

Operating Manual

Translation of the Original Instructions



PowerLossMonitor PLM

PowerMeasuringSoftware

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PRIMES - The Company

PRIMES is a manufacturer of measuring devices used for the characterization of laser beams. These devices are used for the diagnostics of high power lasers that range from high power CO₂-lasers and solid-state to fiber lasers and diode lasers. A great variety of measuring devices for the determination of the following parameters is available:

- Laser power
- Beam dimensions and the beam position of an unfocussed beam
- Beam dimensions and the beam position of a focussed beam
- Diffraction index M²
- Polarization of the laser beam

Both the development and the production of the measuring devices are effected by PRIMES. This is how we ensure an optimal quality, excellent service and a short reaction time which is the basis to meet our customers' requirements fast and reliably.



1 Basic Safety Instructions

Intended Use

The PowerLossMonitor PLM is used to determine power losses at water-cooled optical components of a laser beam guidance. Other forms of usage are improper. To ensure a safe operation, the instructions given in this manual have to be strictly observed.

Improper usage of the device is strictly prohibited and could lead to health endangering or even deadly injuries. When operating the device, it must be ensured that there are no potential hazards to human health.

The device does not emit any laser radiation. However, the device is installed in close proximity to laser beam systems. Hence, valid safety regulations are to be observed and necessary safety measures are to be taken.

Observing Applicable Safety Regulations

Please observe valid national and international safety regulations as 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 that is 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.

Employing Qualified Personnel

All users of the device 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 device 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.



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

3 Application

The PowerLossMonitor PLM is a system that determines power losses especially in water-cooled components of beam guidance systems.

3.1 Operating Principle

The PLM measures the water flow rate of the cooling water as well as the temperature difference between inflowing and outflowing water. These values are then used to calculate the power inducted in the cooling water.

If the mounting of the beam deflection mirrors is thermally insulated from the machine frame, the measured power equals the power that was converted into heat by the mirrors exactly.

Since in reality this is, however, not possible, heat constantly leaks from the machine frame into the cooling water (or vice versa). This results in a zero offset. Therefore, the zero value has to be subtracted from the measured value to determine the power loss.

The main components of the measuring system include:

- Housing including electronic measuring equipment
- Two temperature sensors
- A flow meter



In the current version of the PLM a temperature sensor and the flow meter are integrated in the housing.

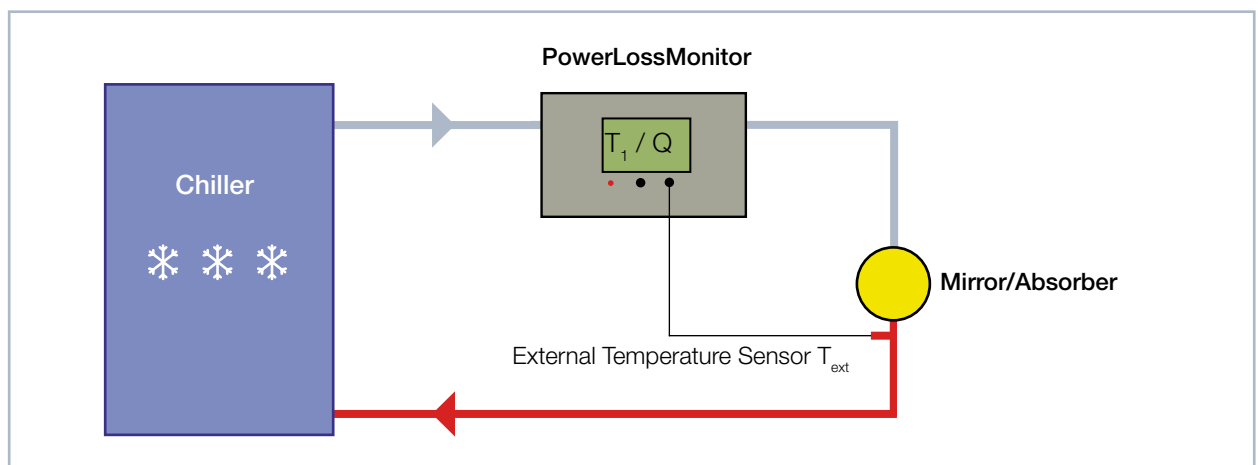


Fig. 3.1: Schematic representation of the measurement setup

3.2 Configurations

Depending on the purpose of use and power, the devices are available with different configurations and connections:

| Designation | Connections | Power in kW |
|-------------|---|-------------|
| PLM-2 | <p>The diagram for PLM-2 shows a central rectangular device with a display screen. On the left side, there is a blue arrow labeled W_{in} pointing into the device, and a black arrow labeled 'Interlock' pointing out. On the right side, there is a blue arrow labeled W_{out} pointing out, a black arrow labeled 'PRIMES Bus' pointing in, and a black arrow labeled T_{ext} pointing in. At the bottom, there is a black arrow labeled 'Analog Out' pointing down, and a black arrow labeled 'USB' pointing down.</p> | 2 |
| PLM-10 | <p>The diagram for PLM-10 shows a central rectangular device with a display screen. On the left side, there is a blue arrow labeled W_{in} pointing into the device, and a black arrow labeled 'Interlock_{Laser}' pointing out. On the right side, there is a blue arrow labeled W_{out} pointing out, a black arrow labeled 'PRIMES Bus' pointing in, a black arrow labeled T_{ext} pointing in, and a black arrow labeled 'Interlock_{MSM}' pointing in. At the bottom, there is a black arrow labeled 'Analog Out' pointing down, and a black arrow labeled 'USB' pointing down.</p> | 10 |
| PLM-30 | <p>The diagram for PLM-30 shows a larger rectangular device with a display screen and a handle on top. On the left side, there is a blue arrow labeled 'From chiller (PCW supply)' pointing into the device, and a red arrow labeled 'To chiller (PCW return)' pointing out. On the right side, there is a blue arrow labeled 'To Absorber' pointing out, and a red arrow labeled 'From Absorber' pointing in. At the bottom, there are several connection points: a black arrow labeled 'PRIMES Bus' pointing in, a black arrow labeled T_{ext} pointing in, a black arrow labeled 'Interlock' pointing in, and a black arrow labeled 'Analog out' pointing in. A black arrow labeled 'USB' points down from the bottom left.</p> | 30 |

Fig. 3.2: PLM configurations

4 Display

4.1 Measuring Value Display

The following measuring values are displayed:

- Absolute temperature
- Temperature difference
- Flow rate of the cooling agent
- Calculated power loss

The measuring values can also be displayed on a PC via the PRIMES bus or the USB-interface. This requires the PRIMES-PowerMonitorSoftware (PMS) (included in the scope of delivery).

4.2 LED „Error“

The red LED glows if the water flow rate is too low.

5 Mechanical Connections

5.1 Connecting the Cooling Circuit

The connections at the PLM-2 and PLM-10 are intended for PE hoses with an outer diameter of 8 mm (PLM- 2) and 12 mm (PLM-10), respectively. To ensure a reliable operation, the following water flow rate is required:

| | | PLM-2 | PLM-10 | PLM-30 |
|------------------------------------|-------|-----------|----------|-----------|
| Cooling water flow rate, typically | l/min | 0.6 ... 4 | 7 ... 12 | 20 ... 37 |



DANGER

Damaging/Destruction of the device due to overheating, risk of fire

In case of a missing water connection or a low water flow rate the mirror or absorber overheats. This may either cause damages or make it catch fire.

- ▶ **Only operate the device with an installed water cooling and a sufficient flow rate!**

5.1.1 Cooling Circuit PLM-2

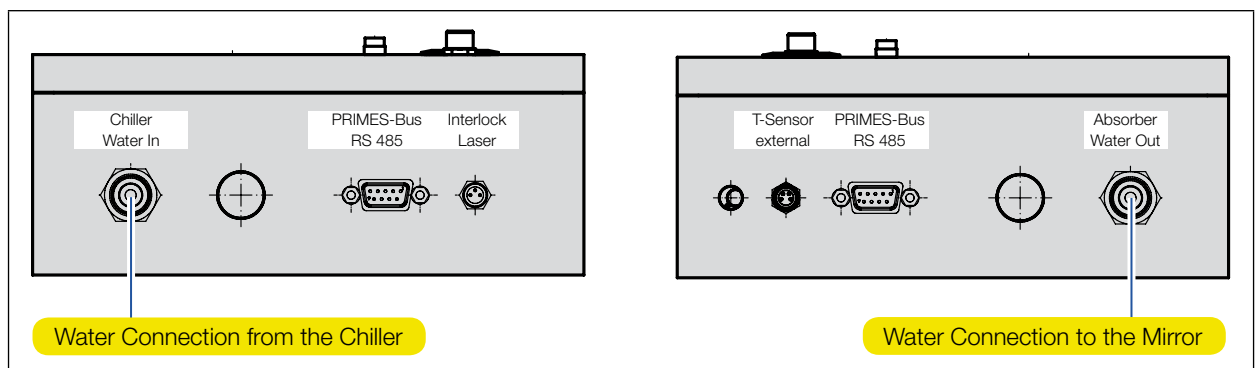


Fig. 5.1: Water Connections PLM-2

5.1.2 Cooling Circuit PLM-10

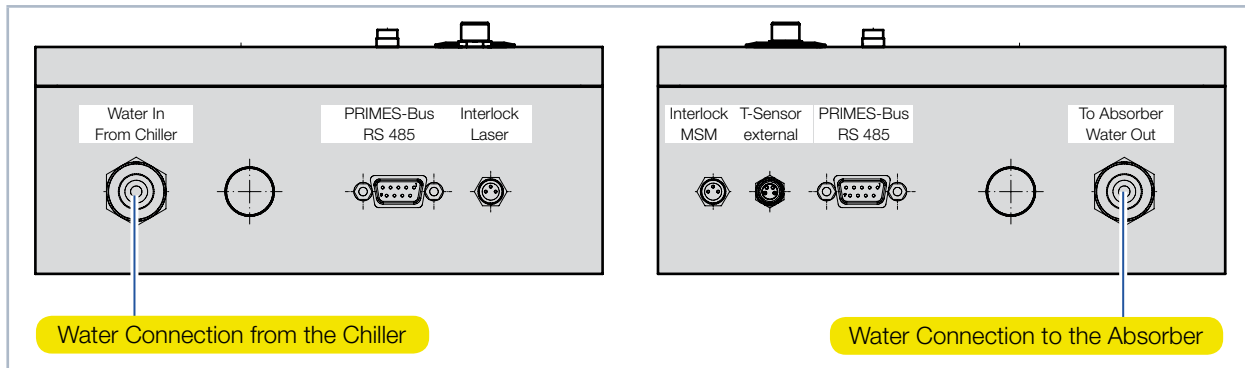


Fig. 5.2: Water Connections PLM-10

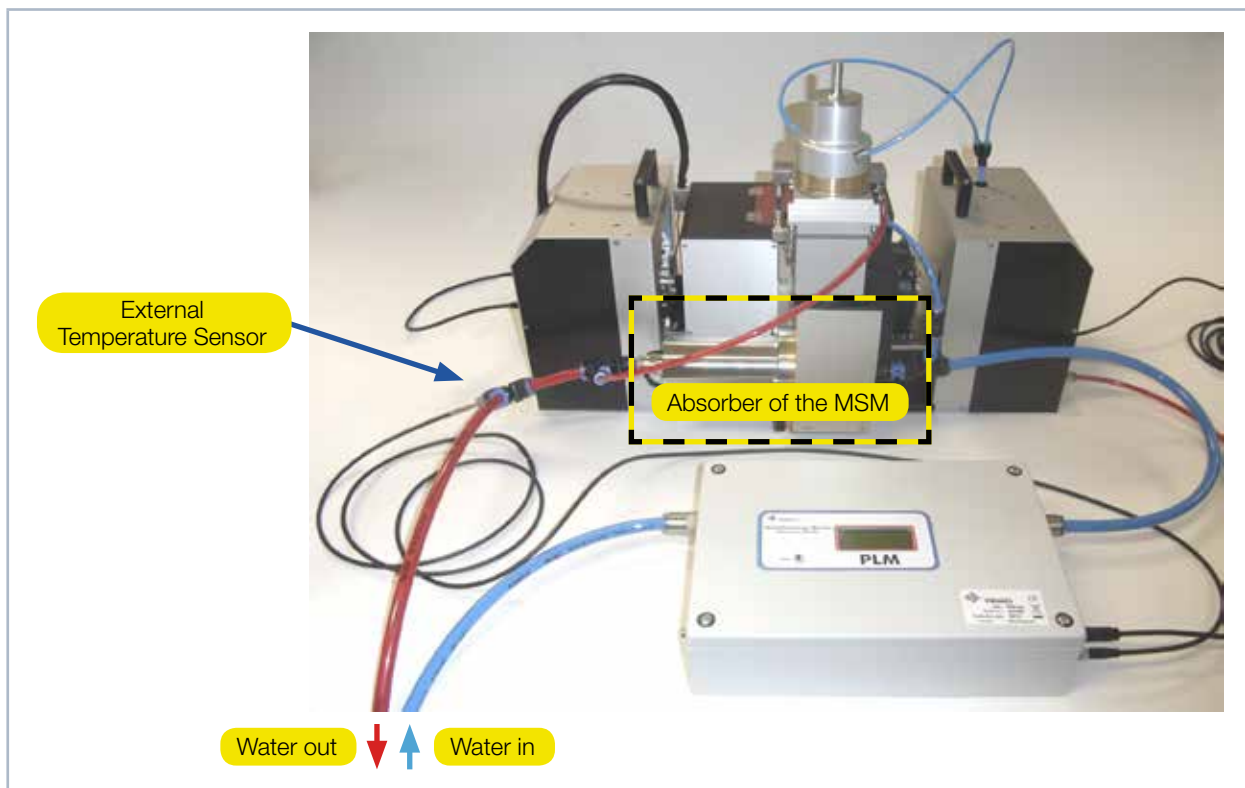


Fig. 5.3: Cooling Circuit PLM-10



The lengths of the hose connections have an influence on the time constants of the measuring devices. Please only use the supplied hoses here!

5.1.3 Cooling Circuit PLM-30

The water connections have a size of 3/4 inches.



When fastening the coupling nut, make sure to use an open-end wrench AF 32 to prevent the screwing inside the housing from loosening.

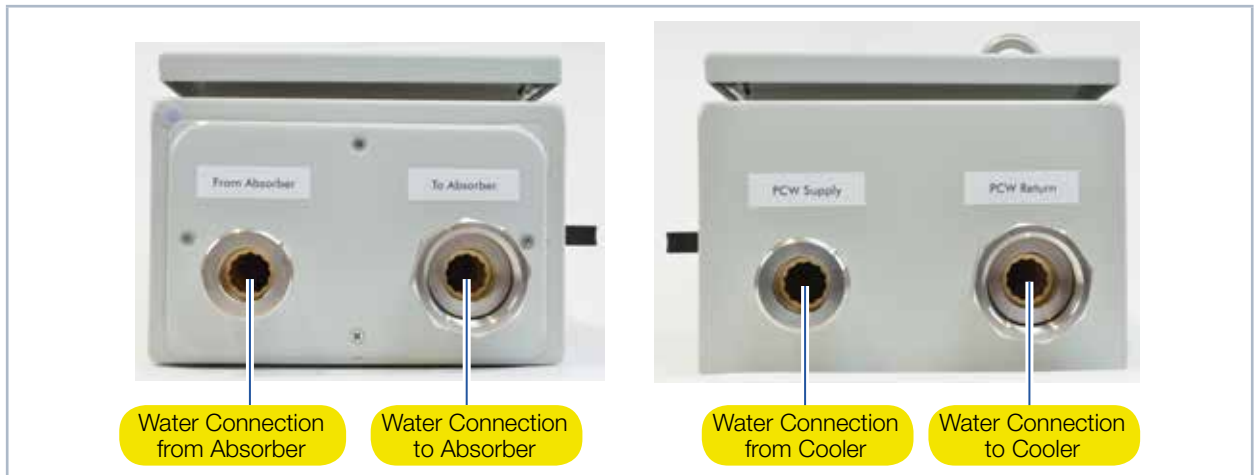


Fig. 5.4: Water Connections PLM-30

6 Electrical Connections

The measuring device has the following electrical connections:

- Connection for the external temperature sensor (T_{ext})
- Safety circuit connection in order to control the water flow rate (Interlock Laser and Interlock MSM respectively)
- PRIMES bus connections (D-Sub sockets, 9-pin) for the power supply and communication
- USB interface
- Analog output 0 V ... 10 V

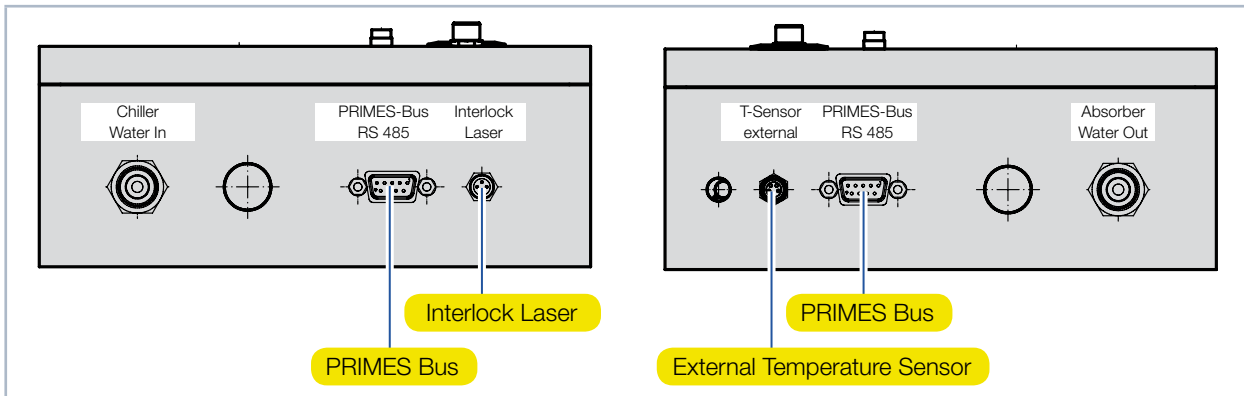


Fig. 6.1: Electrical connections PLM-2, sideward

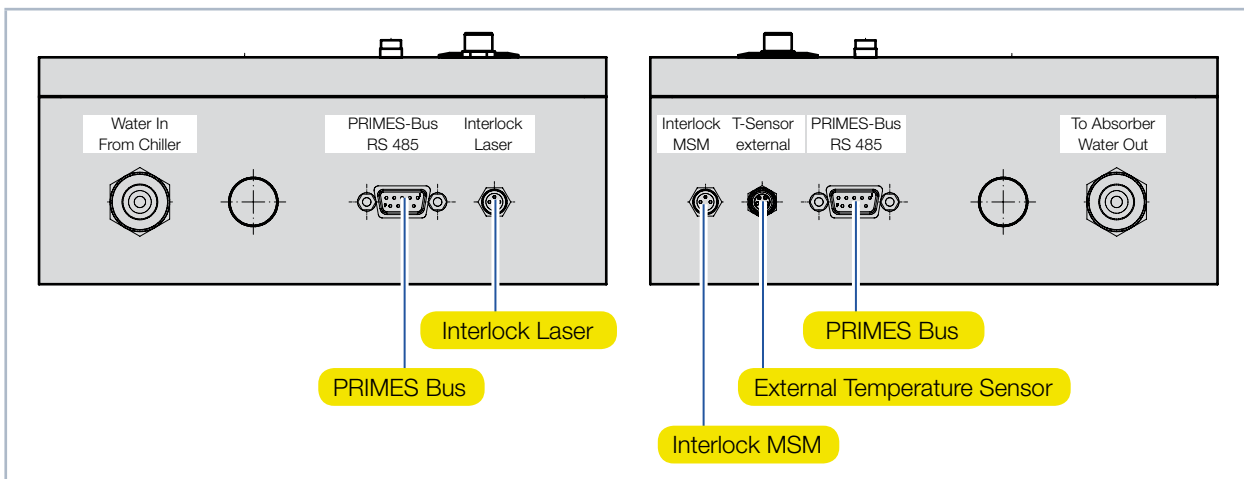


Fig. 6.2: Electrical connections PLM-10, sideward

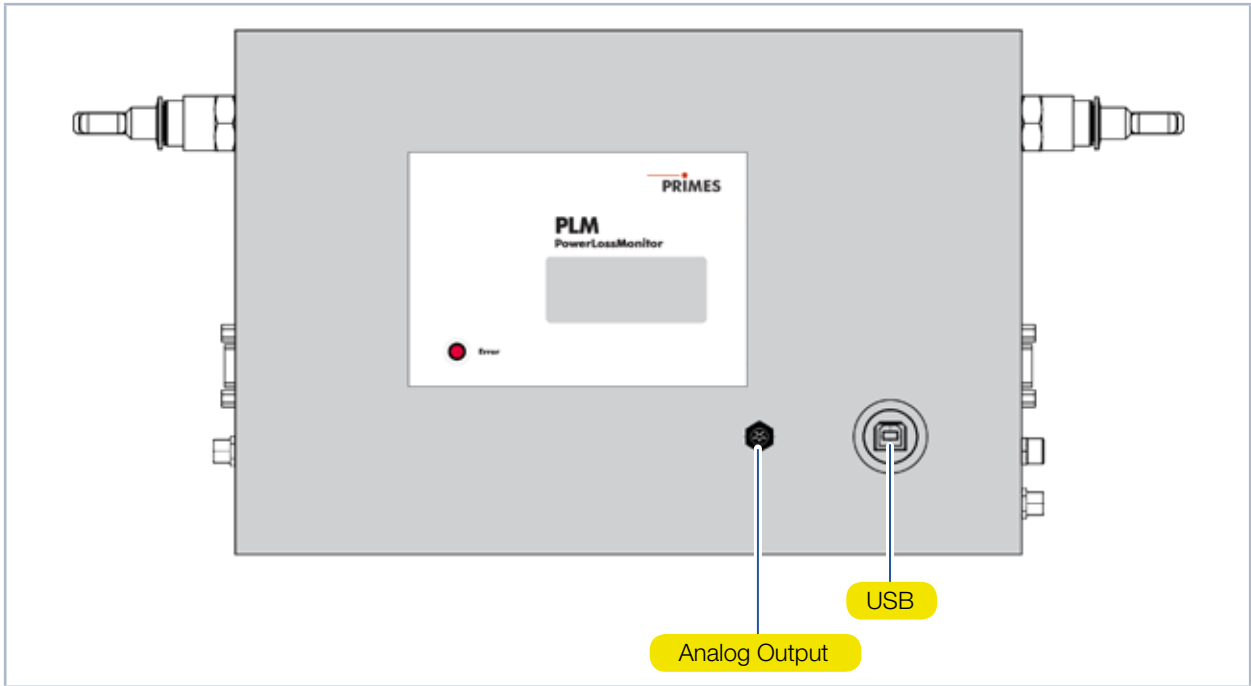


Fig. 6.3: Electrical connections PLM-2/PLM-10 in the cover plate



Fig. 6.4: Electrical connections PLM-30

You can switch between the external and internal temperature sensor in the return flow of the cooling water by means of the toggle switch extern/intern (see Fig. 6.5 on page 14).

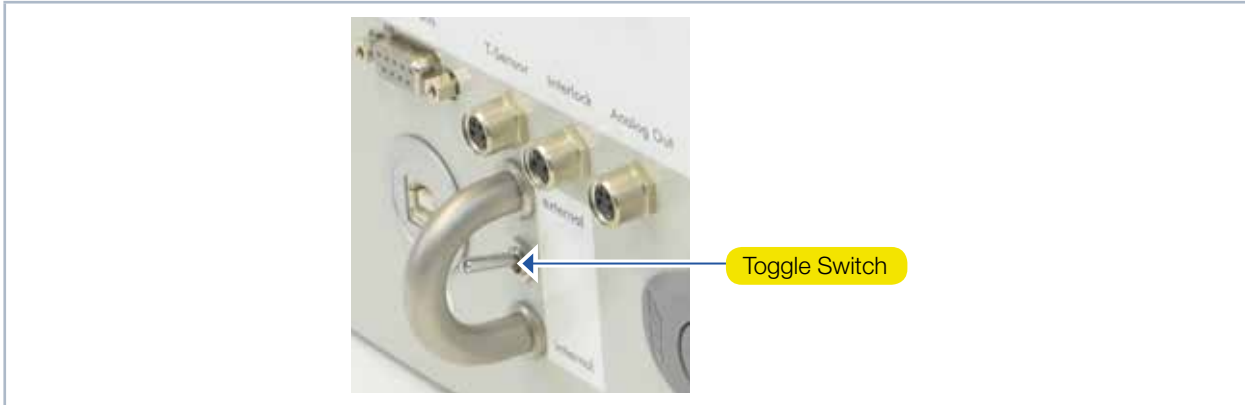


Fig. 6.5: Switch for temperature measuring points

For technical reasons, different resistance values in the temperature sensors can occur (depending on the cable length and the contact resistance), which can lead to different power displays when the laser is switched off.

The PRIMES PowerMeasuringSoftware PMS offers the possibility to adjust this „offset“ before a measurement (tare adjustment).

Click on the button **Use current value as offset** before measurement.

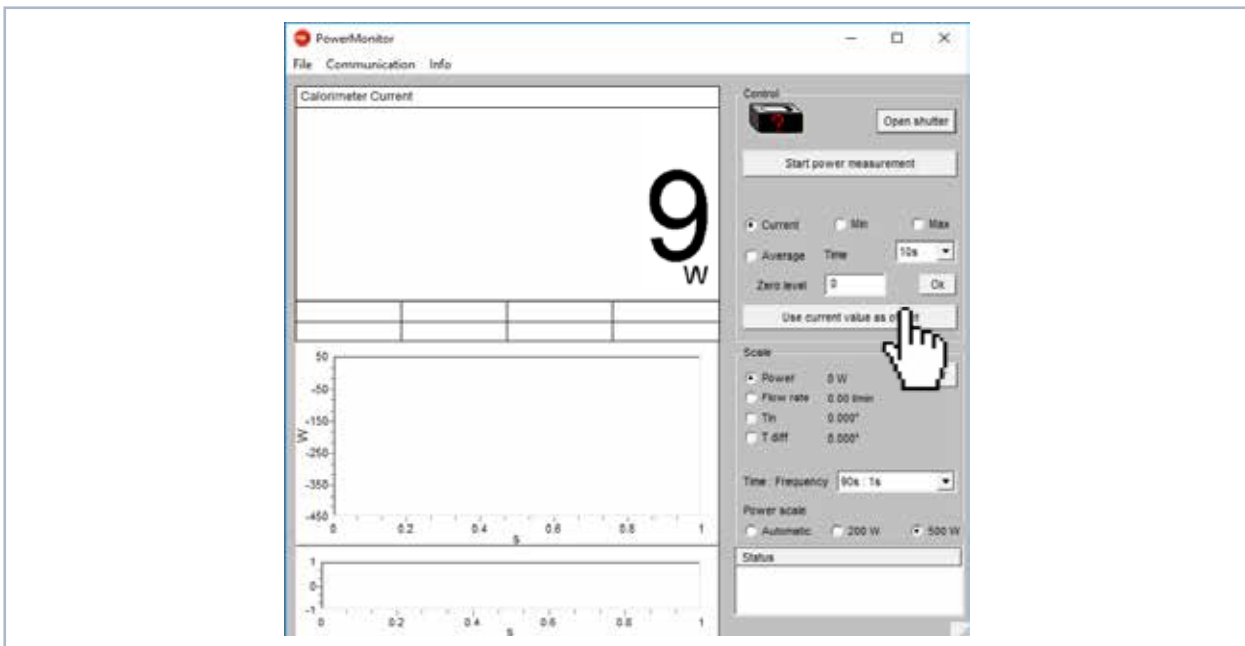


Fig. 6.6: User interface of the PowerMeasuringSoftware (PMS)

6.1 Power Supply

In order to operate, the PLM requires a supply voltage of 24 V \pm 5 % (DC). A suitable power supply unit is included in the scope of delivery.

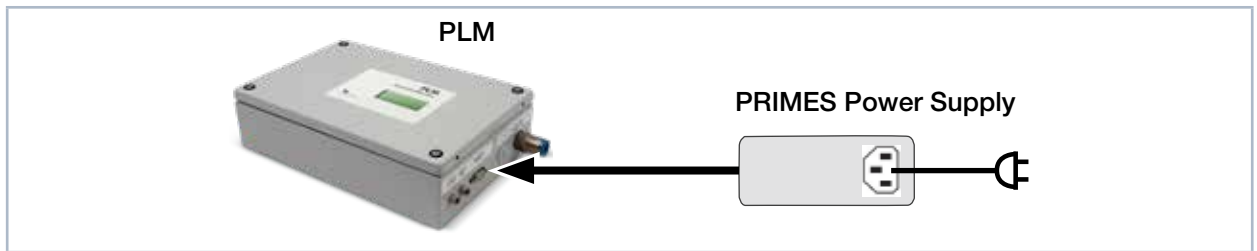
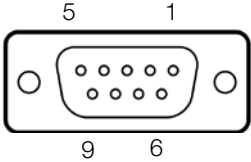


Fig. 6.7: Connecting the power supply

Connect the power supply unit with one of the 9 pin D-Sub sockets (RS 485) of the PLM.

6.2 PRIMES bus

The system is supplied with power by means of the 9 pin D-Sub sockets. Using a converter, the socket can also be used to connect a PC to enable communication (see chapter 6.5 on page 16).

| D-Sub socket, 9 pin (top view, plug-in side) | Pin | Function |
|---|-----|--------------|
|  | 1 | Ground |
| | 2 | RS-485 (+) |
| | 3 | +24 V |
| | 4 | Not assigned |
| | 5 | Not assigned |
| | 6 | Ground |
| | 7 | RS-485 (-) |
| | 8 | +24 V |
| | 9 | Not assigned |

Tab. 6.1 Socket assignment PRIMES bus

6.3 External Temperature Sensor

The temperature sensor is a Pt 100 with a four-wire connection. The connection cable may have a length of up to 10 m.

6.4 External Safety Circuit (Interlock Laser)

The external safety circuit protects the measuring device from damages by turning off the laser in case of an error. The device can be damaged in case of a low water flow rate.

Whenever the water flow rate is too low, pins 1 and 4 are connected. In case the water flow rate is according to the operating conditions, pins 1 and 3 are connected.

NOTICE

Damaging/Destruction of the device

If the safety circuit is not connected, this may lead to damages to the device due to overheating.

- ▶ **Make sure to connect the laser control in a way that ensures that the laser is turned off whenever this connection is interrupted.**

A suitable connection cable with a device plug and free ends is included in the scope of delivery

| Pin diagram socket (top view, plug-in side) | Pin | Wire color | Function |
|--|-----|------------|---|
| | 1 | Brown | Mutual pin |
| | 3 | Blue | Connected with Pin 1 when ready for operation |
| | 4 | Black | Connected with Pin 1 when in Interlock mode (water flow rate too low) |

Tab. 6.2 Socket assignment safety circuit

6.5 PC Connection via RS 232

For the communication with the computer, you require:



Fig. 6.8: Scope of delivery

NOTICE

Damaging of the device

Connecting or disconnecting the bus cable when it is connected with the supply voltage leads to voltage peaks, which may damage communication modules of the measuring device.

- ▶ **Only establish connections when the power supply unit is turned off! Do not disconnect anything as long as the supply voltage is turned on!**

NOTICE

Damaging of the device

The supply voltage of 24 V is ensured by means of the RS485-based PRIMES bus. If the measuring device is directly connected with a PC, the computer may be damaged!

- ▶ Only connect your PC with the measuring system via a PRIMES RS485/RS232 interface converter!

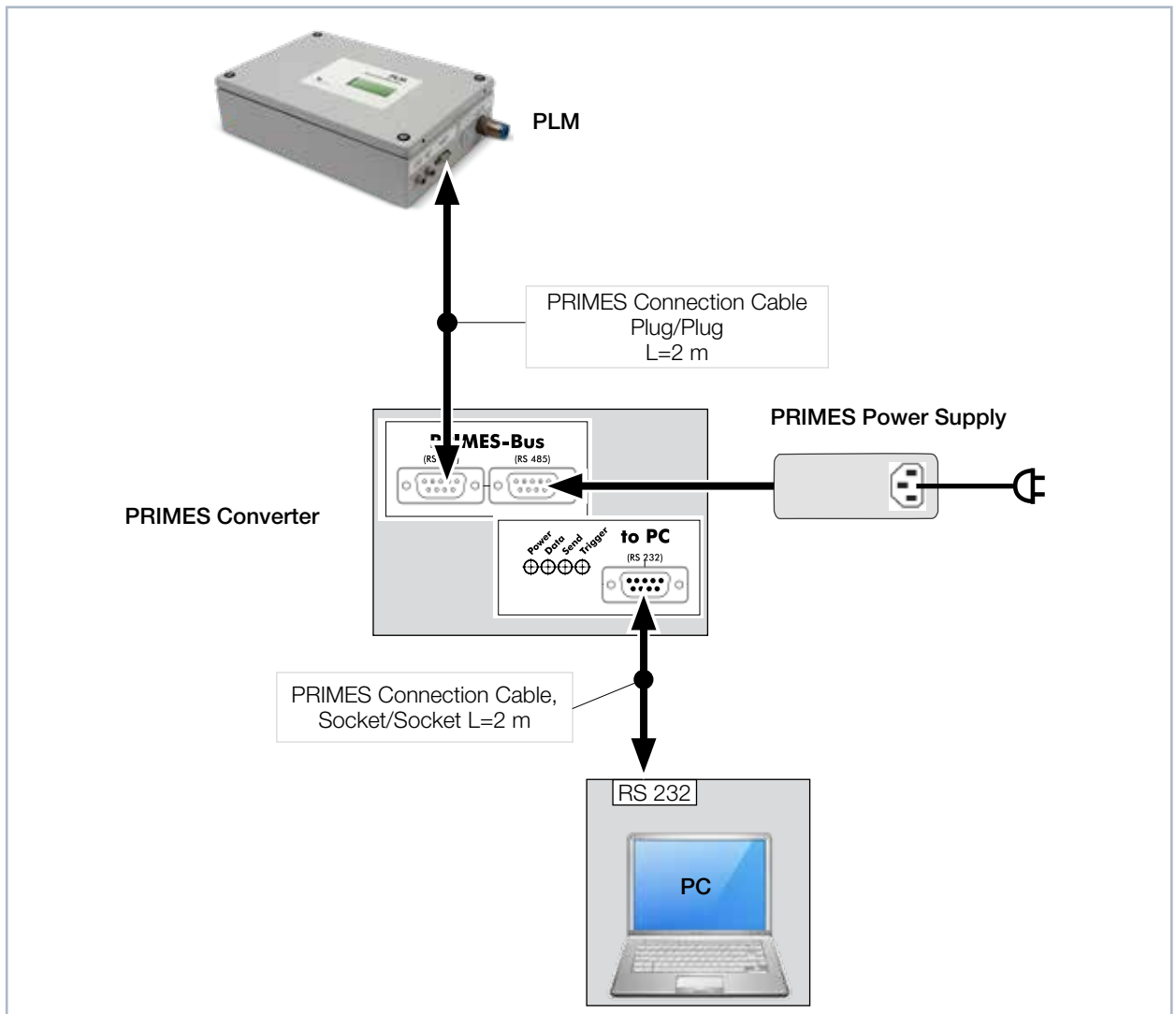


Fig. 6.9: Connection with the PC via RS232 and PRIMES converter

6.6 PC Connection via USB

You can also connect the PC via the USB interface of the PLM. In this case, the PRIMES-RS 485/RS 232 converter is not needed and the power supply is connected directly to the PLM (see Fig. 6.7 on page 15).

6.7 Analog Output

The analog signal is effected via the 4-pin device socket M8 (see Fig. 6.3 on page 13 and Fig. 6.4 on page 13). The output voltage is 0 V ...10 V. A suitable connection cable is included in the scope of delivery.

| | PLM-2 | PLM-10 | PLM-30 |
|---|-------|--------|--------|
| An output voltage of 1 V equals approx. | 250 W | 1000 W | 4000 W |

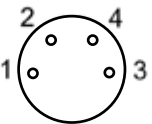
| Polbild Gerätebuchse (Draufsicht Steckseite) | Pin | Wire color | Function |
|---|-----|------------|------------------------------|
|  | 1 | Brown | Not connected |
| | 2 | White | Not connected |
| | 3 | Blue | Ground for the analog signal |
| | 4 | Black | Analog signal 0-10 Volt |

Fig. 6.10: Socket assignment of the analog output

7 Installation of the Temperature Sensor

The temperature sensor has to be installed in a way that ensures that it extends into the water flow but against the flow direction. The tip should protrude from the bottom of the pipe approximately 15 mm.

- Install the temperature sensor as close as possible to the cooling circuit outflow of the mirror or the absorber, respectively.

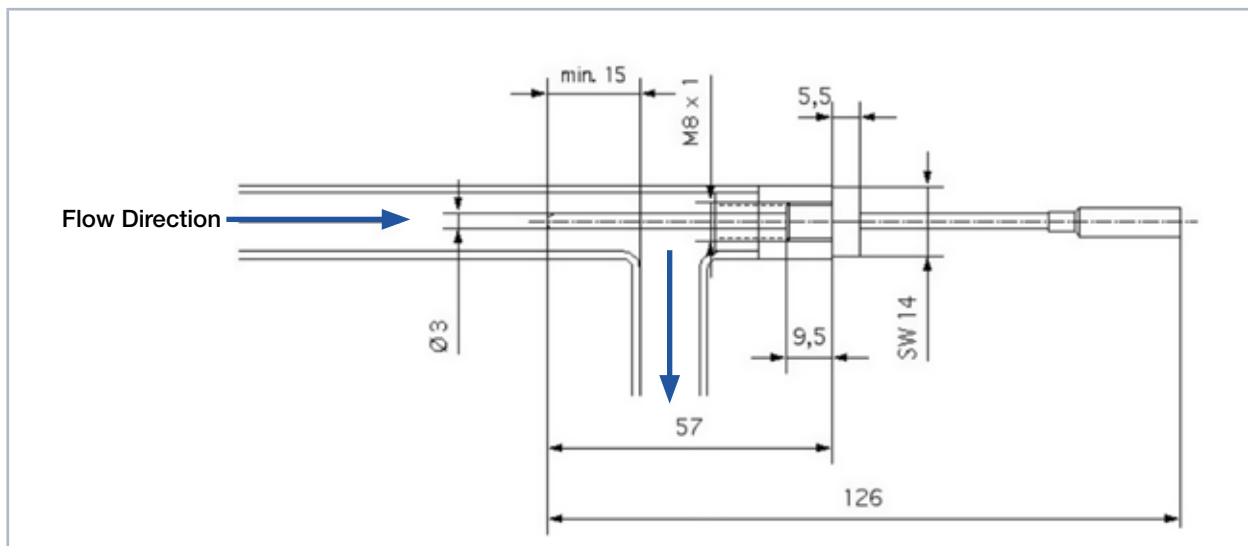


Fig. 7.1: Installation of the Temperature Sensor

8 Installing the Software

For the operation of a PLM with a PC, the PowerMonitorSoftware has to be installed. Start the installation by double-clicking the file “PMS v.2.xx Setup” and follow the instructions on your screen.

9 Storage and Transport

Please note before storing or transporting:

NOTICE

Damaging of the device due to freezing cooling water

A storage or transport at a temperature that is close to or below the freezing point can lead to device damages if the cooling circuit is not completely empty.

- ▶ **Empty the cooling circuit completely!**

NOTICE

Damaging of the flow rate meter

The flow rate meter is not designated for high rotational speed.

- ▶ **Do not use compressed air for emptying the cooling circuit.**

NOTICE

Damaging of the device due to escaping residual water

Even if the line system of the cooling circuit has been emptied completely, a small amount of residual water remains inside the device. This water could escape during transport and could damage the interior of the device.

- ▶ **Seal the connector plugs of the cooling circuit by means of the enclosed sealing plugs before any kind of transport.**

10 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

11 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:

PowerLossMonitor (PLM)

Types: PLM

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

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



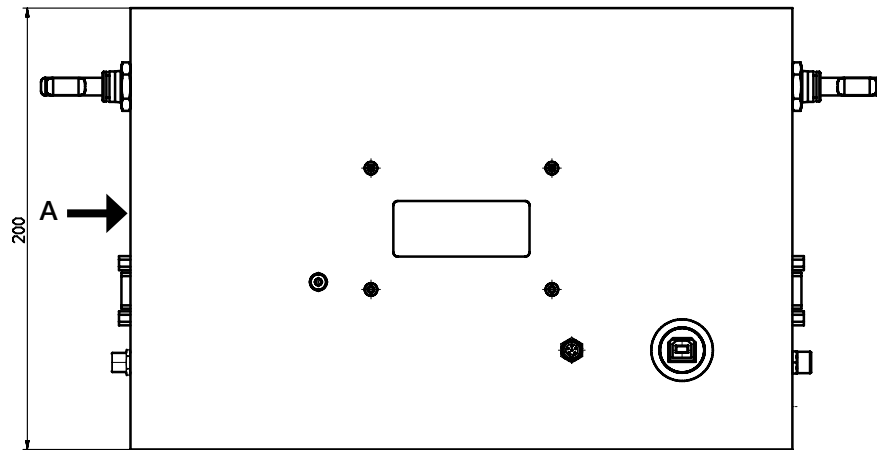
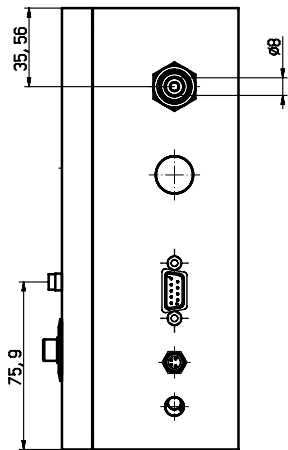
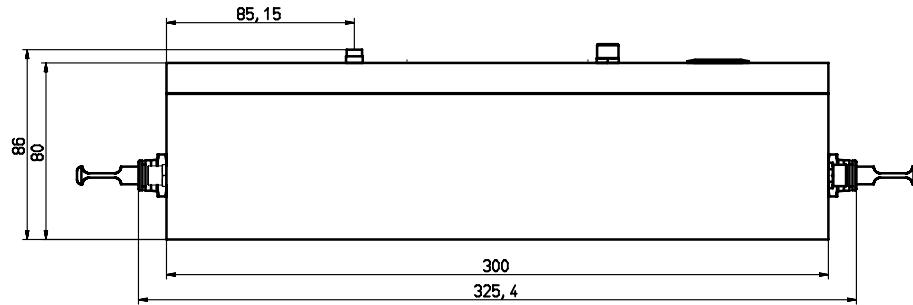
Dr. Reinhard Kramer, CEO

12 Technical Data

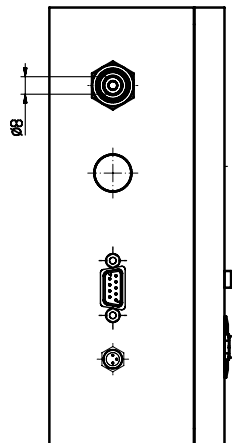
| Measurement Parameters | | PLM-2 | PLM-10 | PLM-30 |
|-------------------------------------|-------|----------------------|----------------------|----------------------|
| Max. Laser power | kW | 2 | 10 | 30 |
| Resolution Temperature Measurement | K | 0,001 | | |
| Resolution Power Measurement | W | 1 | | |
| Supply Data | | PLM-2 | PLM-10 | PLM-30 |
| Power Supply, DC | V | 24 ± 5 % | | |
| Current Demand | mA | < 800 | | |
| Max. Water Pressure on Device Entry | bar | 3 | 4 | 5 |
| Cooling Water Flow Rate, typically | l/min | 0,6 ... 4 | 7 ... 12 | 20 ... 37 |
| Communication | | PLM-2 | PLM-10 | PLM-30 |
| Interfaces | – | 2 x RS485 1 x USB | 2 x RS485 1 x USB | 1 x RS485 1 x USB |
| Dimensions and Weight | | PLM-2 | PLM-10 | PLM-30 |
| Dimensions L x W x H | mm | 300 x 200 x 80 | 300 x 200 x 80 | 304 x 200 x 151 |
| Weight, approx. | kg | 3,8 | 3,8 | 6,7 |

13 Dimensions

13.1 Dimensions PLM-2

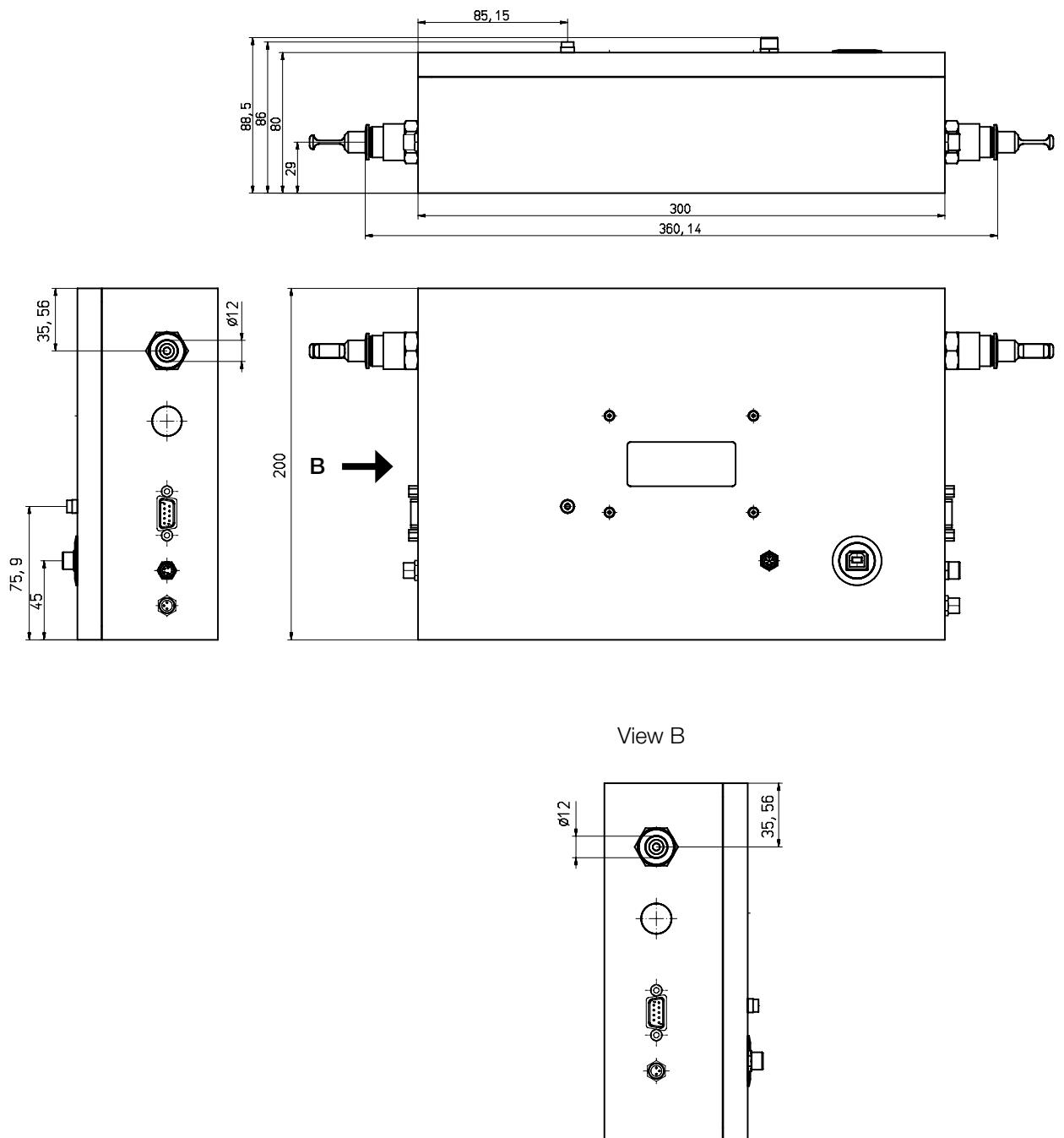


View A



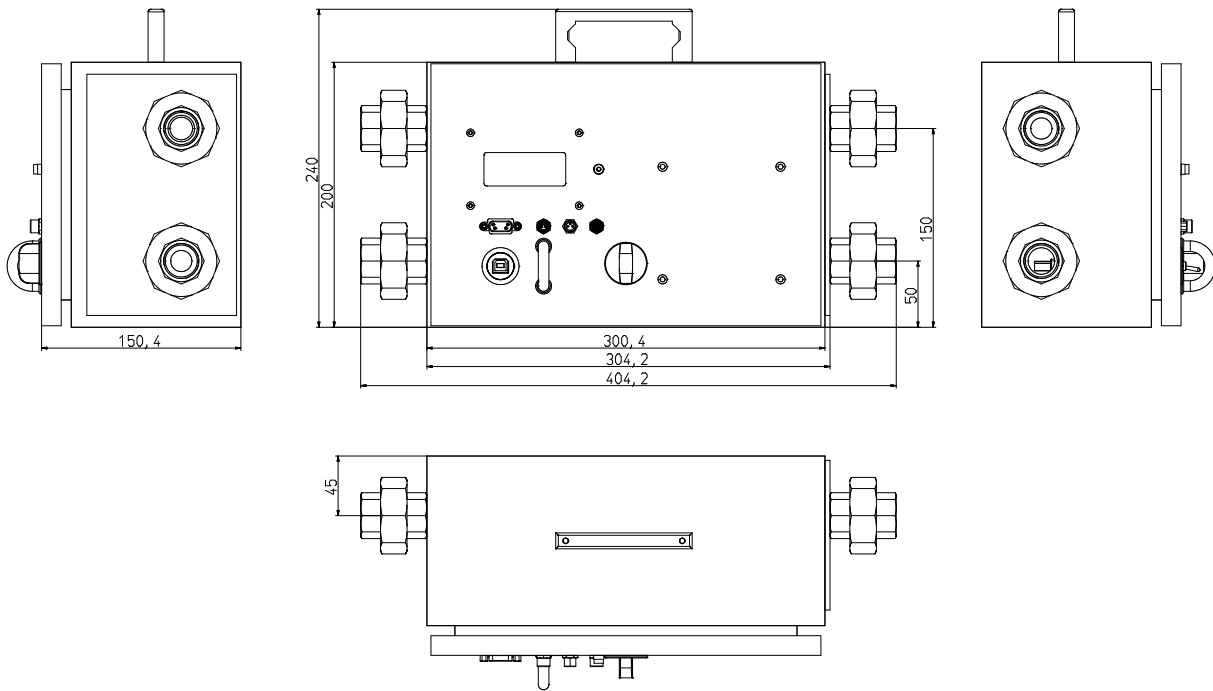
All dimensions given in mm

13.2 Dimensions PLM-10



All dimensions given in mm

13.3 Dimensions PLM-30



All dimensions given in mm