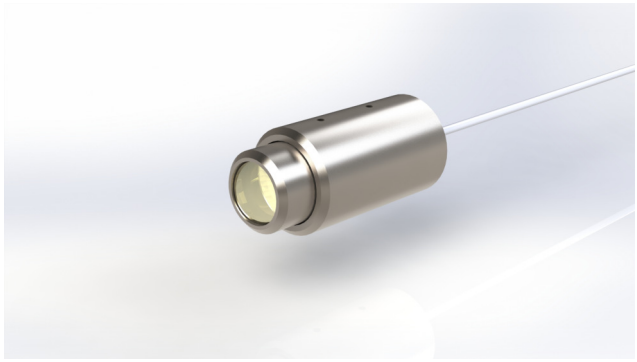
PicoScale sensor head type L01 - Specification Sheet



The L01 is a sensor head for the **PICO**SCALE laser interferometer. The target beam is focused along only one axis with a cylinder lens so that a line focus is generated. This way, the sensor head has a relatively large angular working range along the focused axis while having a large diameter along the orthogonal axis. Typically, these sensor heads are used to measure eccentric movements of rotating cylindrical objects and being insensitive to their wobble, i.e. tip/tilt of the axis of rotation.

1. OPTICAL SPECIFICATIONS

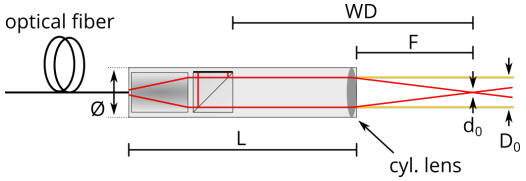


Figure 1. *Schematic drawing of the sensor head L01.*

Each sensor head is based on two main components (cf. Figure 1): the lens system, collimating the fiber output beam, and the beam splitter, which splits the beam into a reference and probe beam. The reference beam is reflected off an internal reference mirror, coated to one side of the beam splitter cube. The probe beam exits the head and is reflected off the target surface in order to track its relative displacement. The front surface of the beam splitter marks the absolute zero position of every **PICO**SCALE measurement as here the probe and reference beams are of equal length and thus the *working distance* is always defined relative to this point. In the L01 sensor head type, the probe beam is then enlarged by telescope optics and subsequently focused by a cylinder lens. Along one axis, the beam gets focused, while staying collimated along the orthogonal axis.

1.1 Beam properties

The probe beam has its waist at the focal length of the cylinder lens, which is 30 mm. In the focused axis, the beam has a beam waist diameter of about 50 µm, and in the collimated axis it is about 1.6 mm.

Table 1. *Summary of optical properties (typical).*

Property	Value
Wavelength	1550 nm
Optical output power	150 µW
Laser output mode	single mode
Beam waist diameter d_0 (focused axis)	50 µm
Beam waist diameter D_0 (collimated axis)	1600 µm
Focal length F	30 mm
Beam geometry	line focused
Angular working range* focused axis	±1.3°
Angular working range* collimated axis	±0.01°
Linear working range in beam direction	±10 mm

*See section 1.3.

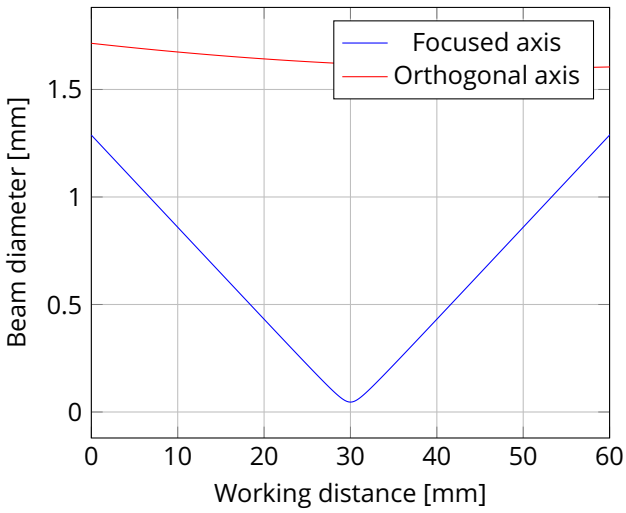


Figure 2. *Beam diameter as function of working distance.*

1.2 Working distances (WD)

The **PICO**SCALE sensor head L01 is specified for working distances of about ±10 mm around the focal dis-

tance when using a pin with a diameter of 25.4 mm. Operation of the sensor head out of these bound might, however, be possible at the cost of reduced signal-to-noise ratio of the measured position signal.

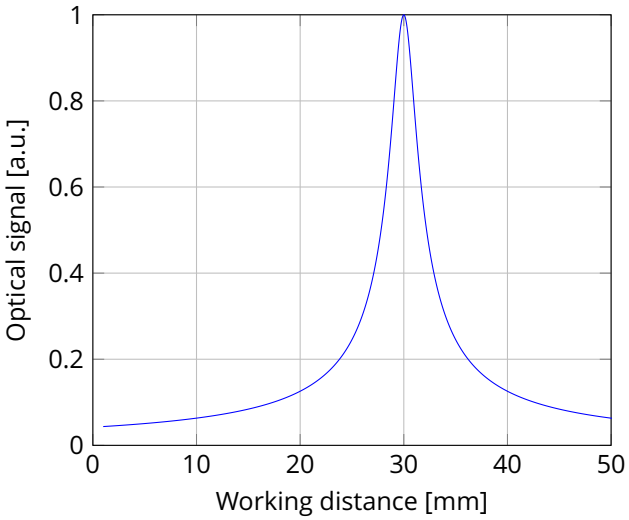


Figure 3. *Optical signal recovered by the sensor head as function of the working distance.*

1.3 Angular working range

The optimal performance of the sensor head is obtained, if the maximum light intensity returns from the target mirror. This is ensured for normal incidence of the probe beam on the target. However, the sensor head still collects some light, if the target is tilted with respect to the beam. If the target is tilted in the direction of the focusing, the sensor head provides an angular working range of about 1.3° (with a *beam interrupt threshold of 75%*), while the collimated axis only allows for tips/tilts of about 0.02°. The sensor head was designed to allow for measurements on cylindrical surfaces that rotate around their axial-symmetric axis with some amount of eccentricity and wobble. The sensor head should be aligned such that the focused axis is parallel to the axis of rotation. This configuration provides high robustness against wobble of the cylinder while maintaining good signal when the rotation is eccentric.

1.4 Options

The C01 sensor heads can be equipped with different beam splitters, allowing to customize the optical properties.

Beam splitter ratio

In standard sensor heads the laser beam is equally split into the reference and the probe arm. When targets with low reflectivity are used, the signal-to-noise ratio can be increased, if the beam splitter guides more power into the probe beam. Therefore, the beam splitter ratio can be customized.

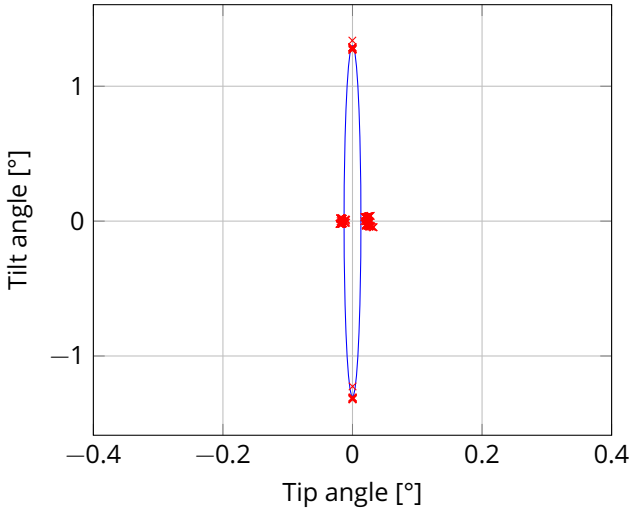


Figure 4. *Angular working range for a sensor head L01 and a target mirror at a distance of 30 mm. The typical minimum angular working range was determined to ±0.01° along the collimated axis and more than 1° in the focused axis.*

High power controller

As the reflected power from the curved surface can be relatively low, SmarAct offers a *high-power* version of the **PICO**SCALE controller so that much more light is guided to the target and the signal quality is increased. Please contact SmarAct for details and consulting.

2. VACUUM COMPATIBILITY

The standard sensor heads are designed to operate in ambient conditions. However, all sensor heads can optionally feature high vacuum or ultra-high vacuum compatibility. For the high-vacuum option (-HV), the sensor heads can be used in vacuum conditions with pressures as low as 10^{-6} mbar.

3. OPTICAL FIBER

The sensor head L01 is interfaced with the **PICO**SCALE controller via an optical fiber with an FC/APC connector (8° angled end face to minimize back-reflections). By default, the sensor heads are equipped with a 900 µm loose-tube fiber, which is 1.5 m long.
Both the fiber length and the actual fiber type can be customized. We offer the following options for the fiber type:

-B: 3 mm stainless steel tubing. Vacuum option on request.

4. HOUSING

A standard sensor head L01 has a titanium housing with a diameter of 9 mm and 25.5 mm length, as shown in Figure 5. Its weight is approximately 5.6 g.

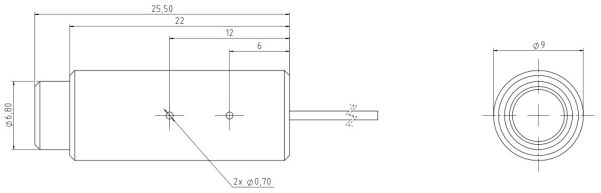
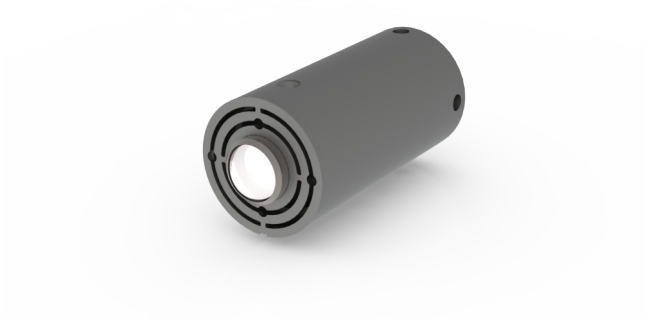


Figure 5. *CAD drawing of the sensor head L01 (General tolerances: ISO 2768-fH).*

4.1 Manual alignment option (MAM)



The MAM (manual alignment mount) option allows easy integration of a sensor head into an existing setup. The housing can simply be clamped in an appropriate bore hole, for example. Fine adjustment screws are used to manually align the sensor head to the target.

Table 2. *Summary of specifications of the MAM option.*

Property	Value
Outer diameter	12.7 mm (1/2 ”)
Length	30.5 mm
Alignment range (tip/tilt)	>±4°
Alignment resolution	0.5° per revolution

4.2 Piezo-actuated alignment option (PAM)

The PAM (piezo-actuated alignment mount) option allows remote alignment of the sensor heads. The housing can simply be clamped in an appropriate bore hole, for example. The PAM option is available as open-loop actuator (”-PAM“).

Table 3. *Summary of specifications of the PAM option.*

Property	Value
Tube diameter	12.7 mm (1/2 ”)
Assembly dimensions	20 mm x 20 mm x 25.5 mm
Alignment range (tip/tilt)	±2°
Alignment resolution	0.1 µrad

5. ORDER CODE

The order code of the sensor heads is built as follows:

PS -SH -L01 ***-A -B -D -E -F -G -H***

The placeholders can be replaced by the respective option code. These codes are given in the table below. If you do not specify an option, the default value is used.

Category	Shortcut	Description
-A Focal length	-xx	Focal length in mm (measured from housing). Standards: 30 mm, 50 mm
-B Vacuum/cryostat option	No entry/default	Operation in ambient conditions
	-HV	High vacuum compatibility; down to 10^{-6} mbar
	-UHV	Ultra-high vacuum compatibility; down to 10^{-11} mbar. Please contact SmarAct.
-D Beam splitter ratio	No entry/default	Beam splitter has 50% transmission
	-BSR80	Beam splitter guides 80% of light into probe beam
-E Fiber length	No entry/default	1.5 m fiber length
	-3.0	3.0 m fiber length. Other lengths on request.
-F Fiber type	No entry/default	900 µm jacket recommended minimal bending radius: 20 mm (ambient/HV); 30 mm (UHV/Cryo)
	-B	3 mm stainless steel tubing recommended minimal bending radius: 30 mm vacuum compatibility on request
-H Housing options	No entry/default	Standard size, 9 mm diameter, 25.5 mm mm length; weight 5.6 g
	-MAM	Manual alignment option, 12.7 mm diameter, 30.5 mm length
	-PAM	Piezo-actuated alignment option

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