

# Operating Manual

Translation of the Original Instructions



## PocketMonitor



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## 1 Basic Safety Instructions

### Intended Use

The PocketMonitor (PMT) is exclusively intended for 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 (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 PMT 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 PMT 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 indicate possible residual risks:



### **DANGER**

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

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### **WARNING**

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

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### **CAUTION**

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

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### **NOTICE**

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

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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:**

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Here you can find useful information and helpful hints.

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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 measuring device must only be operated in a non condensing atmosphere.

### 4 System Description

The PocketMonitor consists of an absorber and a display as well as an operating unit. Both components are connected via a swivel joint. In a folded state, the absorber protects the display as well as the operating elements from damages of any kind.

For the measurement, the absorber is exposed to laser radiation. The microprocessor based electronics measures the temperature rise of the absorber by means of which the power of the laser beam is calculated.

The 4½ digit display either shows the measured laser power or the temperature of the absorber.

A lithium cell supplies the PocketMonitor with current for approx. 10,000 measurements.

Depending on the different power ranges, six different absorber versions are available. The special version has a separate absorber.

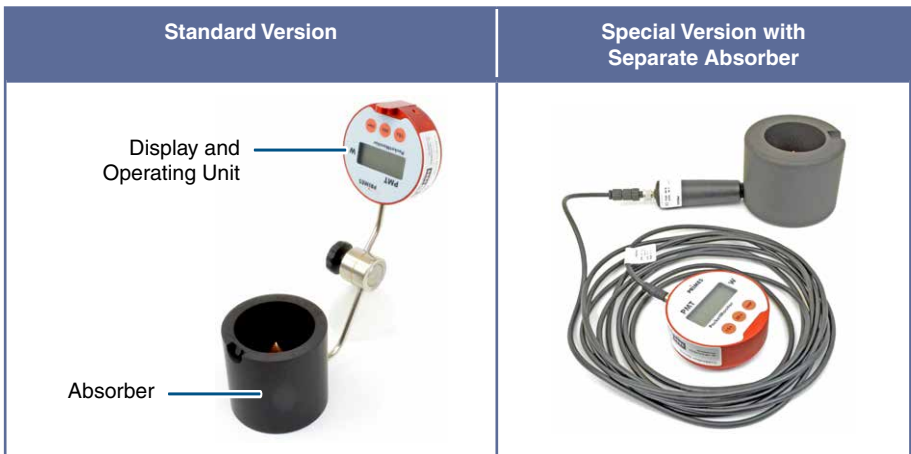


Fig. 4.1: Mechanical Structure of the PocketMonitor

#### **4.1 Measuring Principle**

The laser power is measured according to the calorimetric principle. For the ballistic measurement, the absorber is irradiated with the laser for a defined period of time. By means of the known heat capacity, the measured temperature rise of the absorber and the set irradiation time, the power can be measured.

## **5 Transportation**

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### ***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! If possible, please use the PRIMES transport box for the transportation.**
-

### 6 Assembly

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#### **WARNING**

##### **Danger of injuries**

**An improper assembly by inexperienced personnel can lead to material damages or even personal injuries.**

- ▶ **Read and strictly observe the safety instructions in chapter „1 Basic Safety Instructions“ on page 5.**
- 

#### 6.1 Assembly Position

The PocketMonitor can be assembled in any position. However, the absorber has to be thermally insulated in order to ensure that no heat can dissipate, and the measuring result is not distorted.

#### 6.2 Integration into a Laser System

1. First, the laser source has to be turned **off**.
2. Ensure that all moving parts, e.g. robot arms etc., must be at a standstill, and that they cannot be set in motion unintentionally.
3. **Stability:** When mounting the device, please ensure that a relative movement towards the beam axis is prevented which in turn reduces the risk of scattered radiation.



#### **WARNING**

##### **Danger of injuries**

**If the measuring device is moved out of the measured position, scattered radiation is increasingly caused during the measurement operation.**

- ▶ **When mounting the device, please ensure that it cannot be moved by unintentional impacts or vibrations.**
-

4. Heat insulation: When assembling the device, please ensure that no absorber heat is lost during the measurement. Otherwise, the display values are too low. Put heat insulating and temperature resistant material underneath the device.
5. The absorber has to be placed in the center of the raw beam. Please ensure a vertical beam incidence. If existent, please direct the positioning laser directly to the tip of the absorber cone or the center of the flat absorber respectively.
6. In case of measurements in a divergent beam, the beam diameter on the surface of the absorber or the conus (PMT 70icu; 120icu) has to be approximately 30 mm. As a rough estimation, it is possible to measure one focal width below the focus when it comes to most focusing heads. Determine the power density that is to be expected, and make sure that the measurement is carried out below the damage threshold.

---

**NOTICE****Danger of damage**

**In close proximity to the focus the power density could reach a value that would make the coating of the absorber melt.**

- ▶ **Never operate the PocketMonitor in close proximity to the focus but only use the defocused area. Not the power but the power density is important.**
- 

**6.3 Removal from the Laser System**

1. First of all, the laser source has to be turned off.
2. Ensure that all moving parts, e.g. robot arms, etc. are at a standstill and that they cannot be set in motion unintentionally.
3. Remove the device.
4. Fold the absorber and the display- and operating unit together and tighten the locknut at the swivel joint.

## 7 Operating Buttons

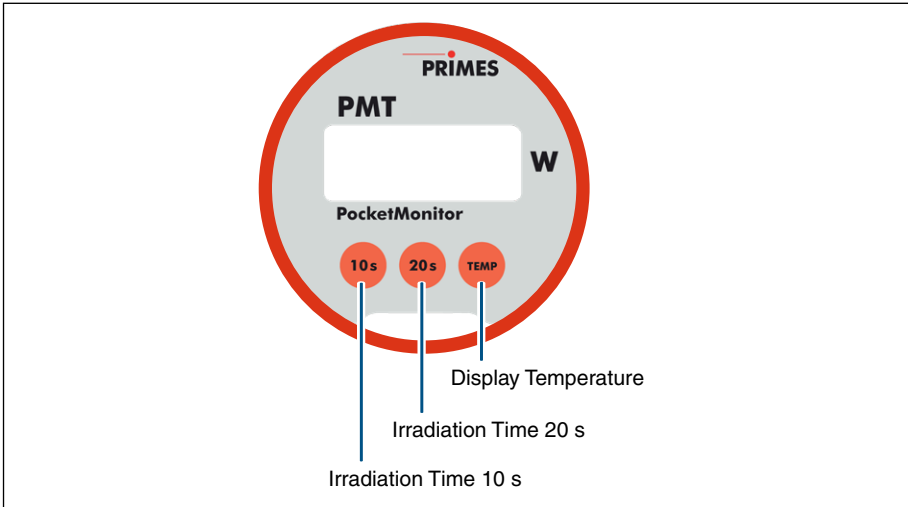


Fig. 7.1: Display and operating unit of the PMT

## 8 Display

After the measurement, the 4½-digit display shows the determined power in watt.

| PMT-Type | Order number | Resolution of the Display in W |
|----------|--------------|--------------------------------|
| 002p     | 400-001-005  | 0.01                           |
| 01p      | 400-001-006  | 0.01                           |
| 05p      | 400-001-007  | 0.1                            |
| 30p      | 400-002-002  | 1                              |
| 70icu    | 400-003-001  | 1                              |
| 120icu   | 400-004-001  | 1                              |

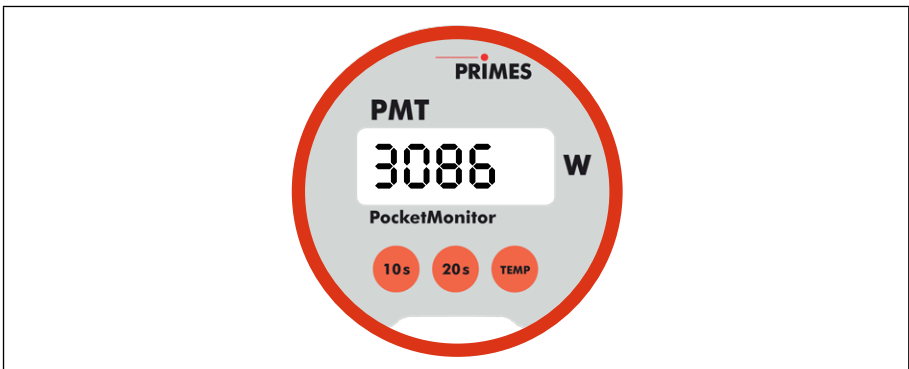


Fig. 8.1: Digital display of the PMT

## 9 Measuring



### WARNING

Danger of injuries due to scattered radiation

The PocketMonitor must not be held into the beam path by hand!

- ▶ Put the PMT onto a thermally isolating, temperature-resistant surface that simultaneously fixates the device.
- ▶ Wear safety goggles that are adapted to the laser wavelength used.

### NOTICE

Danger of damage

The maximum admissible laser power of a PocketMonitor is measured with an irradiation time of 10 s. After 20 s the absorber would overheat.

- ▶ Please mind the limit values in table Tab. 9.1.

| PMT-Type                                   | Irradiation Time |       |
|--|------------------|-------|
|  | 10 s             | 20 s  |
| 002p                                       | 20               | 10    |
| 01p  | 100              | 50    |
| 05p  | 500              | 250   |
| 30p  | 3,000            | 1,500 |
| 70icu                                      | 7,000            | 3,500 |
| 120icu                                     | 12,000           | 6,000 |
| <b>Maximum Admissible Laser Power in W</b> |                  |       |

Tab. 9.1: Maximum laser power depending on the irradiation time.

### 9.1 Measurement Preparation

#### 9.1.1 Getting the Device Ready for Operation

- ▶ Loosen the locknut at the swivel joint.
- ▶ Press the lock button and fold the display- and operating unit into the desired position.
- ▶ Fasten the locknut at the swivel joint again.
- ▶ Remove protective foils from the absorber.




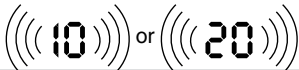

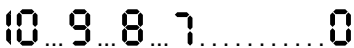
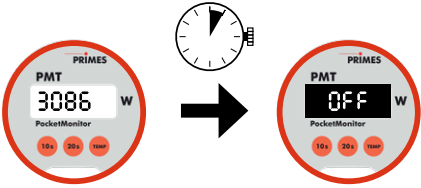
### 9.2 Requirements for Accurate Measuring Results

1. Direct the raw beam vertically to the center ( $\pm 2$  mm) of the absorber.
2. Do not place the absorber on metal surfaces for the measurement. The heat dissipation would influence the measurement value. It should be placed on heat insulating and temperature resistant surfaces.
3. Use the shutter to turn the laser on or off. The power control of lasers often causes overshooting, which distorts the measurement.
4. The on-time of the laser should be set according to the desired measuring time (10 s or 20 s). If the laser is turned on and off manually, the temporal inaccuracy also has an influence on the measurement value. The PocketMonitor does not check the laser irradiation time.
5. Strong airflows, e.g. at a nozzle or the output coupler, should be prevented as they can lower the measurement results.
6. The absorber has to be kept dry and clean. It can be cleaned by means of a dry paper towel or alcohol. The cone, however, must not be touched.
7. The temperature of the absorber should either equal or be slightly lower than the ambient temperature before the irradiation.



8. After it has been cooled down with water, it has to be ensured that the absorber is completely dry again. The heat capacity of the water is extremely high, and evaporated water would distort the measurement result.

### 9.3 Single Measurement

|  |  |
|--|--|
| <p>Turn on the device:</p> <p>▶ Press <b>10s</b> or <b>20s</b></p>   | <p>The PMT is ready for operation after approx. 5 seconds.</p>   |
| <p>Check the temperature of the absorber:</p> <p>▶ Press <b>TEMP</b></p>   | <p>To ensure the highest measurement accuracy, the absorber temperature has to equal the ambient temperature (<math>\pm 5\text{ }^{\circ}\text{C}</math>).</p> |
| <p>Set the desired irradiation time:</p> <p>▶ Press <b>10s</b> or <b>20s</b></p>   | <p>Please mind the limit values in table Tab. 9.1 on page 15.</p> <p>The display shows a value that is around zero.</p>  |
| <p>▶ Turn on the laser.</p>  |   |
| <p>👁 The display flashes; the measurement runs automatically.</p>  |   |
| <p>▶ Turn off the laser.</p>   |   |
| <p>👁 The measuring device counts back to zero (depending on the absorber model 10 s ... 60 s).</p>   |   |
| <p>👁 The measured power is displayed in watt.</p>  | <p>For example: <b>3086</b></p>  |
| <p>After approx. 5 minutes the device turns itself off automatically. However, it can also be turned off manually:</p> <p>Keep the <b>TEMP</b> button pressed and push the <b>20s</b> button for approx. 1 second.</p> |    |



## **CAUTION**

**Risk of burns!**

**After a measurement, the absorber can be very hot (more than 100 °C, depending on the absorber version for a duration of up to 30 minutes).**

- ▶ **Only touch the display- or operating unit or the swivel joint of the device.**
  - ▶ **Allow the absorber to cool down for an adequate period of time or submerge it in cold water (the display- and operating unit as well as the swivel joint must not be submerged!).**
-

### 9.4 Repetitive Measurement





#### CAUTION

##### Risk of burns!

If a measurement has already been carried out by means of the Pocket-Monitor, the absorber can still be very hot (depending on the absorber version for a duration of up to 30 minutes).

- ▶ Only touch the display- or operating unit or the swivel joint of the device.

A new measurement only makes sense if the absorber has cooled down and its temperature equals the ambient temperature.

|  |   |
|--|---|
| <ul style="list-style-type: none"> <li>▶ In order to cool down the absorber, it has to be submerged in cold water.</li> </ul>  | <p><b>Do not submerge the display- or operating unit or the swivel joint!</b></p>   |
| <ul style="list-style-type: none"> <li>▶ Press  .</li> </ul> <p> Observe the temperature display. As soon as absorber temperature approx. equals the ambient temperature (or exceeds it by a maximum of 5 °C), the absorber can be taken out of the water.</p> | <p><b>Notice:</b> If the display reaches the negative range quickly, it is still too hot due to the prior measurement and has to cool down for a longer period of time.</p> |
| <ul style="list-style-type: none"> <li>▶ Carefully dry the absorber by means of compressed air. This cools it down to the ambient temperature and makes it ready for the next measurement cycle.</li> </ul>  |   |
| <ul style="list-style-type: none"> <li>▶ Proceed as described in chapter „9.3 Single Measurement“ on page 18.</li> </ul>   |   |

## 9.5 Possible Errors

| Error  | Possible Reasons  |
|--|---|
| Values are lower than expected.                                | <ul style="list-style-type: none"> <li>• The absorber is wet / Dry the absorber</li> <li>• The absorber is exposed to a strong air stream.</li> <li>• The absorber is in contact with a metal surface.</li> <li>• The absorber was moved during the measurement (type 01p and 002p).</li> </ul> |
| Values are higher than expected.                               | <ul style="list-style-type: none"> <li>• Difference between the set irradiation time at the PocketMonitor and the actual irradiation time by means of the laser.</li> </ul>   |
| The display shows 100 Watt instead of 3000 Watt (as expected). | <ul style="list-style-type: none"> <li>• The temperature button was accidentally pushed after the measurement. Now the temperature is displayed; normally approx. 70 to 120 °C.</li> </ul>  |

## 10 Maintenance

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

### 10.1 Exchanging the Battery

The operating time of the battery is sufficient for approximately 10,000 measurements or at least 2 years. The battery is checked during every service and is exchanged if necessary.

## 11 PMT with a Separate Absorber (OPTION)

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Absorber, operating unit with display as well as the connection cable are calibrated as one unit. Therefore, it is important that only components with the same serial number (S/N) are used together!

---



In contrast to the standard system, the absorber and the display- or operating unit are separate here. They are connected by means of a cable that is screwable on both sides. The standard lengths are 5 m, 10 m and 15 m. The absorber is equipped with a handle.

## 12 Current Loop Interface (OPTION)

This version of the separate display- and operating unit has an additional 4-20 mA-current output. The power is given out by means of an impressed current. A power of 0 Watt equals a current of approx. 4 mA. The current of a maximum of 20 mA equals 16 bits.

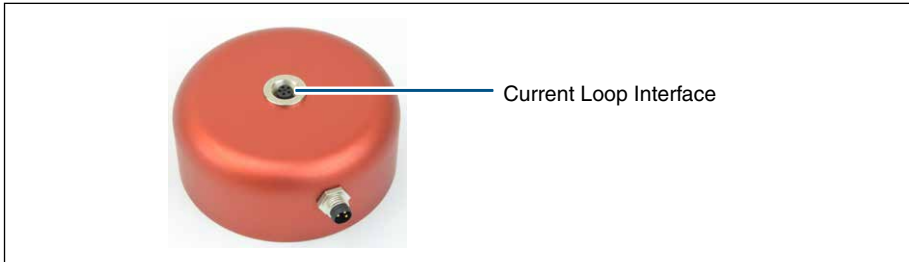
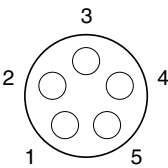


Fig. 12.1: Display- and operating unit with current loop interface

| Socket, 5-pole<br>View: Plug Side   | Pin | Function   |
|---|-----|--|
|  | 1   | GND  |
|   | 2   | Supply voltage +24 V, max. 30 mA                         |
|   | 3   | Current output 4 ... 20 mA (maximum load of 500 ohm)     |
|   | 4   | Start impulse for 20 s measurement (+24 V regarding GND) |
|   | 5   | Start impulse for 10 s measurement (+24 V regarding GND) |

When starting the measurement, i. e. when the timer button is pressed, the current temperature is sent to the current loop interface. The temperature can be measured by means of the following formula:

| Type                       | Calculation Formula   |
|----------------------------|---|
| PMT 01p; PMT 70icu         | $T = (I - 4 \text{ mA}) \cdot 13.652 \text{ } ^\circ\text{C}/\text{mA}$ |
| PMT 120icu                 | $T = (I - 4 \text{ mA}) \cdot 27.307 \text{ } ^\circ\text{C}/\text{mA}$ |
| PMT 002p; PMT 05p; PMT 30p | $T = (I - 4 \text{ mA}) \cdot 6.827 \text{ } ^\circ\text{C}/\text{mA}$  |

T = Temperature in Degree Celsius

I = Impressed Current in mA

After the irradiation time (= laser beam on the absorber) has run out, the output is set back to 4 mA. The measurement of this current can be used for the correction of offsets. In this case, the measured value is used in this formula with a set current of 4 mA. After the thermalization time has run out (depending on the absorber model 10 ... 60 seconds) the power is given out.

| Type       | Calculation Formula                                 |
|------------|---|
| PMT 002p   | $P = (I - 4 \text{ mA}) \cdot 3.4134 \text{ W/mA}$  |
| PMT 01p    | $P = (I - 4 \text{ mA}) \cdot 6.8268 \text{ W/mA}$  |
| PMT 05p    | $P = (I - 4 \text{ mA}) \cdot 34.134 \text{ W/mA}$  |
| PMT 30p    | $P = (I - 4 \text{ mA}) \cdot 341.34 \text{ W/mA}$  |
| PMT 70icu  | $P = (I - 4 \text{ mA}) \cdot 682.68 \text{ W/mA}$  |
| PMT 120icu | $P = (I - 4 \text{ mA}) \cdot 1365.36 \text{ W/mA}$ |

P = Power in watt

I = Impressed current in mA

The 20s- or 10s measurements can be started via the 24 V inputs. The PocketMonitor is supplied with current by means of the 24 volts for the current loop.

With regard to the external supply of the PocketMonitor with 24 V, the device does not turn itself off automatically but is constantly in operation. The measurement can be started any time by means of a start impulse for pins 4 or 5.

The temperature can be measured by means of the start impulse.



### 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.-Nr. 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 Accessories

Transport Box

| Type   | Order Number |
|--|--------------|
| 002p; 01p; 05p; 30p                              | 400-010-004  |
| 002p; 01p; 05p; 30p (Option sep)                 | 400-010-005  |
| 70icu  | 400-010-006  |
| 70icu sep  | 400-010-007  |
| 120icu   | 400-010-008  |
| 70icu sep<br>120icu sep<br>(Cable length > 15 m) | 400-010-009  |

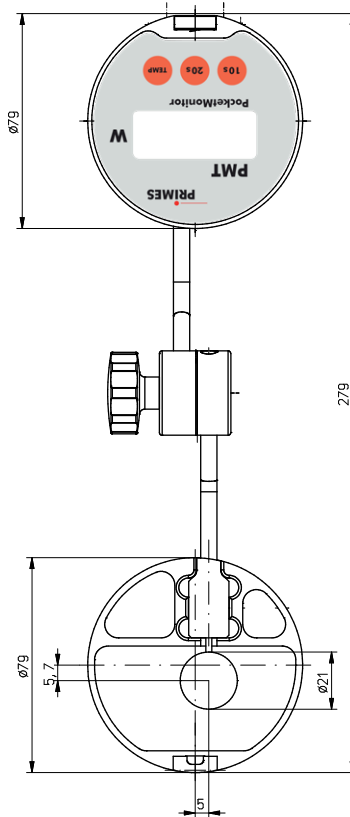
## 15 Technical Data

| Type  |                     | 002p      | 01p  | 05p  | 30p  | 70icu | 120icu |
|---|---------------------|-----------|------|------|------|-------|--------|
| Max.Power                                     | kW                  | 0.02      | 0.1  | 0.5  | 3    | 7     | 12     |
| <b>Parameters Measurement</b>                 |                     |           |      |      |      |       |        |
| Max. Power Density                            |                     |           |      |      |      |       |        |
| < 1 kW  | kW/ cm <sup>2</sup> |           | 2.5  |      |      | –     | –      |
| < 3 kW  | kW/ cm <sup>2</sup> |           | 1.5  |      |      | –     | –      |
| at 5 kW                                       | kW/ cm <sup>2</sup> |           | –    |      |      | 5     | 5      |
| Measurement Accuracy                          | %                   | ±4        |      |      |      |       |        |
| Reproducibility                               | %                   | ±2        |      |      |      |       |        |
| Irradiation time                              | s                   | 10 or 20  |      |      |      |       |        |
| <b>Ambient Conditions</b>                     |                     |           |      |      |      |       |        |
| Operating Temperature Range                   | °C                  | 15 ... 35 |      |      |      |       |        |
| Storage Temperature Range                     | °C                  | 5 ... 45  |      |      |      |       |        |
| Reference Temperature                         | °C                  | 23        |      |      |      |       |        |
| Admissible Relative Humidity (non-condensing) | %                   | 0 ... 80  |      |      |      |       |        |
| <b>Dimensions and Weight</b>                  |                     |           |      |      |      |       |        |
| Absorber Height                               | mm                  | 20        | 20   | 15   | 20   | 75    | 75     |
| Absorber Diameter                             | mm                  | 21        | 25   | 45   | 79   | 79    | 99     |
| Weight, approx.                               | kg                  | 0.53      | 0.53 | 0.56 | 0.67 | 1.11  | 1.55   |
| <b>Protection</b>                             |                     |           |      |      |      |       |        |
| Protection Type                               | –                   | IP51      |      |      |      |       |        |

**PocketMonitor PMT**

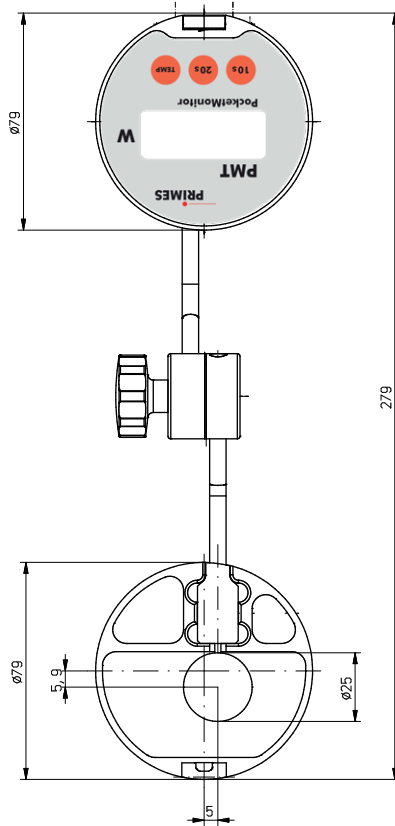
**16 Dimensions**

**16.1 PMT 002p**



All dimensions given in mm.

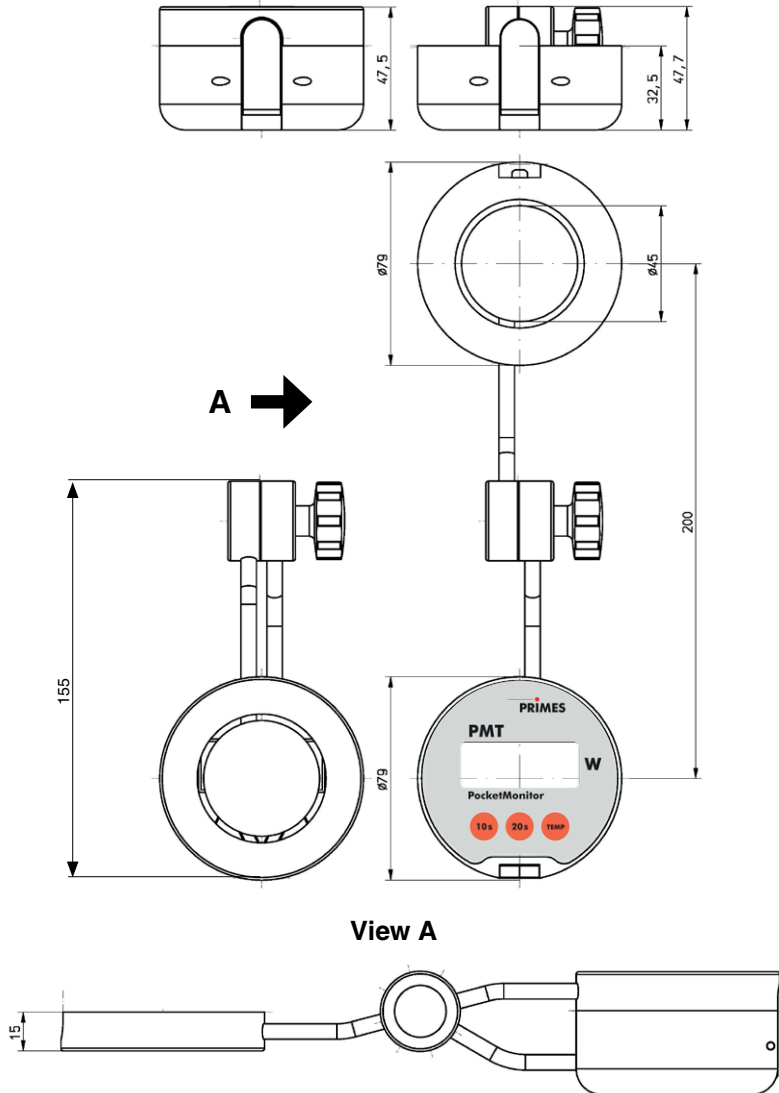
**16.2 PMT 01p**



All dimensions given in mm.

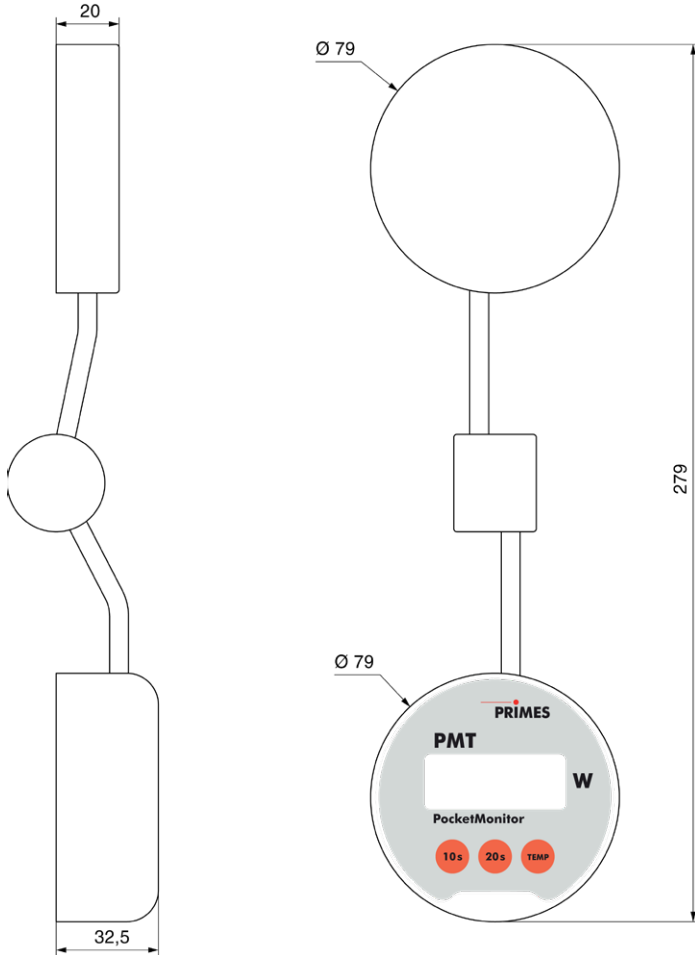
# PocketMonitor PMT

## 16.3 PMT 05p



All dimensions given in mm.

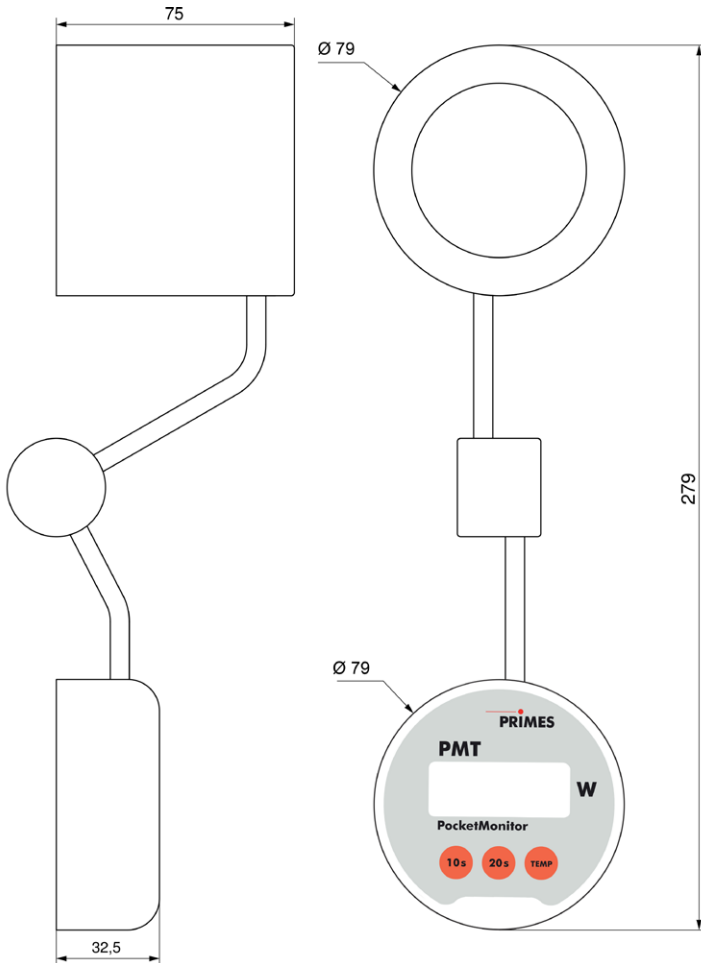
**16.4 PMT 30p**



All dimensions given in mm.

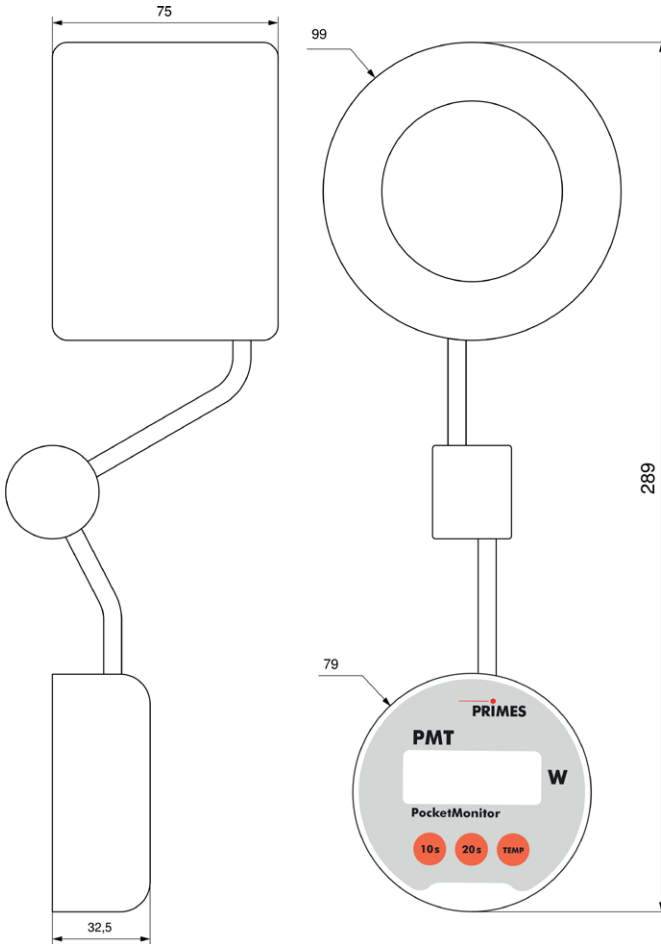
**PocketMonitor PMT**

**16.5 PMT 70icu**



All dimensions given in mm.

**16.6 PMT 120icu**

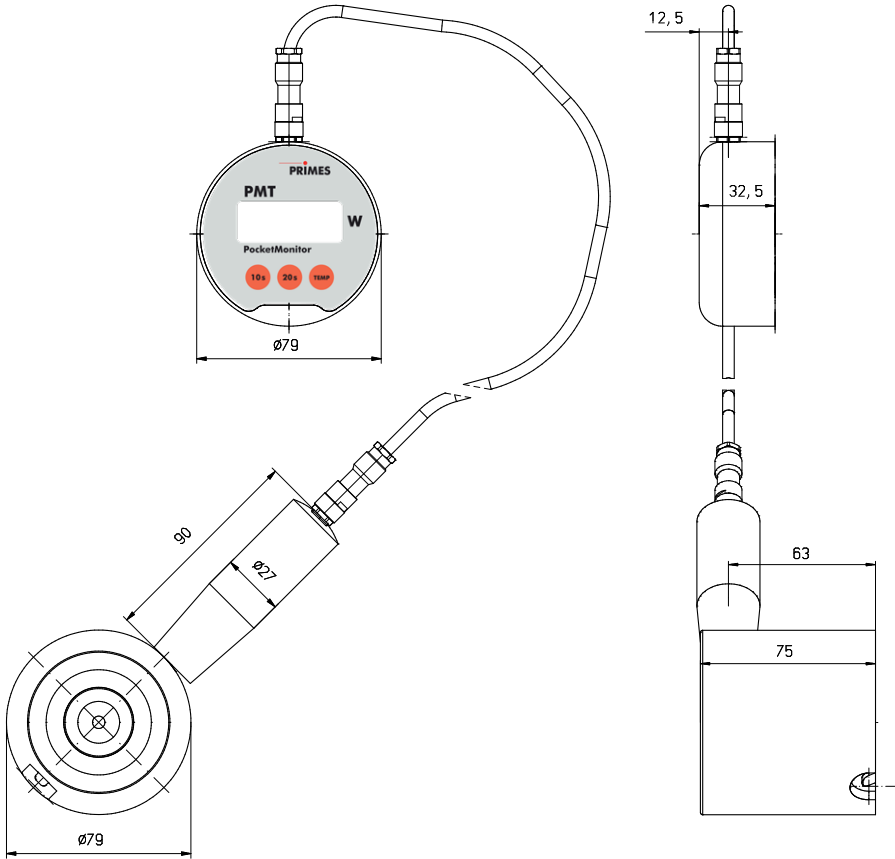


All dimensions given in mm.



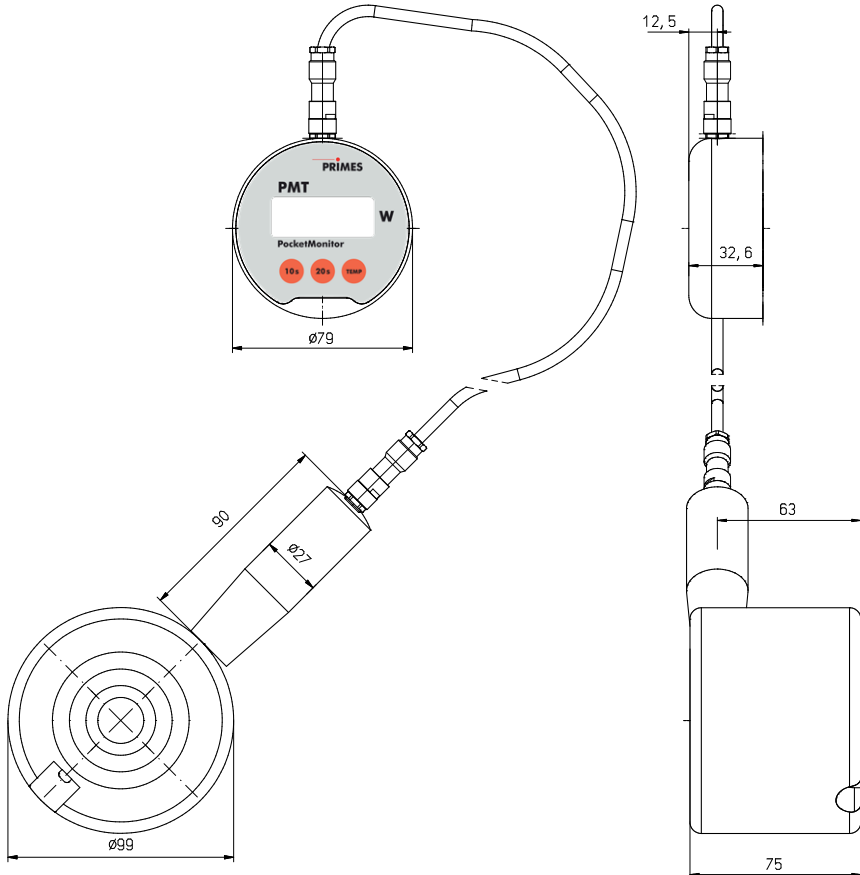
# PocketMonitor PMT

## 16.7 PMT 70icu sep



All dimensions given in mm.

**16.8 PMT 120icu sep**



All dimensions given in mm.

## **17 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:

#### **PocketMonitor (PMT)**

**Types: PMT 002p; 002p sep; 01p; 01p sep/out; 05p; 30p; 70icu; 120icu**

is in conformity with the following relevant EC Directives:

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

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 27, 2017

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

Dr. Reinhard Kramer, CEO