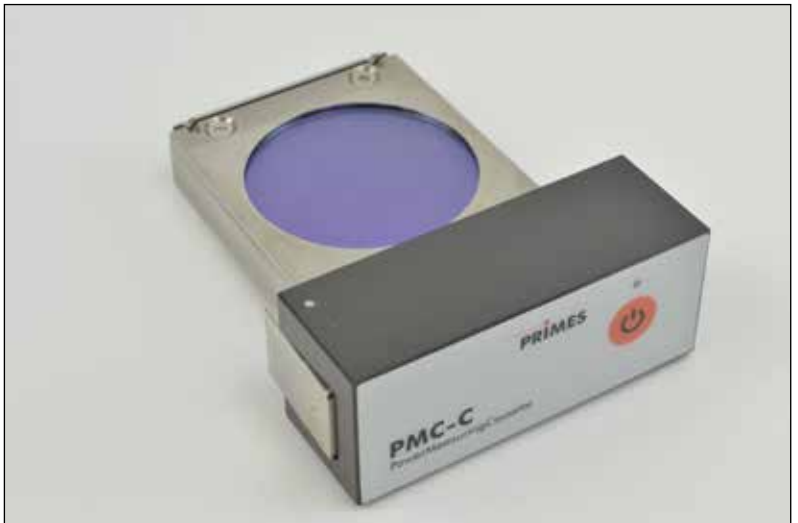


## Operating Manual

Translation of the Original Instructions



## Power Measuring Cassette PMC-C



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## 1 Basic Safety Instructions

### Intended Use

The PowerMeasuringCassette (PMC-C) is exclusively intended for laser power measurements which are carried out in or nearby the optical path of high power lasers. The PMC-C is used instead of the protective glass cassette in the laser processing head. 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 (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 PMC-C 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-C 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-C 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-C. This also applies to high environmental dust exposure.

### 4 System Description

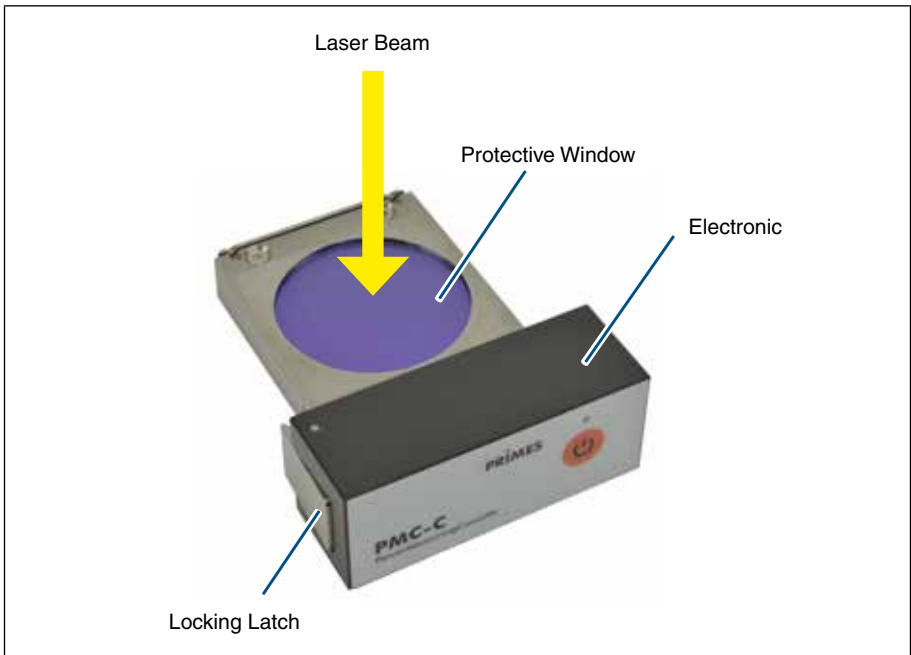


Fig. 4.1: Mechanical assembly of the PMC-C

The PowerMeasuringCassette-Compact is intended for power measurements of solid-state lasers for a direct integration into the laser processing head (type BEO).

## 4.1 Measuring Principles

The PMC-C 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.

## 4.2 Function

The PMC-C does not feature a screen for displaying measurements. Operation requires a smartphone or tablet with Android OS (refer to chapter 12 on page 14). The operating software (PRIMES Cube App) for Android mobile devices is available in the Google Play-Store/Tools. The PMC-C must be connected to this device using Bluetooth interface.

## 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 Window Cassette from the processing head, making sure to keep the glass safe from any contaminants.
4. Remove the protective foil from the protective window of the PMC-C.
5. Insert the PMC-C into the slot of the processing optics until the locking latch locks in place.

### **6.2 Mounting Position**

The PMC-C is mainly used in BEO processing optics. Here, the mounting position is stipulated.

### **6.3 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. Press the locking latch and remove the device.
4. Apply the protective foil to safeguard the PMC-C against contamination.
5. Insert the Protective Window Cassette back into the processing head.

## 7 Connections

### 7.1 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.

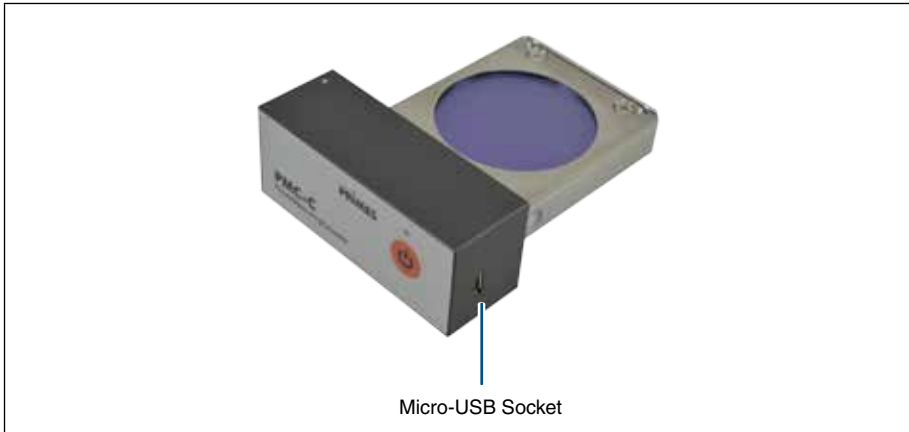



Fig. 7.1: Micro-USB connection

## 8 Control Elements

### 8.1 On-/Off Button

	Keystroke	Function
	5 seconds	Turn on/Turn off

Power up is indicated by a flashing LED above the power button. The LED will go out when the PMC-C is switched off.

## 9 LED Display

The display is a multi-color LED and indicates different operating states.

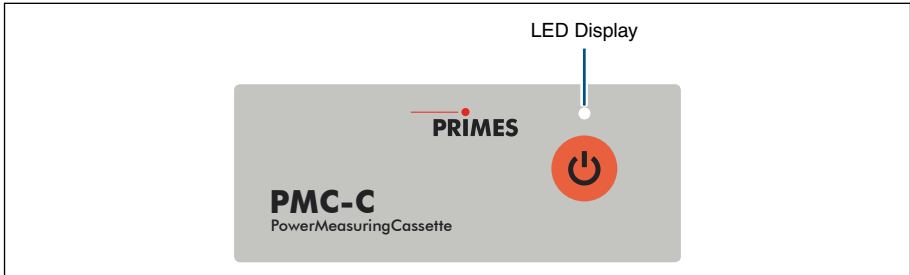


Fig. 9.1: LED Display

LED Color	Meaning
Blue	Ready for operation (after booting)
Green	Waiting for Laser
Yellow	Thermalization
White	Measurement finished
Red	Error (configuration)

## 10 Battery Capacity

The capacity of the rechargeable lithium-ion battery is displayed in percentage in the Cube App. 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 (≙ approx. 100 measurements).

## **11 Operation**

The PMC-C is controlled through an Android OS Device using the corresponding application. The operating software (PRIMES Cube App) is available in the Google Play-Store/Tools.

An operation- and evaluation software for PCs (LDS 3.0) is currently being prepared.

## **12 PRIMES Cube App**

### **12.1 Application**

PRIMES Cube App is a mobile app for Smartphones and Tablets running on Android Operating Systems.

In measuring mode, the app will display the following information:

- Current readings (Power, pulse duration, energy)
- Device status (current temperature, remaining capacity, battery capacity)

Besides the graphic representation and recording of the readings, you can use your smartphone or tablet to define parameters for entire sets of tests and then transmit them to the device via Bluetooth. PMC-C will then run using these parameters.

### **12.2 System Requirements**

PRIMES Cube App will run on smartphones and tablets using Android OS 4.1 as well as having a screen-resolution of HVGA 320x480 or higher.

### **12.3 Download**

PRIMES Cube App is freely available from the Google Play Store and can be downloaded to any Android device free of charge. Only a valid Google account is required. The app can be quickly found using the following search terms: "Primes cube", "Primes laser", "Laser power meter".




## **12.4 Installation**

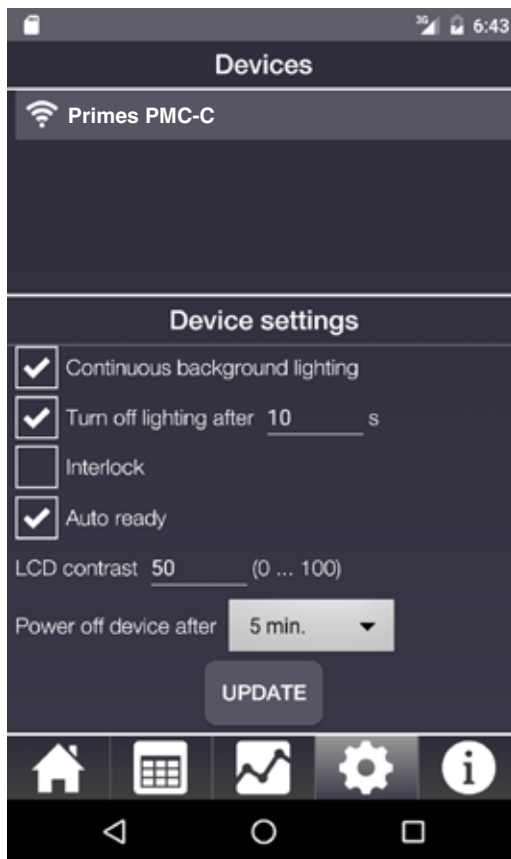
Installation of the app varies depending on the specific mobile device. Please consult your mobile device's operating manual for instructions.

## **12.5 Deinstallation**

Deinstallation of the app varies depending on the specific mobile device. Please consult your mobile device's operating manual for instructions.

## 12.6 Connecting to PMC-C

After launching PRIMES Cube App, a screen titled “Devices” will appear on screen. Press the button **Start device Search**. Any devices found will be displayed on screen. Choose the correct Device to establish a connection and reply to the query with **OK**. After successfully connecting to the device, a connected-icon  will appear on the left next to the device name. Device-settings will also be activated now (additional information can be found in Chapter „12.11.4 Devices“ on page 25).





### 12.7 Composition of the Graphic User Interface

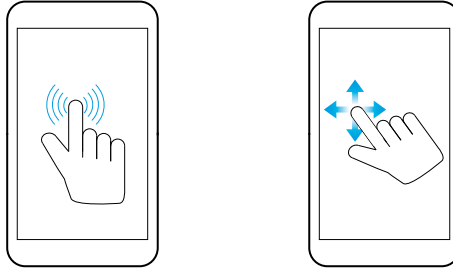


The Graphic User Interface consists of the following pages: :

- Measuring Operation
- Measurement Selection
- Evaluation
- Devices/Settings
- Information

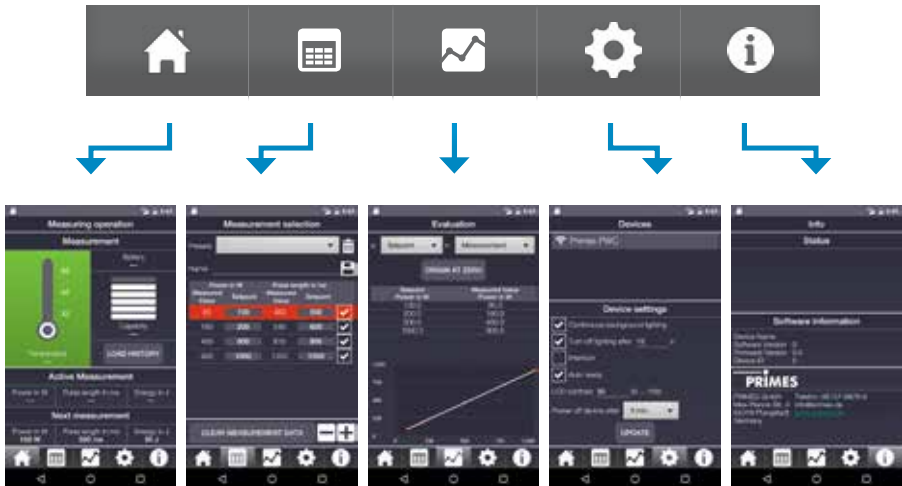
### 12.8 Operation

As is normal for mobile devices, PRIMES Cube App can be operated by tapping and swiping the device screen.













### 12.9 Navigation

Quick access to the individual pages is available through the navigation bar. By tapping the Symbols on the bar, the corresponding pages can be opened. You can also browse the pages by swiping horizontally across the Navigation bar. Depending on the size of your devices' screen, it may be possible to display two pages side-by-side.



## 12.10 Icons

Icon	Function
	Measuring Operation
	Measurement Selection – choosing data to save or delete
	Evaluation, graphical display of set and measured values
	Device settings
	Software Information and Status
	The Page “Software Information” contains a status update
	Bluetooth-link to device is active
	Save File
	Delete presettings
	Check box for activating/deactivating of a function

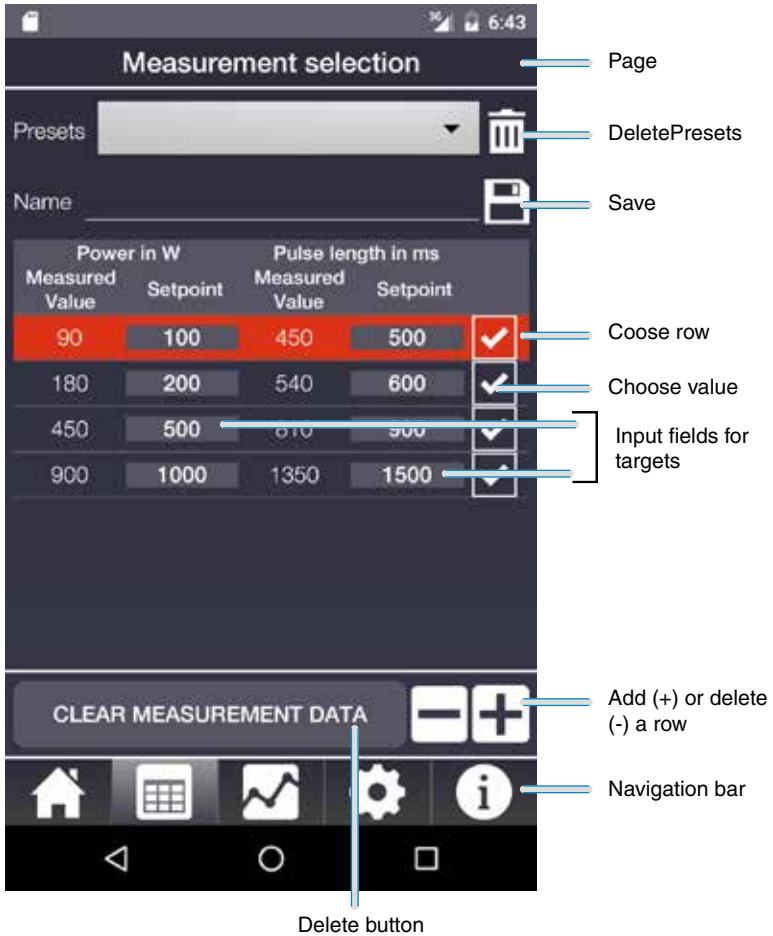
### 12.11 Pages

#### 12.11.1 Measurement Operation



### 12.11.2 Measurement Selection

The targets and actual values from the Measurement Operation Screen can be listed here in a table. Result tables can be edited and then saved under a name of your choosing. Preconditions from earlier can also be loaded or deleted.



The delete button deletes the entire table.

Targets for Power and Pulse Duration can be entered into the table. Targets for the next Measurement will then be displayed on **Measuring Operation**.

After measurement, the real values for Power and Pulse Duration will be displayed in the table as measured data.

If a set of values should be ignored in the graphic representation, the control box in the corresponding row needs to be unchecked.

The Button **Clear Measurement Data** will delete all values in the table, if pressed.

Upon tapping the “Setpoint” window, a NumPad will open. Enter the setpoint value on the pad and confirm with “OK”.

In order to ...	Action
... select a row	Tap on a value (the row will be marked red).
... add a row	Tap (+).
... delete a row	Select a row (it will be marked red) and tap (-).
... add a row in a specific place	Tap a value in the intended row and tap (+). A new row will be appear beneath the selected row.
... enter a target value	Tap a setpoint field (NumPad will appear) and enter the intended target value. Confirm with OK.

If none of the rows are selected, +/- will either add a row at the bottom or delete the last row.

### 12.11.3 Evaluation

This page will display the selected Values or all values graphically. The x-axis displays the target values, the y-axis the actual results. If no targets have been entered, the real values will automatically also be input into the target list.

Both axes can display either Power, Pulse Duration or Energy. The y-axis can also display standard deviation ( $\sigma$ ) between the target and real values.





If the minimal values are displayed in the upper part of the graph, they can be shifted with using the button ***Origin at Zero*** to improve readability.

---



12.11.4 Devices

The lower half of the page allows for various changes to device settings, most of them with the aim of conserving power.




Function	Possible Settings
Measuring Mode	Manual / automatic operation (device automatically ensures readiness for operation after a completed measurement)

Function	Possible Settings
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

The **Update** Button must be pressed after any change in device settings in order to execute the change.

### 12.11.5 Info

The **Info** Page offers information on the device software and the address of the manufacturer. The **Status** bar will display notifications, most of which are intended to prevent false measurements.

Regardless of which page is currently open, the navigation bar will always announce a Notification by adding an exclamation mark to the Info Icon . Simultaneously, the

Temperature-display on the Measurement Operation page will be marked red.



Status Message	Action
The temperature gradient is too high for the pre-set measurement. The absorber must cool down further.	Let the PMC-C cool down.
The measured energy is less than the minimum energy required	Increase the laser power.
The preset pulse length is greater than 2 s, which will lead to an invalid measurement result.	Minimize the pulse duration.
The current absorber temperature is above 70°C. It is not advised to conduct a further measurement.	Let the PMC-C cool down.

## 13 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 chapters 16 on page 33 and 18 on page 35.



### CAUTION

Risk of injury from broken glass.

A contaminated protective window can be destroyed during measurement.

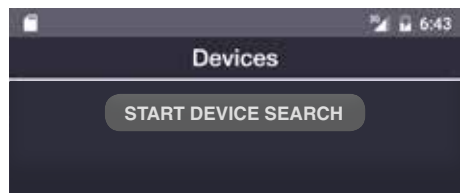
- ▶ Regularly check the condition of the protective window and exchange it in case of pollution (see chapter 14.1 on page 31).

### 13.1 Preparing for Measurement

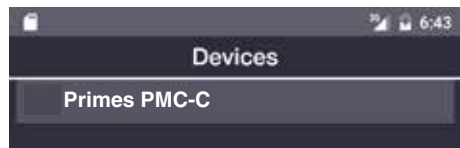
- ▶ Tap the Cube Icon to launch the app.


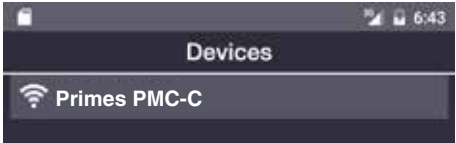


- ▶ The “Devices” Page will be displayed. Tap the **Start Device Search** Button.



- 👁 Any discovered devices will now be displayed here.



<ul style="list-style-type: none"> <li>▶ Tap the name of the intended device and confirm with <b>OK</b></li> <li>👁 Bluetooth link to the device will be displayed </li> </ul>	
<ul style="list-style-type: none"> <li>▶ Change device settings as needed and tap <b>Update</b>.</li> </ul>	
<ul style="list-style-type: none"> <li>▶ Switch to <b>Measurement Operation</b>.</li> </ul>	
<ul style="list-style-type: none"> <li>▶ Under <b>Next Measurement</b>, enter target power and pulse duration</li> </ul>	
<ul style="list-style-type: none"> <li>▶ Adjust the laser to conform to target power and pulse duration</li> </ul>	<p>Note: Neither the PMC-C nor the PRIMES Cube App will transmit any data to the laser!</p>

## 13.2 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. 13.1: 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. 13.1.

## 14 Maintenance

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

### 14.1 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.**

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

## 15 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



## 16 Technical Data

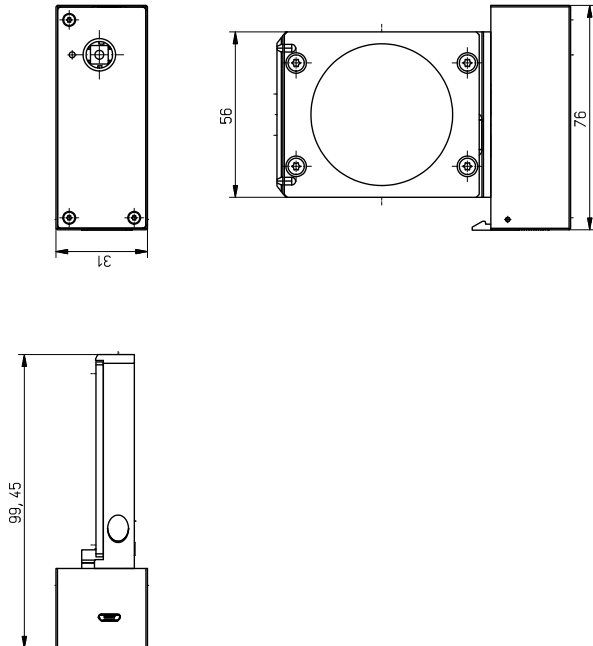
<b>Measurement Parameters</b>			
Max. beam diameter	mm	30	
Typical beam diameter	mm	15 ... 25	
Absorber diameter	mm	48	
Wavelength range	nm	900 ... 1090	
Power range	W	400 ... 8000 <sup>1)</sup>	
Max. power density (peak) at beam diameter	> 10 mm	kW/ cm <sup>2</sup>	1.5
	10 mm – 3 mm	kW/ cm <sup>2</sup>	2.5
	3 mm – 1.5 mm	kW/ cm <sup>2</sup>	5
	1.5 mm – 1 mm	kW/ cm <sup>2</sup>	6
	< 1 mm	kW/ cm <sup>2</sup>	8
Irradiation time	s	0.1 ... 1 <sup>1)</sup>	
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	
<b>Limit Values</b>			
Max. absorber temperature	°C	120	
Min. energy per pulse	J	50	
Max. energy per pulse	J	3000	
Max. power density at the absorber	kW/ cm <sup>2</sup>	1.5	
Max. laser rise time	µs	100	
<b>Supply Voltage</b>			
Lithium-Ion Battery, rechargeable			
Voltage	V	3.7	
Capacity	mAh	420	

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

### Technical Data (continued)

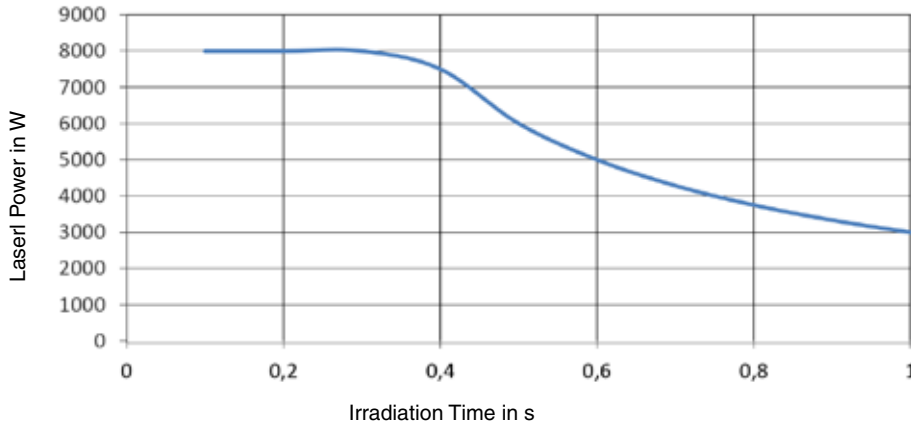
Environmental Conditions		
Operating temperature range	°C	+10 ... +40
Storage temperature range	°C	+5 ... +50
Reference temperature	°C	+22
Permissible relative humidity, non condensing	%	10 ... 80
Dimensions and Weights		
L x W x H (without cables and connectors)	mm	100 x 76 x 31
Weight, approx.	g	350

## 17 Dimensions



## 18 Appendix

### 18.1 Max. Laser Power per Puls Depending on the Irradiation Time



### 18.2 Max. Laser Power per Pulse Depending on the Beam Diameter

