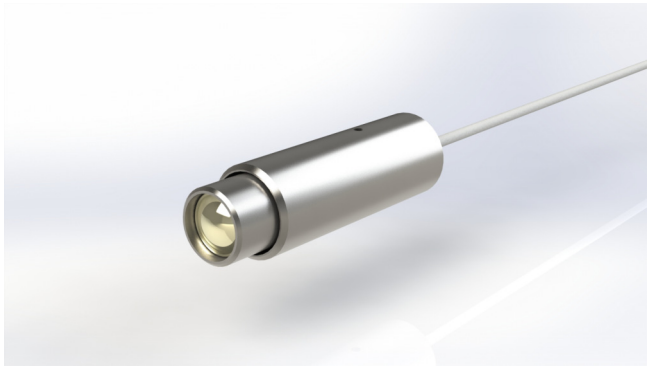
PicoScale sensor head type F01 - Specification Sheet



The F01 is a sensor head type with focused probe beam. This allows to measure displacements of small targets. Furthermore, the sensor heads provide high angular tolerances.

1. OPTICAL SPECIFICATIONS

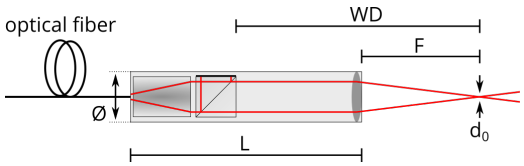


Figure 1. *Schematic drawing of the sensor head F01.*

After pre-collimation, an integrated beam splitter splits the light into a reference and probe beam as shown in Figure 1. The reference beam is reflected off the reference mirror which is coated to one side of the beam splitter cube. The probe beam is focused by a lens system and exits the head. The front surface of the beam splitter marks the absolute zero position of every **PICO**SCALE measurement as here the probe and reference beam are of equal length. Thus, the working distance (WD) is not equal to the distance from the head (i.e. focal length F) since the lens system is only integrated into the probe beam.

1.1 Beam properties

The probe beam has its waist at a customizable focal distance. The resulting beam diameter is dependent on the focal distance of the lens system and is typically in the range of 20 to 120 µm. The beam exhibits a large divergence and the beam diameter increases significantly if the target is away from the focal point, cf. figure 2.

Table 1. *Summary of optical properties (for a typical sensor head with a focal distance of 10 mm).*

Property	Value
Wavelength	1555 nm
Optical output power	150 µW
Laser output mode	single mode
Beam waist diameter (d_0)	28 µm
Focal distance (F)	10 mm
Working distance (WD)	23.5 mm
Working range	±0.5 mm
Beam divergence	35 mrad
Beam geometry	circular
Angular working range*	±2°

*See section 1.3.

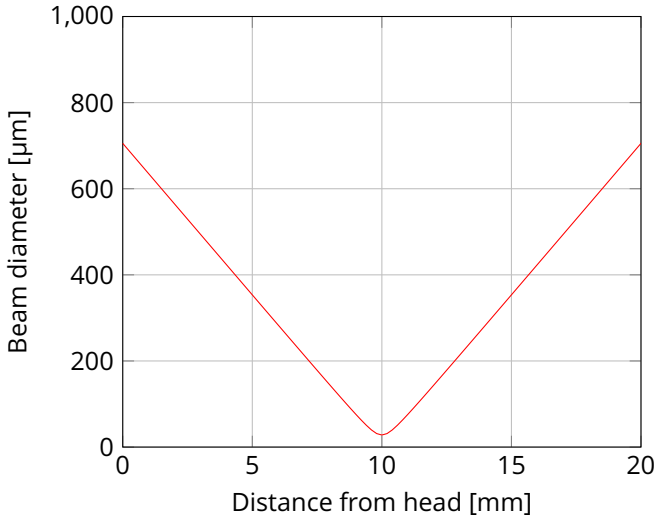


Figure 2. *Beam diameter as function of the distance from the head (for a sensor head with a focal distance of 10 mm).*

1.2 Working distances (WD)

The **PICO**SCALE sensor head F01 is optimized for probe mirrors close to the focal point. Due to the inevitable divergence of the laser beam, the optical power collected by the sensor head decreases if the target moves away from the focal point. Figure 3 shows the expected optical signal for varying distances. We recommend operation within ±0.5 mm around the specified focal length.

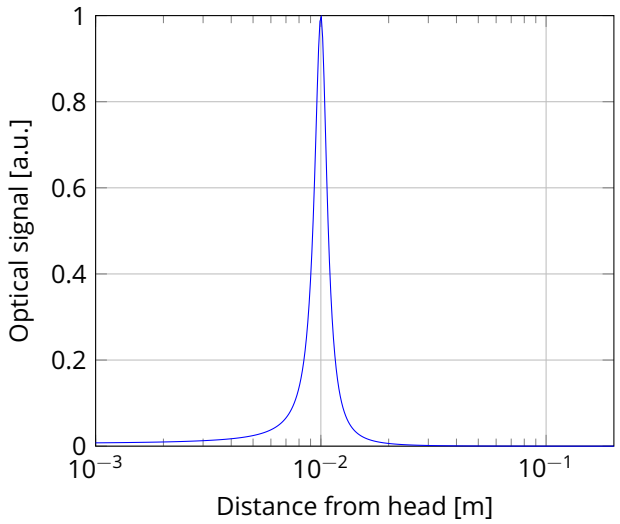


Figure 3. *Recovered optical signal as function of the distance from the head (typical values for a F01-10 sensor head).*

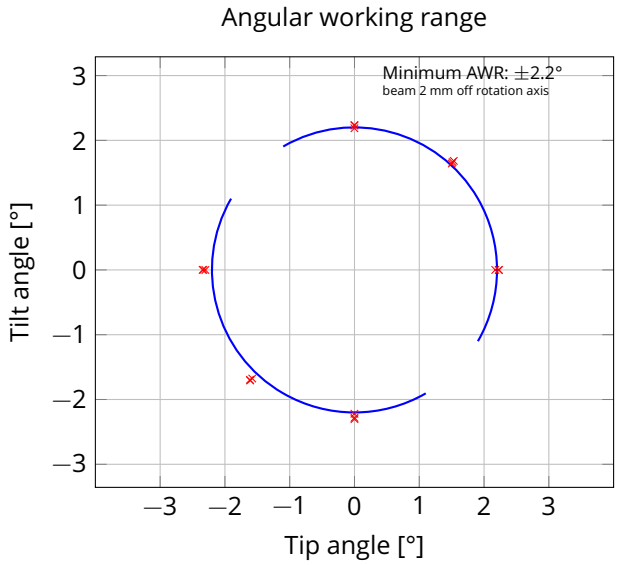


Figure 4. *Angular working range for a typical sensor head F01. The target mirror is placed at the focal point, which is not the pivot point here. The typical minimum angular working range is determined to ±2 degrees.*

1.3 Angular working range

The optimal performance for 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 mirror. However, the sensor head still collects some light if the target mirror is tilted with respect to the beam. Figure 4 shows the angular working range of a typical F01 sensor head. For this measurement a target mirror was placed at the focal point. The sensor head was aligned and the automated optimization routine was performed. Then, the target mirror was tipped/tilted and the angle at which the **PICO**SCALE recognized a "beam interrupt" event[1] was recorded. The blue circle indicates the minimum angular working range for standard "beam interrupt" settings. Due to the high signal intensity variations during tipping/tilting, the system needs to adjust its digital gain parameters. Therefore it is favorable to shift the pivot point, the center of rotation, a few millimeters away from the focal point to induce a continuous longitudinal displacement.

Please note, that a smaller spot size increases the angular working range (also given in the plot), but reduces the linear working range correspondingly. The focal distance needs to be specified in the order code (see below).

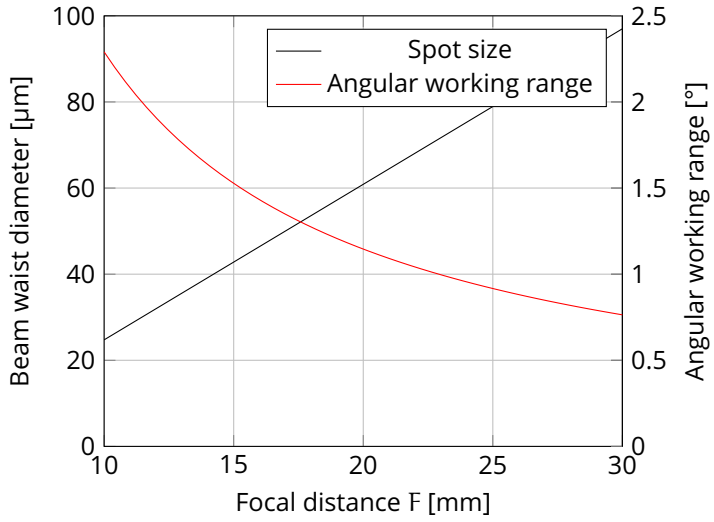


Figure 5. *Focus diameter and angular working range as function of the focal distance for the sensor head F01.*

1.4 Options

The F01 sensor heads can be equipped with different beam splitters, allowing to customize the optical properties.

Focal length

Each F01 sensor head is built with a customized focal length, which in turn determines the minimum achievable spot size. Figure 5 gives an overview of possible focal distances and corresponding focus diameters.

Beam splitter ratio (BSR)

In standard sensor heads the laser beam is equally split into the reference and the probe arm. In order to increase the signal-to-noise ratio when working with targets with low reflectivity, the beam splitter should guide more power into the probe beam. Therefore, the beam splitter ratio can be customized.

[1] The **PICO**SCALE controller provides an event notification system and can alert the user in case the signal quality drops below a specified level.

2. VACUUM COMPATIBILITY

The standard sensor heads are designed to operate in ambient conditions. However, all sensor heads can optionally feature high vacuum, ultra-high vacuum or cryostat compatibility. The high-vacuum option (-HV) can be used in vacuum conditions with pressures as low as 10^{-6} mbar.
The ultra-high vacuum option (-UHV) is required if the sensor heads are used at pressures as low as 10^{-11} mbar. They are specified for bake-out temperatures of up to 150°C.

3. OPTICAL FIBER

The sensor head F01 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 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

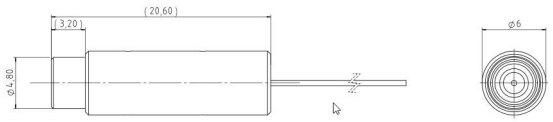


Figure 6. *CAD drawing of the sensor head F01 (General tolerances: ISO 2768-fH).*

A standard F01 sensor head has a titanium housing with a diameter of 6 ± 0.05 mm and 20.6 mm length, as shown in figure 6. Its weight is approximately 1.6 g.

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-acutated 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 -F01 ***-A -B -D -E -F -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: 10 mm, 20 mm, 30 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.
-D Beam splitter transmission	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, 6 mm diameter, 20.6 mm length; weight 1.6 g
	-MAM	Manual alignment option, 12.7 mm diameter, 30.5 mm length
	-PAM	Piezo-actuated alignment option

Sales partner / Contacts

Germany

SmarAct GmbH

Schuette-Lanz-Strasse 9
26135 Oldenburg
Germany

T: +49 441 - 800 879 0
Email: info-de@smaract.com
www.smaract.com

France

SmarAct GmbH

Schuette-Lanz-Strasse 9
26135 Oldenburg
Germany

T: +49 441 - 800 879 956
Email: info-fr@smaract.com
www.smaract.com

USA

SmarAct Inc.

2140 Shattuck Ave. Suite 302
Berkeley, CA 94704
United States of America

T: +1 415 - 766 9006
Email: info-us@smaract.com
www.smaract.com

China

Dynasense Photonics

6 Taiping Street
Xi Cheng District,
Beijing, China

T: +86 10 - 835 038 53
Email: info@dyna-sense.com
www.dyna-sense.com

Natsu Precision Tech

Room 515, Floor 5, Building 7,
No.18 East Qinghe Anning
Zhuang Road,
Haidian District
Beijing, China

T: +86 18 - 616 715 058
Email: chenye@nano-stage.com
www.nano-stage.com

Shanghai Kingway Optech Co.Ltd

Room 1212, T1 Building
Zhonggeng Global Creative Center
Lane 166, Yuhong Road
Minhang District
Shanghai, China

Tel: +86 21 - 548 469 66
Email: sales@kingway-optech.com
www.kingway-optech.com

Japan

Physix Technology Inc.

Ichikawa-Business-Plaza
4-2-5 Minami-yawata,
Ichikawa-shi
272-0023 Chiba
Japan

T/F: +81 47 - 370 86 00
Email: info-jp@smaract.com
www.physix-tech.com

South Korea

SEUM Tronics

1109, 1, Gasan digital 1-ro
Geumcheon-gu
Seoul, 08594,
Korea

T: +82 2 - 868 10 02
Email: info-kr@smaract.com
www.seumtronics.com

Israel

Trico Israel Ltd.

P.O.Box 6172
46150 Herzeliya
Israel

T: +972 9 - 950 60 74
Email: info-il@smaract.com
www.trico.co.il