

Preparations for the efficient performance of measurements by PRIMES



ScanFieldMonitor SFM

PRIMES - the company

PRIMES is a manufacturer of measuring devices which are used to analyze laser beams. These devices are employed for the diagnostics of high-power lasers ranging from CO₂-, fiber- and solid-state lasers to diode lasers. A wavelength range from infrared through to near UV is covered, offering a wide variety of measuring devices to determine the following beam parameters:

- Laser power
- Beam dimensions and position of an unfocused beam
- Beam dimensions and position of a focused beam
- Beam quality factor M²

Development, production and calibration of the measuring devices is performed at PRIMES. This guarantees optimum quality, excellent service, and a short reaction time, providing the basis for us to meet all of our customers' requirements quickly and reliably.



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

Tel +49 6157 9878-0
info@primes.de
www.primes.de

1 Safety is important to us

1.1 Personal protection equipment

In order to ensure the health of our employees, wearing personal protective equipment (PPE) is essential for many activities. Therefore, please inform us whether and what kind of personal protective equipment is required in your company.

1.2 Laser protection and safety regulations

In order to perform safe measurements, the place of operation must comply with the current laser protection and safety regulations. Please understand that we cannot perform the measurements if the safety precautions on site are inadequate.

2 Measuring principle

The SFM is equipped with a glass plate with a small scattering structure in the middle. As the laser beam passes over the scattering structure, part of the laser beam is scattered along the lines of the scattering structure. This scattered light is detected by a photodiode in a time track.

By knowing the exact position, angle and shape of the scattering structure, the laser path and the beam radius of the laser beam are determined by evaluating the time track in the LaserDiagnosticsSoftware LDS. When measuring at one position, the following quantities can be determined:

- Beam radius along the scan direction of the vector
- Scanning speed
- Position of the vector (start and end point, angle and length)

In order to measure the working plane, especially the corner areas of the closed building platform optimally, the device is positioned at different positions within the building platform.

The SFM can also be used to measure a building platform with several lasers or to align adjacent building platforms. The examination of the overlapping areas of these building platforms is particularly important because the two lasers must be precisely matched to each other in order to irradiate this region completely and, above all, uniformly. Since the SFM allows an angle of incidence of $\pm 20^\circ$, this range can also be measured.

To measure the caustic of the laser beam along the beam propagation direction, the SFM must be raised or lowered along the z-axis of the laser system to be measured. By moving the SFM in the z direction, beam diameters can be measured in different planes. Thus, all important propagation parameters of the entire caustic of the laser beam are obtained:

- like focus position and focus diameter
- the beam quality factor M^2
- the Rayleigh length
- the divergence and the angle of incidence

not only in the center position of the building platform but also for the deflected laser beam.

By evaluating of all measurements, additional derived variables are obtained, such as the focus position over the entire processing field. Furthermore, measuring the switch-on and switch-off delay of the laser is possible via a separate measurement mode.

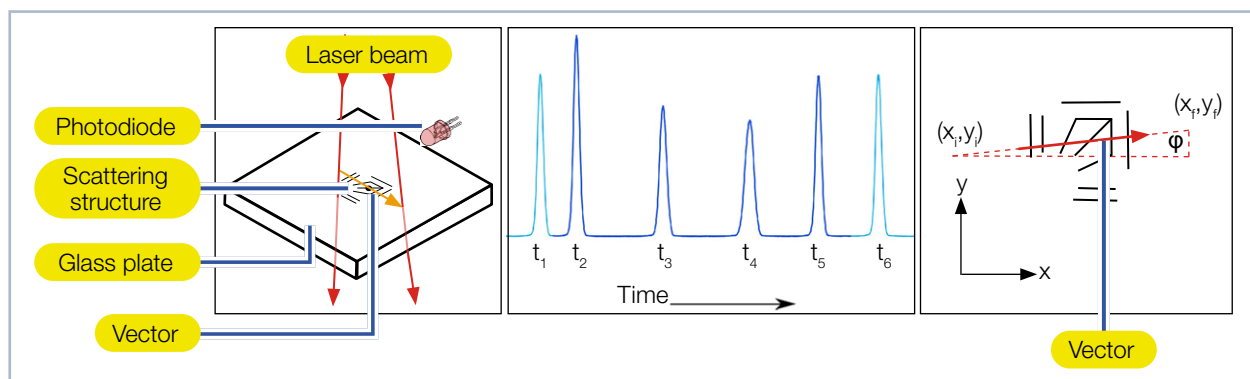


Abb. 2.1: Measuring principle of the SFM

3 Structural conditions

3.1 Installation position and space conditions

The SFM is mounted in an upright position. In order to measure the working plane, especially the corner areas of the closed building platform optimally, the device is positioned at different positions within the building platform.

Since the laser radiation passes through the SFM during the measurement and exits at the bottom, the mount for the SFM must be able to absorb the emerging laser radiation. The included device holder can be used to mount the device.

The installation of the device holder on the building platform of the laser system has to be carried out by the customer. The measuring accuracy that can be achieved when measuring the position of the vector in the building platform is mainly determined by the accuracy of the customer's mounting.

The processing unit is placed in any radiation-free position, e.g. in the powder compartment of the laser system.

Drawings with the dimensions can be found on the following pages.

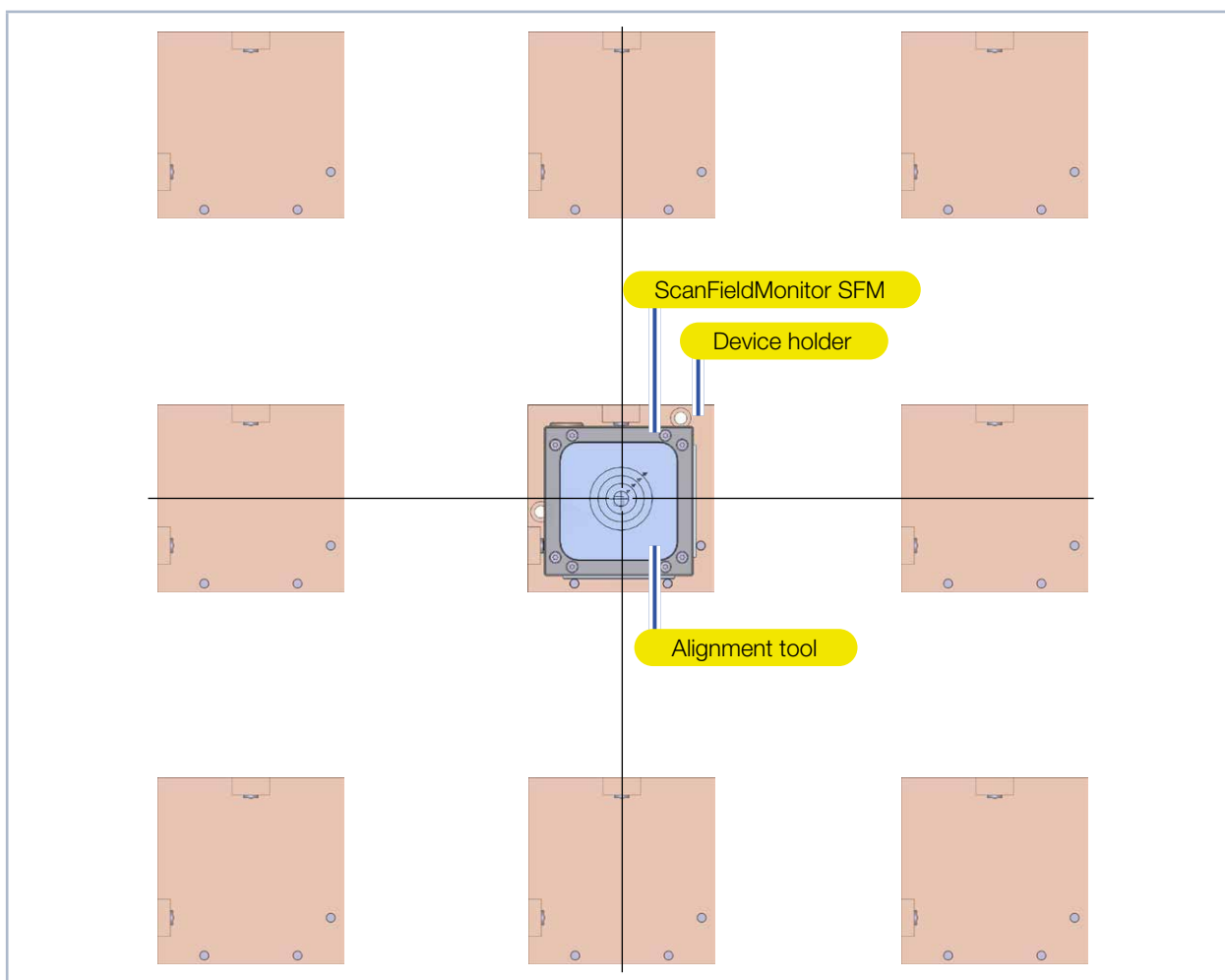


Abb. 3.1: Installation position on the building platform of the laser system

3.2 Clean the building platform and deactivate/remove the recoater (scraper)

Powder residues or contamination on the SFM lead to burn marks during measuring operation. Burn marks disturb the measurement and can cause the protective window to shatter or splinter. Before the measurement, the entire building platform including the inner walls must be cleaned. There must be no powder residues and contamination left on the building chamber.

To be able to measure along the z-axis without restriction the recoater (scraper) must be deactivated or dismantled.

3.3 Deactivate inert gas supply and switch off preheating

If possible, deactivate the inert gas supply of the laser system. Otherwise, long waiting times are to be expected when placing and aligning the SFM in the building platform, as the building platform is flooded with inert gas each time.

If possible, switch off the preheating of the laser system. The temperature of the building platform should be $< 30\text{ }^{\circ}\text{C}$.

3.4 Alignment to the laser beam

The SFM is mounted in an upright position and must be aligned to the laser beam. The SFM is positioned in the focal plane.

The SFM has a square entrance aperture of 20 mm x 20 mm. Within this area the laser radiation can enter the device. The scattering structure relevant for measuring amounts approx. 7.5 mm x 7.5 mm. PRIMES recommends the use of vectors with a length of 10 mm.

The scattering structure can be crossed by the laser in x and y direction. During a measurement, the laser must pass over the scattering structure at a constant speed and always in one direction as a straight line.

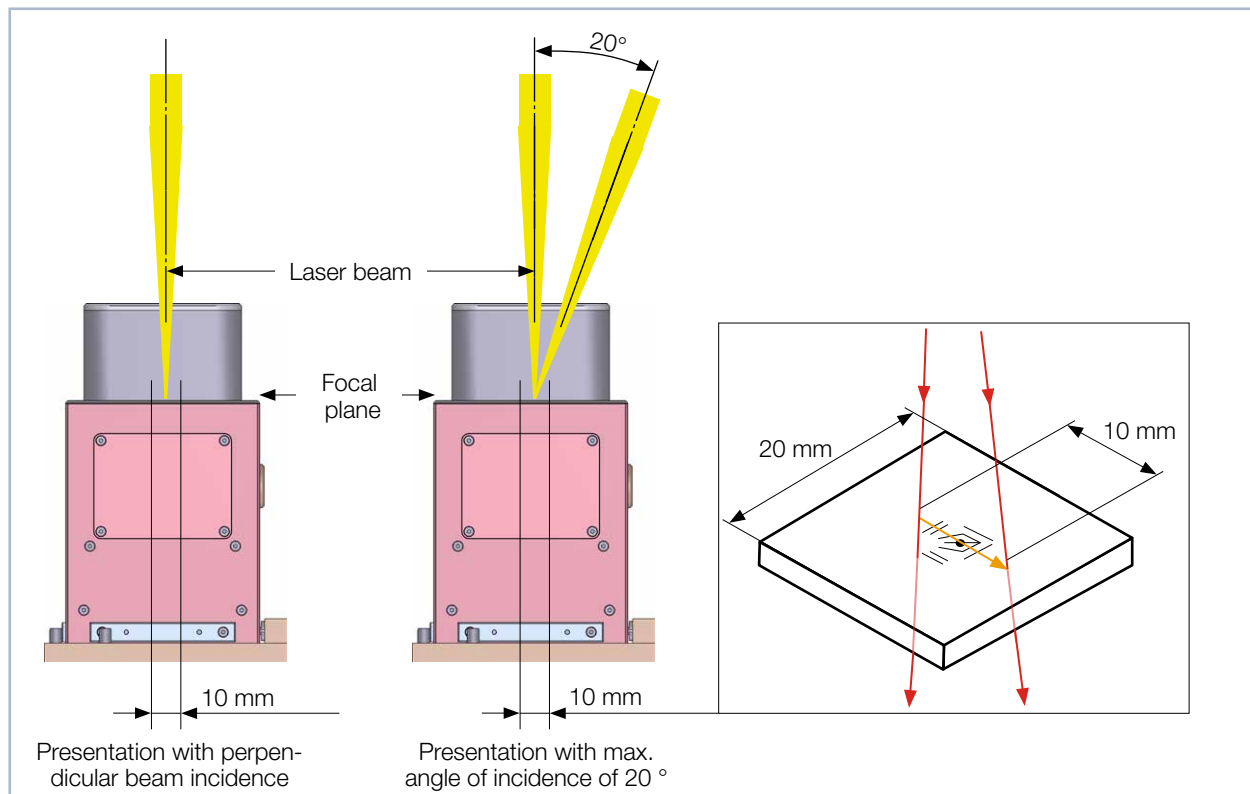


Abb. 3.2: SFM alignment to the laser beam with installed protective window spacer

4 Preparing/programming the vectors

4.1 Auto trigger

For automatic trigger adjustment, the laser must be switched on for ≥ 0.5 seconds. PRIMES recommends switching the laser on at a fixed position within the entrance aperture. It is also possible to move the laser at low speed within the entrance aperture window during automatic trigger adjustment. The laser does not necessarily have to pass the scattering structure.

Example: Vector length $L = 10.0$ mm; scanner speed $v = 20$ mm/s.

4.2 Vectors

For the measurements, vectors with a length of 10 mm must be run over the scattering structure. Two vectors (orange) must be prepared as shown in Figure 4.1.

For on-site alignment, it is helpful if the vectors can also be moved with the pilot laser. This significantly shortens positioning in the building platform.

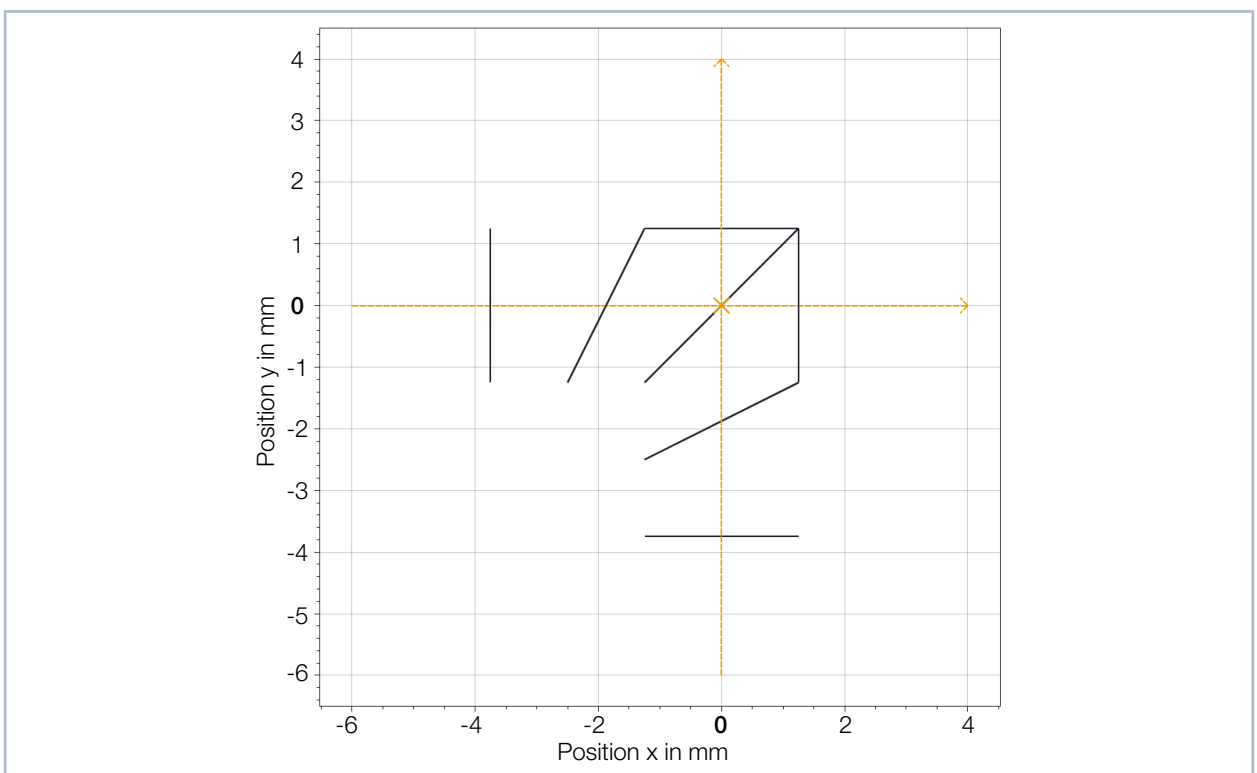


Abb. 4.1: Vectors over the scattering structure

4.3 Delay time

To measure the delay time, geometrically identical vectors with the same laser power must be moved at different speeds. To do this, create a build job with identical vectors whose scanning speed increases from vector to vector. This procedure measures the delay resulting from the power-dependent switch-on behavior of the laser. Scanning speeds of: 0.01 m/s, 0.5 m/s, 1 m/s, 2 m/s and max. scan/process speed are useful.

4.4 Caustic

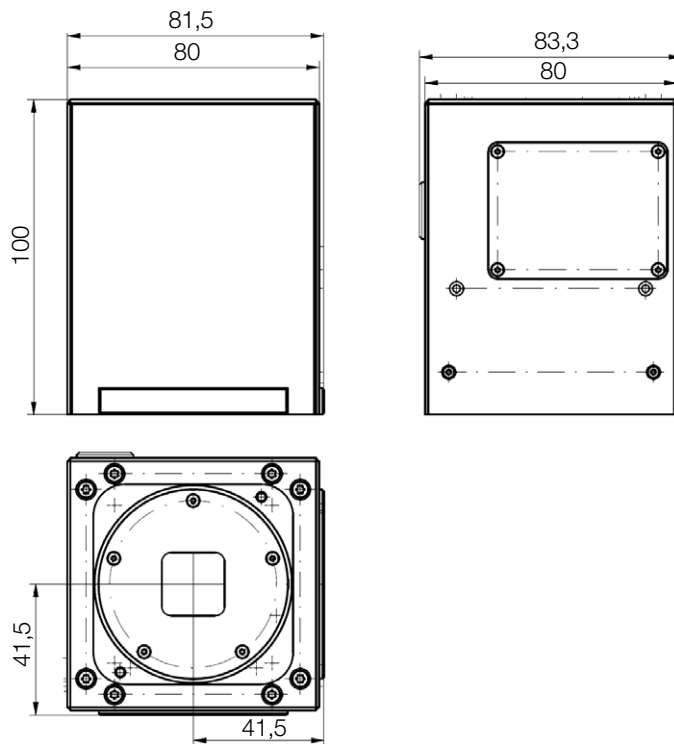
To measure the caustic of the laser beam along the beam propagation direction, the building platform must be able to be raised or lowered along the z-axis. The recoater (scraper) must not be moved after the building platform is moved (see Chapter 3.2). Otherwise the recoater (scraper) and the SFM will be damaged.

5 Environmental conditions

Environmental conditions	
Operating temperature range	+15 °C ... +40 °C (Reference temperature + 22 °C)
Permissible relative humidity (non-condensing)	80 %

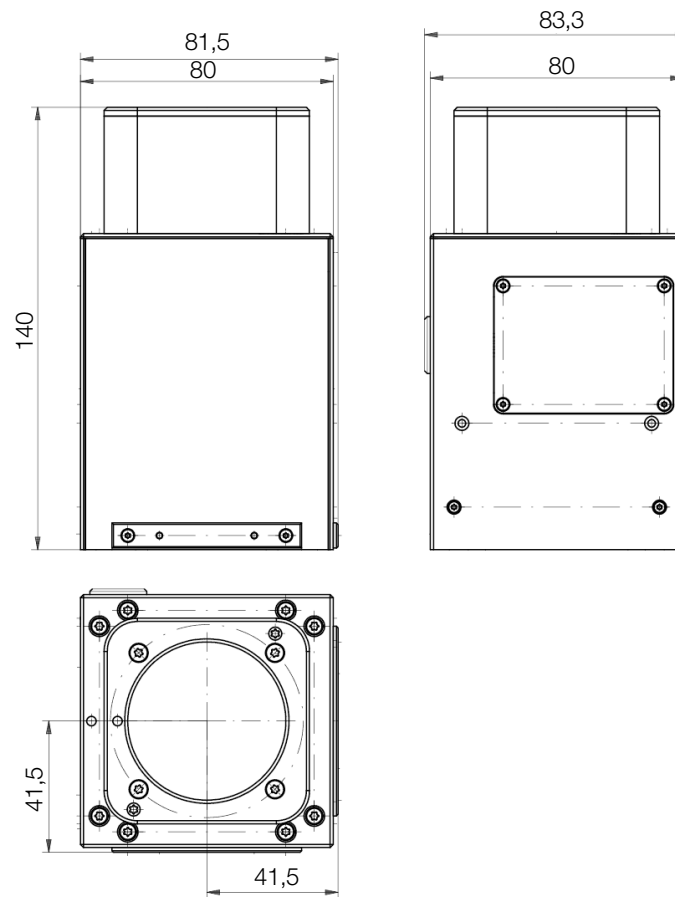
6 Dimensions

6.1 ScanFieldMonitor SFM



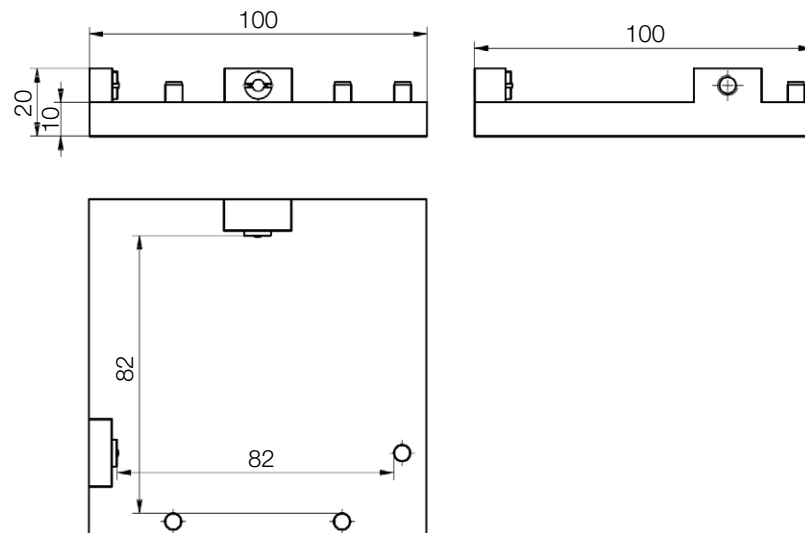
Dimensions in mm

6.2 ScanFieldMonitor SFM with protective window spacer



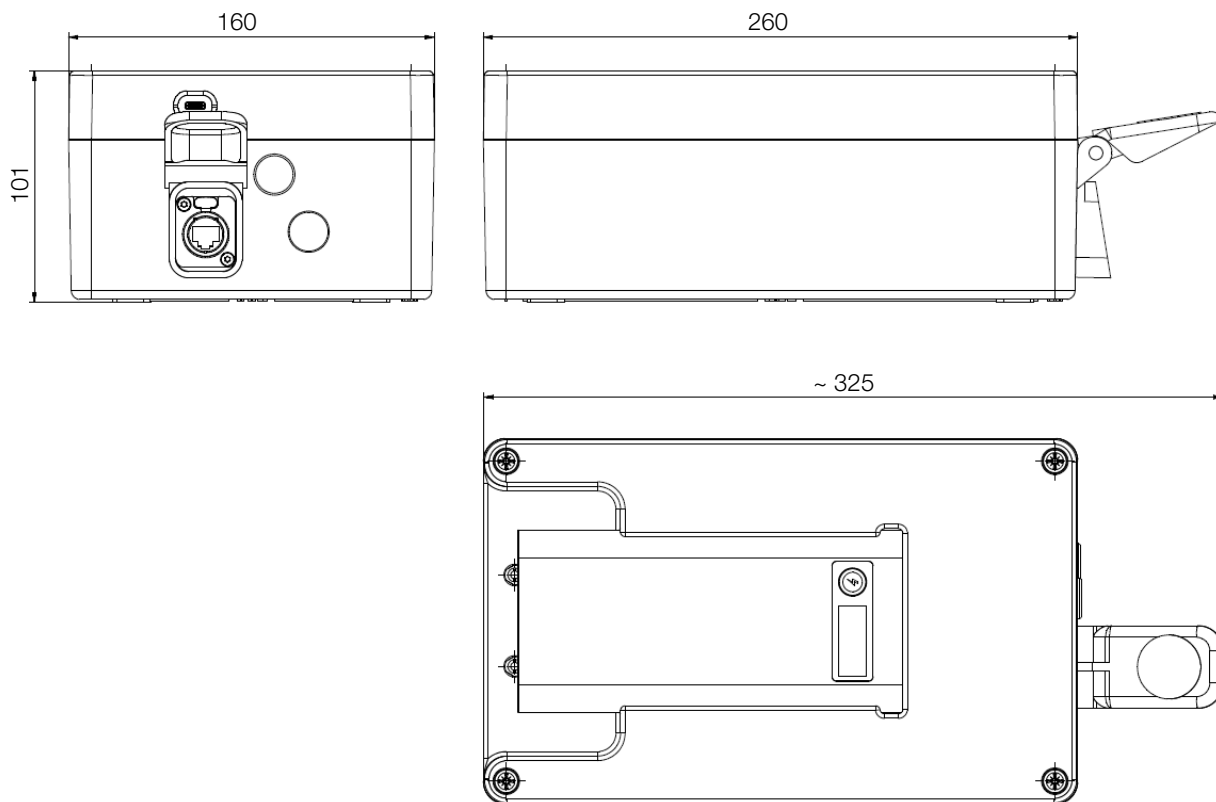
Dimensions in mm

6.3 Device holder



Dimensions in mm

6.4 Processing Unit



Dimensions in mm

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

Tel +49 6157 9878-0
info@primes.de
www.primes.de