

PicoScale sensor head type C03 - Specification Sheet



The C03 is a sensor head type optimized for moderate working distances and using retro-reflectors as target. The probe beam is enlarged so that its divergence is reduced and more optical power can be collected after reflection at the target mirror.

1. OPTICAL SPECIFICATIONS

The C03 sensor head type is based on the standard sensor head type C01, including the fiber collimation optics and the beam splitter. The beam splitter splits the beam into a reference and probe beam. The reference beam is reflected by an internal reference mirror, coated to one side of the beam splitter cube. In the C03 sensor head, the probe beam exits the head after being expanded by a telescope (two lenses) to significantly reduce the beam divergence. It is reflected off the target surface and tracks 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 beam are of equal length.

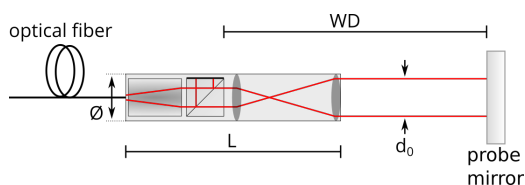


Figure 1. Schematic drawing of the sensor head C03.

1.1 Beam profile

The beam diameter is smaller than 2 mm for the whole specified working distance, as shown in figure 2, providing very low divergence.

Table 1. Summary of optical properties (typical).

Property	Value
Wavelength	1555 nm
Optical output power	75 μ W
Laser output mode	single mode
Beam waist diameter (d_0)	1590 μ m
Waist position	0.5 m
Beam divergence	0.6 mrad
Working distance	13-1000 mm
Beam geometry	circular
Angular working range*	$\pm 0.013^\circ$

*See section 1.3.

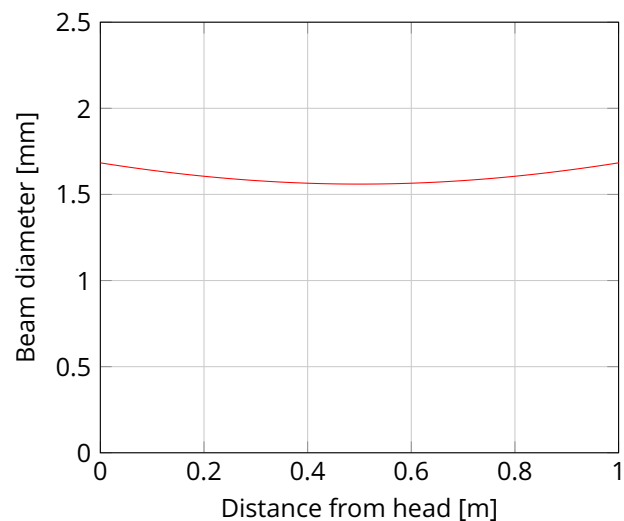


Figure 2. Beam diameter as function of working distance.

1.2 Working distances

The PICO SCALE sensor head C03 is specified for working distances between 13 mm and 1000 mm. Figure 3 shows the optical signal for varying working distances. For the sensor head C03, the recommended working range is not limited by the divergence of the laser beam. However, damping of the modulation depth for long distances limits the actual optical signal.

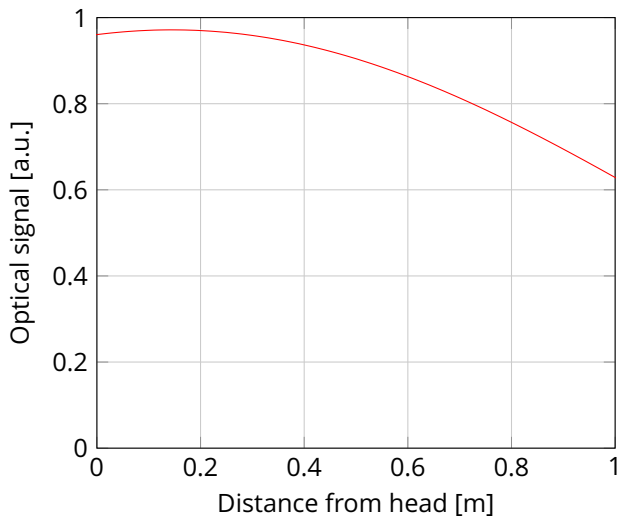


Figure 3. Optical signal recovered by the sensor head as function of the working distance.

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 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 C03 sensor head when a plane mirror is used as target. For the measurement, a target mirror was placed at a working distance of about 50 mm. The sensor head was aligned and the automated optimization routine was performed, generating optimum signal quality. Then, the target mirror was tipped/tilted and the angle at which the PICO SCALE recognized a "beam interrupt" event¹ was recorded. The blue circle indicates the minimum angular working range in all directions, for standard beam interrupt settings.



Please note, that the C03 sensor head type has a much larger spot size than other sensor heads. This allows to use retro-reflectors as targets, which significantly increases the angular working range!

1.4 Options

The C03 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 tar-

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

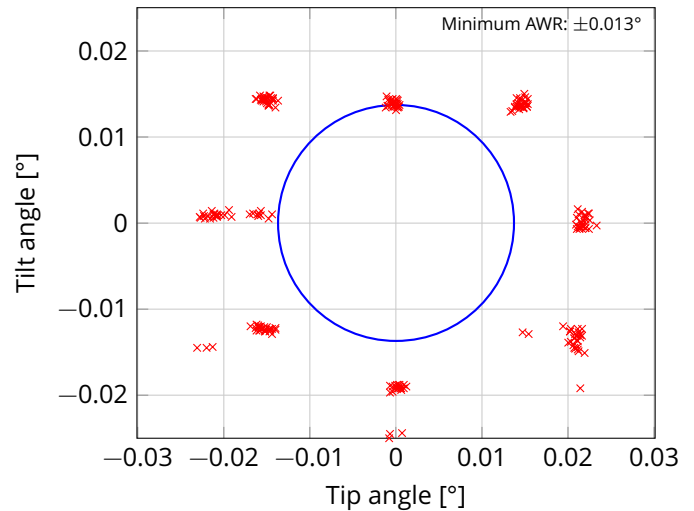


Figure 4. Angular working range for a sensor head C03 and a target mirror at a distance of 50 mm. The typical minimum angular working range was determined to ± 0.013 degrees.

gets 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.

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. For the high-vacuum option (-HV), the sensor heads 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. This option is currently under development; please contact SmarAct for detailed information.

3. OPTICAL FIBER

The sensor head C03 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. SmarAct offers the following options for the fiber type:

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

3.1 Stainless steel tubing for high vacuum

The protective fiber tubing from stainless steel requires special fixture to the sensor head. Thus, directly behind the sensor head the fiber is rigid and cannot be bent, cf. Figure 5.

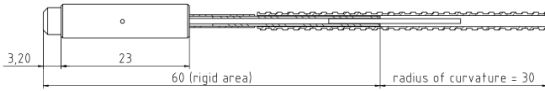


Figure 5. Sensor head with stainless steel tubing (HV-option). See text for details.

4. HOUSING

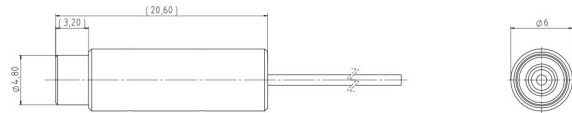


Figure 6. CAD drawing of the sensor head C03 (General tolerances: ISO 2768-fH).

A standard sensor head C03 has a titanium housing with a diameter of 6 ± 0.05 mm and 20.6 mm length. A CAD drawing of this head is 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)	$>\pm 4^\circ$
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)	$\pm 2^\circ$
Alignment resolution	0.1 μ rad

5. ORDER CODE

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

PS -SH -C03 -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
-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 μ m 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 mm length; weight 1.6 g
	-MAM	Manual alignment option, 12.7 mm diameter, 30.5 mm length
	-PAM	Piezo-actuated alignment option

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