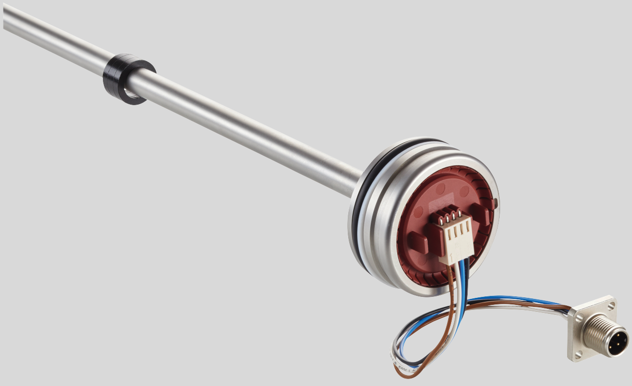
TECHNICAL INFORMATION

MAX48

Non-contact position sensors

SICK
Sensor Intelligence.



Product described

MAX48

Manufacturer

SICK AG
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Germany

Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Purpose of this document

In this document, the MAX48 position sensor is referred to simply as “device”.

This Technical Information describes:

- Device components
- Mechanical preparation of the device
- Electrical preparation of the device
- Necessary maintenance work for safe operation

1.2 Target audience

This document is intended for technicians (persons with technical expertise) tasked with installing and maintaining the device.

These technicians must be trained on the device.

Only trained electricians are permitted to carry out work on the electrical system or electrical assemblies.

1.3 Further information

- MAX48 Operating Instructions

Product web page for the MAX48

www.sick.com/MAX48

1.4 Symbols and document conventions

1.4.1 Warning levels and signal words

Important

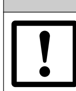
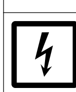
Hazard which could result in property damage.

Note

Tips

1.4.2 Information symbols

Table 1: Information symbols

Icon	Meaning
	Important technical information for this product
	Important information about electrical or electronic functions

2 Safety information

2.1 General notes

Should persons be placed at risk, or operating equipment potentially be damaged in the event of a malfunction or failure of the device, this must be prevented by means of suitable protective devices, e. g., emergency shutdown systems.

If the device is not functioning correctly, it must be taken out of operation and secured against unauthorized operation.

To guarantee proper operation of the device, please observe the following:

- Protect the device against mechanical stress during installation
- Do not open the device
- Connect the device with the correct polarity, supply voltage and control pulses
- Observe the permissible operating and ambient conditions for the device
- Regularly check the device for correct operation and document the results

2.2 Intended use

2.2.1 Purpose of the device

The MAX48 sensor is designed to take position measurements in mobile hydraulic applications and therefore can be used to control the hydraulic components of construction machinery, e.g., in hydraulic cylinders. The rugged housing offers optimal protection against dust, climatic influences, vibrations, surrounding media as well as electrical and magnetic fields.

The device is an accessory and must be connected to a suitable electronic control unit.

2.3 Responsibility of user

Designated users

see "Target audience", page 5.

Correct project planning

- This document assumes that appropriate project planning has been carried out before delivery of the device (e.g., based on the SICK application questionnaire), and the device is in the required delivery state based on that planning (see supplied system documentation).
  - ▷ If you are not certain whether the device corresponds to the state defined during project planning or in the supplied system documentation, please contact SICK Customer Service.

Special local conditions

In addition to the instructions in this Technical Information, follow all local laws, technical rules and company-internal operating directives applicable at the respective device installation location.

Read the technical information

- Read and follow the technical information in this document
- Follow all safety notes
- If there is anything you do not understand, please contact SICK Customer Service

Retention of documents

This Technical Information:

- Must be made available for reference.
- Must be conveyed to new owners.

3 Product description

3.1 Product identification

Type code

Table 2: Type code

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
M	T	X	4	8	N	-	1	1	R	1	0	T	T				

Table 3: Type code Explanation

Position	Meaning	Value
1	Series	M = Mobile
2	Technology	A = Magnetostrictive
3	Installation type	X = Integrated (hydraulic cylinder)
4 5	Size	48 = Housing diameter
6	Version	N = Non-Safety
7	Place holder	-
8	Diameter Pressure pipe	1 = 10 mm / 30 mm damping 7 = 7 mm / 30 mm damping
9	Voltage supply	1 = 12 VDC 2 = 24 VDC
10	Electrical Interface	V = Voltage A = Current
11 12	Signal output	10 = Analog 4.00 ... 20.00 VDC 21 = Analog 4.75 ... 0.25 VDC 40 = Analog 1.00 ... 9.00 VDC
13	Connection type	A = 4-pin analog (1 = VDC, 2 = n.c., 3 = GND, 4 = OUT) B = 4-pin analog (1 = VDC, 2 = OUT, 3 = GND, 4 = n.c.) M = 4-pin analog (1 = n.c., 2 = VDC, 3 = GND, 4 = OUT) K = Analog cable/3-wire PWM
14	Connector length	A = 60 mm M12 E = 100 mm M12
15 16 17 18	Measuring range Position measurement in 1 mm steps	e.g., 0300 = 50 ... 300 mm

3.2 Device variants

The device is available in the following variants:

- M12 male connector (4-pin) or 3-wire PUR cable

3.3 Construction and function

Construction of the device

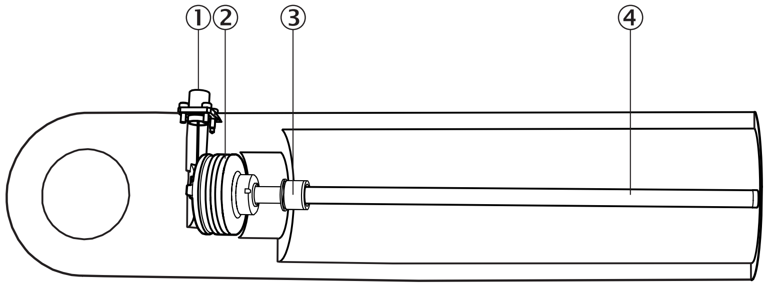


Figure 1: Construction of the MAX48

①	M12 connector system
②	Protective housing (electronics)
③	Position magnet
④	Pressure pipe

Connector system:
The M12 connector system requires very little time to attach. It is suitable for applications in harsh environments up to IP69K (when using a suitable mating connector).

Protective housing (electronics):
The housing is designed to be installed in a hydraulic cylinder and protects the sensor electronics against external influences.

Position magnet:
This is the only moving component in the measuring device when installed in the piston. The position magnet is located inside the piston and moves over the pressure pipe without contacting it. The magnet field thereby produced identifies the current position of the piston.

Pressure pipe:
Pressure-resistant construction - is inserted in the piston rod of the cylinder. It contains the hermetically protected magnetostrictive sensing element.

Principle of operation

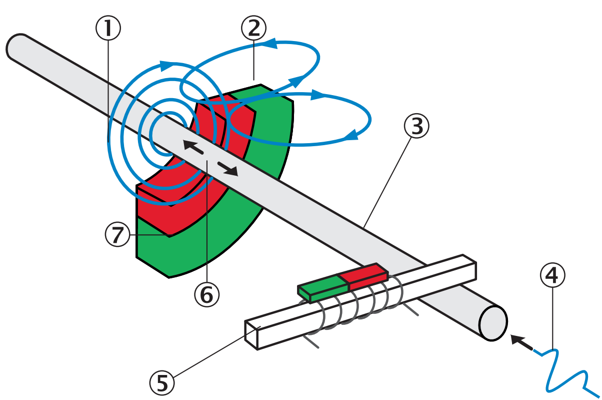


Figure 2: Schematic of the magnetostrictive measurement principle

①	Magnet field of the current pulse
②	Magnet field of the position magnet
③	Magnetostrictive sensor component
④	Current pulse
⑤	Sound wave converter

⑥ Structure-borne sound wave

⑦ Position magnet

The device operates on the magnetostrictive measurement principle that records the actual path of a position magnet:

The radial magnet field (1) generated by the current pulse (4) interacts with the magnet field (2) of the position magnet (7).

As a result of the interaction of the two magnet fields, a wave (ultrasonic) (6) is produced in the magnetostrictive sensor component (3). This travels to the converter (5) and the sensor electronics produce an electrical output signal.

The time interval between the current pulse and the detection of the structure-borne sound wave is measured and enables the precise position of the magnet – which changes as the cylinder moves – to be determined. As this measurement principle does not require a reference point, no recalibration is necessary for this type of device.

The device is also maintenance-free as a result of the non-contact measurement.

4 Mounting

4.1 Preparation for installing the sensor

4.1.1 Installation cavity for the sensor

The method of installation depends on the cylinder design. Generally, the sensor is installed from the piston rod side. It is also possible to install the sensor from the head side of the cylinder.

The sensor dimensions are listed in the technical specifications: see "Dimensions of sensor", page 32.

Fit dimensions and tolerances

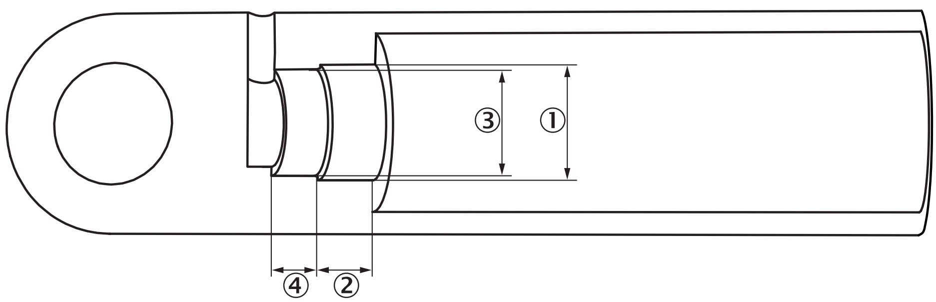


Figure 3: Dimensions of the sensor installation cavity

① Diameter for the housing
② Depth for the housing
③ Diameter for the electrical connection
④ Depth for the electrical connection

▶ Prepare an installation cavity for the sensor in accordance with the following dimensions.

Table 4: Installation cavity for the housing and electrical connection

Type	Installation cavity for housing		Installation cavity for electrical connection	
	① **Ø**	② **Depth**	③ **Ø min. ... Ø max.**	④ **Depth**
MAX48	48H8	21.2 mm + 0.2	d > 32.5 mm d < 40 mm	≥ 10 mm

Mean roughness value of the surface: Ra < 0.8 mm.

4.1.2 Installation cavity for the piston rod

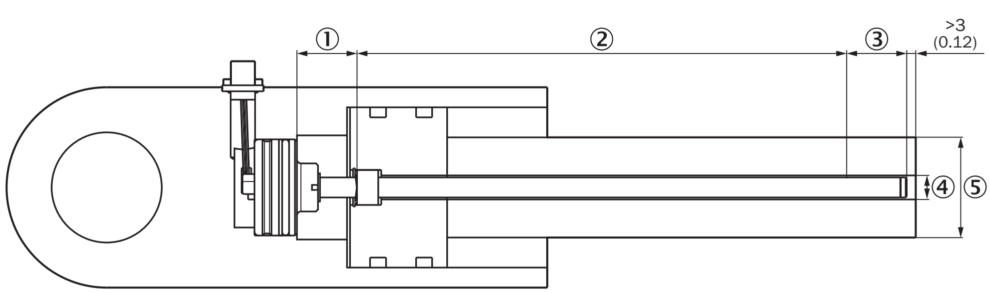


Figure 4: Installation cavity for the piston rod and pressure pipe

① Null zone

② Measuring range
③ Damping
④ Diameter of the pressure pipe
⑤ Diameter of the piston rod bore hole

Table 5: Depth of the piston rod

① = Null zone	30 mm
② = Measuring range	as per the applicable data sheet and selected device variant
③ = Damping	

▶ Prepare an installation cavity for the piston rod in accordance with the following dimensions.

Table 6: Bore hole diameters for the pressure pipe and piston rod

④ **Ø Pressure pipe**	⑤ **Ø Bore hole in the piston rod**
Ø 7 mm	Ø 10 mm
Ø 10 mm	Ø 13 mm

NOTE
The total bore hole depth comprises the measuring range (S), the damping (D), and an addition distance of 3 mm.

4.1.3 Insertion chamfer

To ensure proper and secure installation of the device in the cylinder, a insertion chamfer must be provided.

NOTICE
Risk of damage to the device during installation
The device can be damaged by any sharp edges present at the transition from the cylinder bore hole to the insertion chamfer on the O-ring.

▶ Prepare an insertion chamfer with a radius of 0.6 mm … 1 mm at the end of the cylinder bore hole.

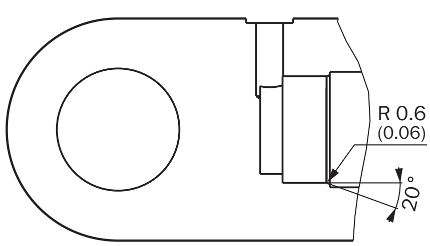


Figure 5: Insertion chamfer

4.1.4 Bore hole for the retaining screw

▶ Prepare a bore hole for the retaining screw in accordance with the following dimensions.

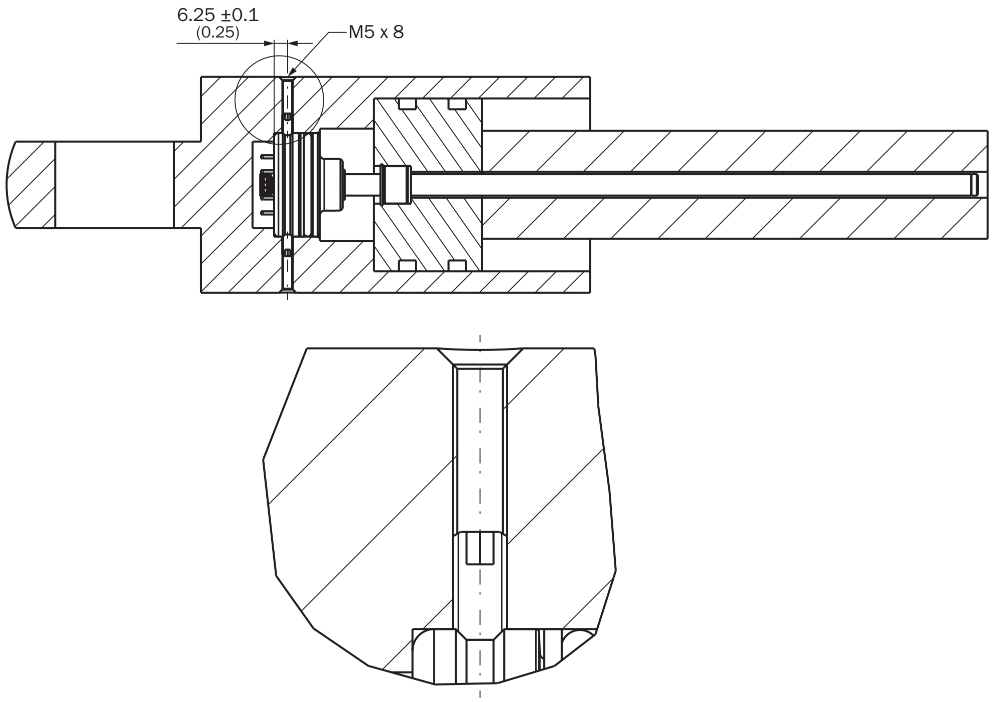


Figure 6: Installation cavity for the retaining screw

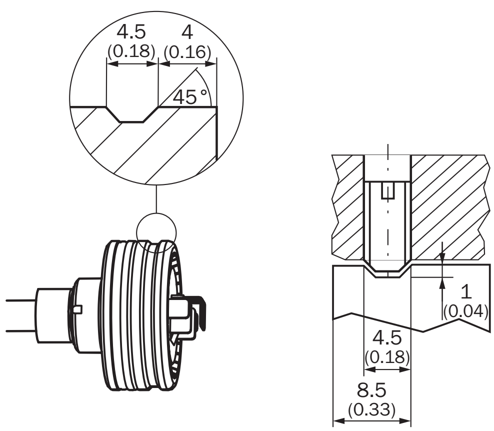


Figure 7: Position on the sensor

Permissible tightening torque for the retaining screw: 0.5 Nm ... 1.0 Nm. (based on the max. permissible force on the housing surface)

4.1.5 Bore hole for the connector system

▶ Prepare an installation cavity for the connector system and flange plate in accordance with the following dimensions.

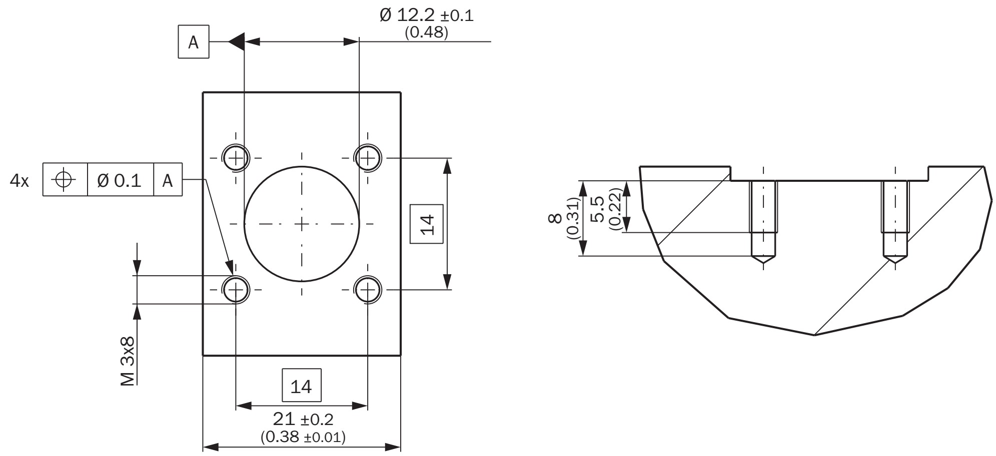


Figure 8: Dimensions of the flange plate bore holes

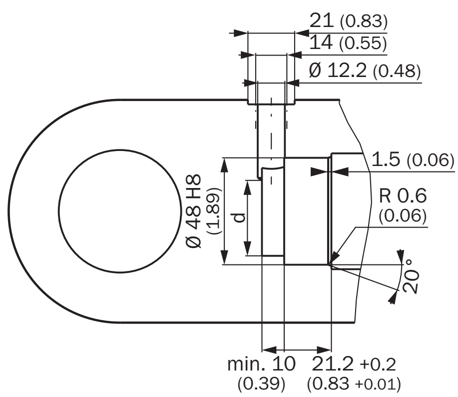


Figure 9: Dimensions of the connector system bore hole

4.1.6 Piston for the position magnet

▶ Prepare an installation cavity for the position magnet in accordance with the following dimensions.

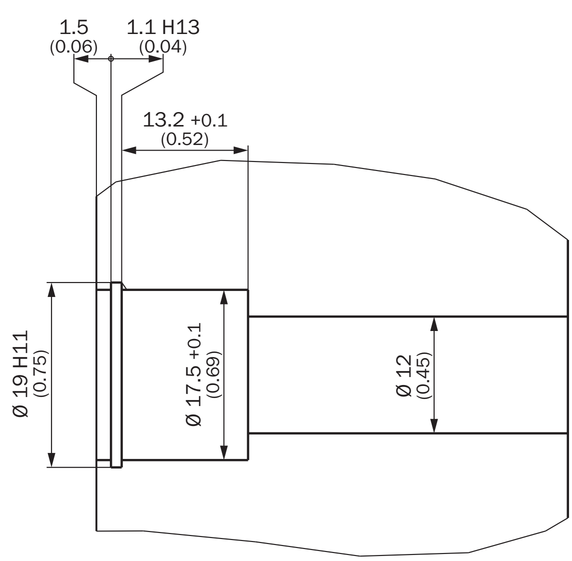


Figure 10: Dimensions of the position magnet installation cavity

4.2 Installing the position magnet

Table 7: Fit dimensions for the piston

① Magnet	17.4 x 10.6 x 12.0
② Corrugated ring	OD: 16.5 - 17.4 ID: 13.5 - 14
③ Circlip	DIN 472 - 18 x 1
Diameter of the position magnet bore hole	13.2 + 0.1
Depth of the position magnet bore hole	10.7 + 0.1

Sequence of work steps:

NOTICE

- The position magnet must not rub against the pressure pipe.
- Observe the operating pressures: see "Technical data", page 30.

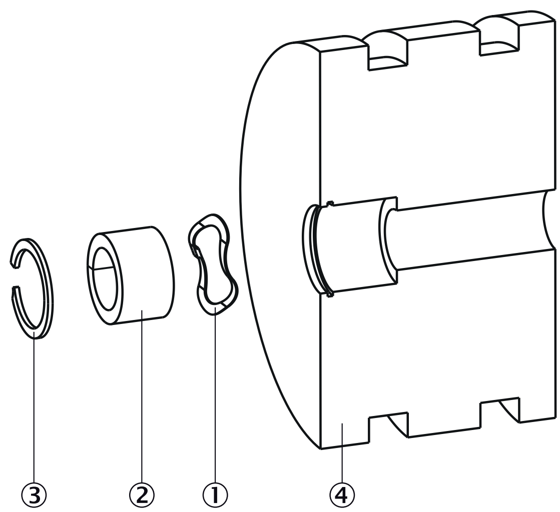


Figure 11: Installation of the position magnet

① Corrugated spring washer
② Position magnet
③ Circlip
④ Piston

1. Prepare the piston for installation of the magnet: see "Piston for the position magnet", page 14.
2. Mount the corrugated spring washer.
3. Mount the position magnet.
4. Mount the retaining ring.

4.3 Location of the O-ring and support ring

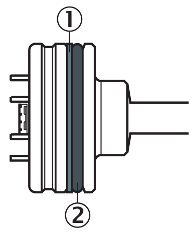


Figure 12: O-ring and support ring

① Support ring
② O-ring

The O-ring and support ring are pre-installed as shown in the figure and prevent oil from penetrating into the connector area.

4.4 Installing the sensor in the cylinder

4.4.1 Installing using an M12 connector system

The M12 connector system has an enclosure rating of IP69K and is pre-assembled ready for installation.

NOTE
When selecting the mating connector, ensure that it also has an enclosure rating of IP69K.

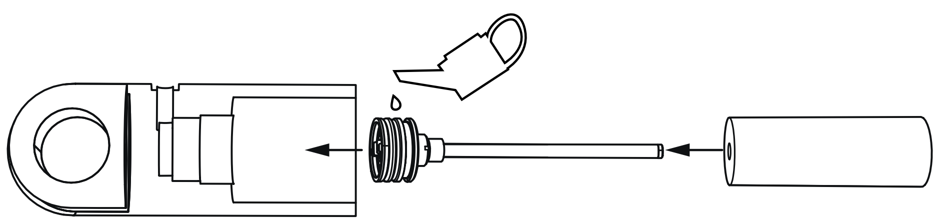


Figure 13: Installation steps

1. Lubricate the O-ring and support ring.
2. Guide the connector system and its connecting cables carefully through the cylinder wall.

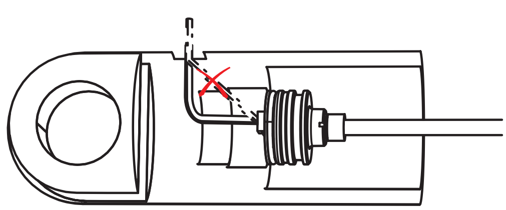


Figure 14: Tensile load at edges

NOTICE
Risk of damage to the connecting cables during installation.

Tensile loads and sharp edges can damage the stranded wires and connecting cables of the connector system.

▶ Avoid tensile loads and look out for sharp edges when installing the connector system.

3. Carefully insert the device into the cylinder.
4. Mount and engage the contact carrier in the flange plate.

NOTE
When mounting the contact carrier in the flange, ensure the lug of the contact carrier is aligned correctly.

5. Press the flange plate into the bore in the cylinder wall.
6. Fasten the flange plate using suitable screws or rivets.
7. Use a specially prepared sleeve (e.g., made from polyamide) to locate the device in its final position.
8. If necessary, carefully tap in the device and sleeve using a mallet.

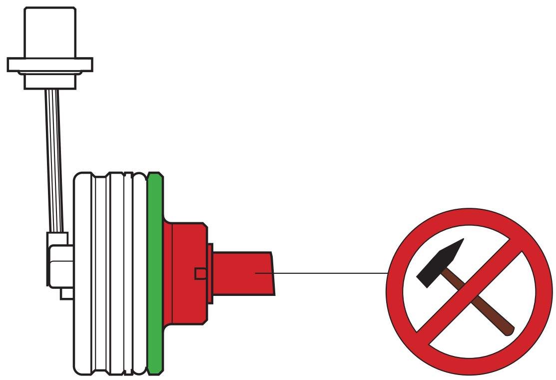
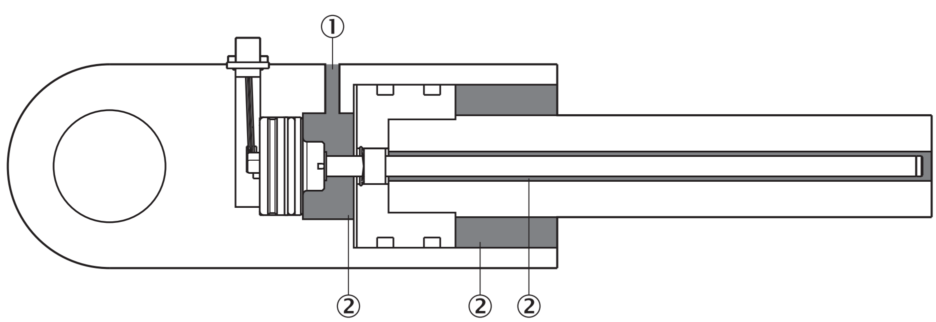


Figure 15: Load-bearing surfaces

NOTICE
Risk of damage to the device during installation.
Forces acting on the load-bearing features of the housing can damage the device.

▶ Do not apply any load on the pressure pipe or behind the head of the device when mounting the sensor.



① Oil inlet
② Areas requiring lubrication

9. Lubricate the indicated areas via the oil inlet.

Recommended screws for mounting the M12 flange

The screws should be selected so that no collision with the coupling nuts of the connected mating connectors can occur, e.g.,:

- M3 socket head cap screw with flat head
- DIN 912 hexagon socket head cap screw
- ISO 14580 Torx screw
- DIN 84 slotted-head screw
- Comparable Phillips head screws or self-tapping screws

A soluble screw locking adhesive should be used when installing the screws.

Alternatively, the flange plate can be fastened using DIN 6660 button-head rivets.

4.4.2 Installation using cable connector and screwed cable gland

For devices with a cable connection, a protection class rated (preferably IP68) metallic cable gland should be used for sealing and strain relief. The cable glands should also be protected against damage by surrounding them with metal profiles (e.g. U-steel).

When installing connector plugs on devices with a cable connector, please consider the following:

- Enclosure rating: (preferably IP68)
- Connector housing:
  Metal or impact-resistant plastic (check media resistance)
- Protect against external influences: enclose the cable sheath and male connector
- Prevent fluid ingress: the cable sheath should ideally be coated with sealing compound at offset locations
- Polarity: ensure correct polarity
- Male connector with screw terminals:
  Apply ferrules and clamp all strands in the ferrule
- Soldered connections: no projecting strands or “cold joints”
- Crimp contacts: use a suitable tool to produce a gas tight crimp
- ESD protection: protect workplaces and persons from electrostatic discharge
- Prevent fluid ingress:
  Use suitable caps to seal the male connector after installation
- Screwed cable glands: protect by enclosing within steel profiles

4.5 Install the retaining screw

The retaining screw prevents the sensor housing from moving in the axial direction. A DIN 913 M5x10 threaded pin with tapered head should be used for this purpose. Use a soluble screw locking adhesive when installing the threaded pin.

! **NOTICE**
Risk of damage to the device during installation.

The screw must only rest in the slot and not be tightened too hard.

▶ Tighten the screws with a torque of 0.5 Nm ... 1.0 Nm.

4.6 Cylinder handling after sensor installation

4.6.1 Washing and drying the cylinder

To protect the connecting cable and male device connector from ingress of cleaning agents, please observe the following:

Sensors with M12 connector system

- Drying temperature: max. 90 °C
- Pressure of the cleaning fluid: ≤ 5 bar
- Protective cap: use the supplied plastic protective cap
- In case of higher pressures: use a metallic protector
- Protection class: IP69K

Sensors with cable connector / installed male device connector

- Cable connectors / male device connector: protect against ingress of cleaning agents using suitable sheathing
- Screwed cable glands: protect against ingress of moisture

4.6.2 Electrostatic painting of the cylinder

The electrostatic painting process uses very high voltages (up to 100 kV) which can damage the electronics of the sensor integrated into the cylinder. To avoid damage, observe the following when painting the cylinder:

- To avoid electrical isolation of the piston rod and the cylinder/sensor housing, do not the suspend the cylinder by the piston rod
- Clean off all lacquer and other residues from the hanging devices in the paint shop, all connectors used to short-circuit the connecting wires, and all connections to the paint shop earth

Painting of cylinders with an integrated sensor and M12 connector system or installed male device connector

To protect the sensor electronics, use metal protective caps that meet the following requirements:

- The cap must not be made from aluminum
- The cap must be made from a permanently electrically-conductive material
- The cap must have an M12x1 thread
- The cap must be screwed on until it contacts the flange plate on the connector as desired
- Always use a torque of ≥ 5 Nm to tighten the cap
- Make sure no paint particles get onto the thread or pin contacts

Any paint particles on the outside of the cap will not impair the sensor.

A suitable cap can be purchased from the manufacturer as an accessory: see "Accessories", page 34.

Painting of cylinders with an integrated sensor and cable connector or third-party connector

Cylinders with an integrated sensor and cable connector cannot be electrostatically painted because the cable connector is not protected against over voltages. Reliable electrostatic painting is only possible when using a combination of M12 connector system and protective cap.

4.6.3 Mounting the cylinder on mobile hydraulic machines

When mounting the cylinder on mobile hydraulic machines, ensure no male connectors, cables or cable ends can be damaged in the process.

4.6.4 Electrical and electrostatic interference

Insulation tests

When performing insulation tests on mobile hydraulic machines, disconnect all sensor connection cables to avoid damage from high voltages.

Welding

Welding currents may be produced when carrying out welding work on nearby components. Welding currents can damage the sensor pipe or the sensor electronics.

The following must also be observed when welding:

- Disconnect all sensor connections during welding
- Never fasten the grounding point to the piston rod or cylinder pipe
- Never perform welding work directly on the cylinder
- Never perform welding work near a cylinder if it has a built-in sensor
- Welding currents and similar effects can also arise at any bearing location on the machine

5 Electrical installation

5.1 Electrical connection

The device is equipped with an M12 connector system. For the pin assignment of the selected device variant, see: see "Connection diagrams, pin assignment", page 21.

A variant with a cable connection is also available. Male device connectors must be used in this case.

Enclosure ratings

To guarantee an IP69K enclosure rating (M12 connector system), a suitable mating connector must be used.

5.1.1 Connection diagrams, pin assignment

M12 connector system

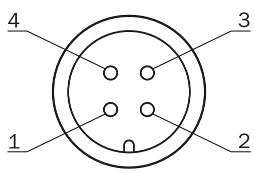


Figure 16: M12 pin assignment

Pin assignment as per position 13 of the type code.

Table 8: M12 pin assignment

Type code	A	B	M
12/24 VDC	1	1	2
GND (0 V)	3	3	3
Signal	4	2	4
n.c.	2	4	1

Table 9: Allocation of wire colors (cable connector: position 13 of type code = "K")

12/24 VDC	BR (brown)
GND (0 V)	BL (blue)
Signal voltage, depending on variant	BK (black)
Signal current, depending on variant	WH (white)

5.1.2 Connection sequence

Connect the wires in the following sequence:

1. Connect the 12/24 VDC voltage supply.
2. Connect the GND (0 V).
3. Connect the signal.

5.2 Connection diagram for vehicle electronics

Machine ground

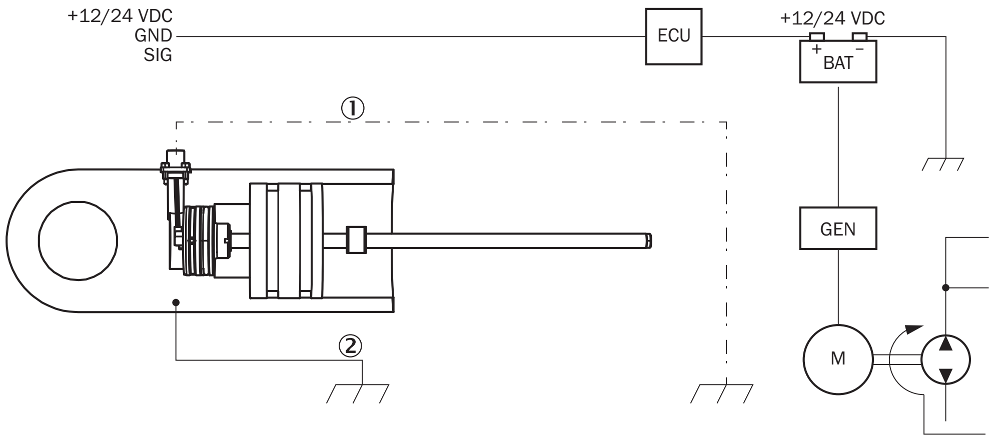


Figure 17: Connection diagram

① Cable shielding (optional)

② Chassis GND

To guarantee fault-free operation of the device, the cylinder must be connected to machine ground (Chassis GND).

The physical contact with another machine component equalizes the potential of the cylinder. If the cylinder is mounted in an insulated manner, a separate grounding must be provided, e.g., by connecting a ground strap directly to the cylinder.

Cable shielding

The device is adequately shielded by the cylinder when installed, and therefore has not been provided with its own shielding. If a shielded cable is used, it is necessary to check, depending on the application, whether one side or both sides of the shield should be connected to machine ground. Any high voltage or high frequency fields in the vicinity can influence the shielding and the signal in the cable.

6 Commissioning

6.1 Commissioning the device

1. Check that the connectors have been connected correctly: see "Connection diagrams, pin assignment", page 21.
2. Select a suitable fuse: see "Select a suitable fuse", page 23.
3. Set up the filter wiring: see "Set up the filter wiring", page 23.
4. Put the device into operation.
5. Check the sensor function: see "Checking the device function", page 27.

6.2 Select a suitable fuse

When selecting a suitable fuse, the transient peak current when switching on the device for the time must be taken into consideration:

Table 10: Inrush current when switching the device on

Inrush current for an supply voltage of 12 VDC	2.5 A / 50 µsec typical
Inrush current for an supply voltage of 24 VDC	5.0 A / 50 µsec typical

6.3 Set up the filter wiring

Thermal noise, for example from resistors, becomes evident when the signal output is amplified sufficiently. The supply voltage ripple (see "Technical data", page 30) and other sources of interference, e.g., electromagnetic interference, can also affect the quality of the analog output signal. To reduce the noise when acquiring analog measurement data, it is essential to use a filter.

A suitable filter, for example, is a combination of R1 = 50 Ω and C1 = 100nF bis 1µF. This will keep the signal delay time within the cycle time (internal measurement frequency) while not changing the dynamic behavior significantly.

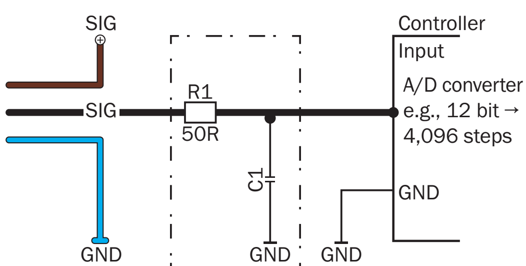


Figure 18: Filter wiring

NOTICE
The A/D converter at the input of the installed electrical controller will determine the resolution of the sensor, e.g.,:

- 8 bit = 256 steps
- 10 bit = 1,024 steps
- 12 bit = 4,096 steps

Signal output when switching on the device

When switching on the device, the signal output is ≥ F.S.O = Full Scale Output. After that the device is ready for use.

Table 11: Signal output when switching on the device

Output Signal		
F.S.O	During powering on	In case of internal failure
20 mA	> 10 mA	> 21.0 mA
4.75 Volt	> 5 VDC	> 5.1 VDC
4.50 Volt	> 5 VDC	> 5.1 VDC
9.50 Volt	> 5VDC	> 10.0 VDC

Internal failure:

a) missing position magnet
b) malfunction of magnetostrictive device

6.4 Tolerance considerations for the set point

The set points (zero/end point) of the device are adjusted by the manufacturer to a tolerance of ± 1 mm.

NOTICE
Further tolerances must be observed when installing the cylinder.

During teach-in, the piston rod moves to the zero point and to the end point in order to eliminate all tolerances in the cylinder/sensor combination. The measured signals are programmed in the controller accordingly. When operating the device without teach-in, please note the following tolerance-related information:

Table 12: Tolerances when operating the device without teach-in

Example for a measuring range of 400 mm		
Range	4,000 mV	16 mA
Signal	0.5 ... 4.5 V	4 ... 20 mA
Zero/end point ± 1.0 mm	± 10 mV	± 0.04 mA
Position magnet ± 1.0 mm	± 10 mV	± 0.04 mA
Mechanical assembly ± 0.5 mm	± 5 mV	± 0.02 mA
Total of all tolerances ± 2.5 mm	± 25 mV	± 0.10 mA

Considerations for zero end point

Table 13: Zero end point

Example for a measuring range of 400 mm		
Output	VDC output	mA output
Signal	0.5 ... 4.50 V	4 ... 20 mA
Zero point	± 25 mV	± 0.10 mA
min. zero point	0.475 mVDC	3.90 mA
max. zero point	0.525 mVDC	4.10 mA
End point (F.S.)	± 25 mVDC	± 0.10 mA
min. end point	4.475 mVDC	19.90 mA
max. end point	4.525 mVDC	20.10 mA

After installation of the sensor in the cylinder, deviations from the target values will arise due to these permissible tolerances. These deviations must be taken into consideration when setting limit values in the controller:

Table 14: Deviation from the limit values

Typical values						
	VDC			mA		
Cylinder stroke (mm)	200	400	800	200	400	800
Tolerances	± 50 mV	± 25 mV	± 15 mV	± 0.20 mA	± 0.10 mA	± 0.05 mA

7 Transport and storage

7.1 Transport and storage conditions

When transporting the fully assembled cylinders, ensure that the cable and male connector of the built-in sensor are not subjected to tensile loads.

The cylinders must be stored in a dry place. When storing the cylinders on top of one another, ensure no male connectors or cables are crushed.

Cover the connectors any free cable ends with an anti-static bag. The original packaging, for example, is suitable for this purpose. The dust protection caps of the connector system can also be reused during storage.

For part numbers for the original packaging and the dust protection caps, see: see "Accessories", page 34.

8 Maintenance

8.1 Checking the device function

Analog sensors

To verify the proper operation of the device, perform the following checks:

- Connections and pin assignments
- Supply voltage
- Check the device by disconnecting it and testing it using an external supply
- Check the device using a multimeter as described below

Measuring the VDC output signal

The following output signals can be measured:

- 0.25 … 4.75 VDC
- 0.5 … 4.5 VDC
- 0.5 … 9.5 VDC

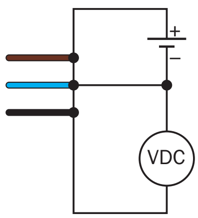


Figure 19: Measuring the output signal in VDC

1. Switch the measuring range of the multimeter to VDC.
2. Connect the multimeter to the signal lead and 0 V lead.
3. Connect the voltage supply (+12/24 V).
4. Connect 0 V (-0 V).

Measuring the 4 … 20 mA output signal

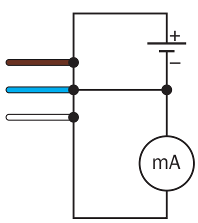


Figure 20: Measuring the output signal in mA

1. Switch the measuring range of the multimeter to mA.
2. Connect the multimeter to the signal lead and 0 V lead.
3. Connect the voltage supply (+12/24 V).
4. Connect 0 V (-0 V).

Alternative measuring method: using a resistor (e. g., 100 Ω):

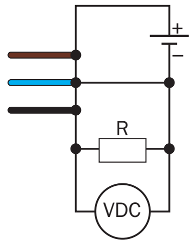


Figure 21: Measuring the output signal using a resistor

1. Connect the resistor to the signal lead and 0 V lead.
2. Switch the measuring range of the multimeter to VDC.
3. Connect the multimeter in parallel to the resistor.

When using a resistor of, for example, 100 Ω, the following values are displayed:

Table 15: Example measurement values

Supply	at 4 mA (null zone)	at 20 mA (end position)
12 V, 24 V	0.4 V	2 V

8.2 Error table

Table 16: Errors during installation

Error cause	Possible consequences
Incorrect pin assignment	No signals
Ambient temperature too high	Damage to the device components
Cylinder bore hole too small	Damage to the device components when installing the device
Not noticing pointy or sharp edges	Damage to male connectors, wires, cables
Careless handling of the device	Damage to the device components
Welding work after installation	Damage to the sensor housing or electronics due to welding currents
Damage to the cable	Short-circuiting or failure of the electronics
Male connector not sealed	Short-circuiting or corrosion of electronic components due to liquids
Ground or shielding connected incorrectly	Signal interference, possible damage to the electronics

8.3 Repairs

All necessary repair work on the device must be carried out by SICK Service.

9 Decommissioning

9.1 Dismantling

When dismantling the cylinder and the sensor, ensure that no male connectors, cables or cable ends can be damaged in the process.

9.2 Disposal

Any device which can no longer be used must be disposed of in an environmentally friendly manner in accordance with the applicable country-specific waste disposal regulations. As the device is categorized as electronic waste, it must never be disposed of with household waste.

10 Technical data

10.1 Analog MAX48

Table 17: Technical specifications

Performance	
Measurand	Position
Measuring range	0050 ... 2,500 mm (in 1 mm steps)
Unusable measuring range:	
Null zone (zero point)	30.0 mm
Damping (end point)	30.0 mm/ 36.0 mm/ 63.0 mm (depending on type)
Power-up delay	< 250 msec
Measuring frequency (internal)	2 ms
Setpoint tolerance Zero and end point of the usable piston stroke	≤ 1.0 mm
Resolution	0.1 mm typical (noise-free)
Hysteresis	± 0.1 mm
Linearity	± 0.25 mm of measuring range up to 500 mm (typical) ± 0.04% F.S. of measuring range above 500 mm (typical)
Temperature drift (warm-up phase)	max. ± 0.25 mm

Interface	
Electrical interface	Analog
Voltage signal	0.25 ... 4.75 VDC 0.50 ... 4.50 VDC 0.50 ... 9.50 VDC 1.00 ... 9.00 VDC
Current signal	4 ... 20 mA

Electrical connection	
M12 male connector	4-pin, wire length 060 ... 240 mm (depending on type)
3-wire cable	3 x 0.32 mm^2 (AWG22), stripped 300 ... 10,000 mm (depending on type)

Electrical data	
Supply voltage	12 VDC (8 ... 16 VDC) 24 VDC (8 ... 30 VDC)
Supply voltage ripple	< 1% p-p
Power consumption:	
12 VDC voltage signal	≤ 0.5 W
24 VDC voltage signal	≤ 0.5 W
24 VDC current signal	≤ 1.0 W
Current consumption:	
12 VDC voltage signal	≤ 30 mA
24 VDC voltage signal	≤ 20 mA
24 VDC current signal	≤ 40 mA
Load resistance:	
Voltage signal	RL ≥ 10 kΩ

Electrical data	
Current signal	100 ≤ RL ≤ 500 (load resistance)
Switch-on current:	
12 VDC supply voltage	2.5 A / 50 µsec typical
24 VDC supply voltage	5.0 A / 50 µsec typical
Over voltage protection	ISO 16750-2: ≤ + 36 VDC on all poles
Reverse polarity protection	ISO 16750-2: on all poles
Insulation resistance	ISO 16750-2: Riso ≥ 10 MΩ, 60 sec
Dielectric strength	ISO 16750-2: 500 VDC (0 VDC to housing)

Dimensions	
Size	48F7 mm (for installation in a 48H8 clearance)
Unusable range:	
Null zone (zero point)	30.0 mm
Damping (end point)	30.0 mm/ 36.0 mm/ 63.0 mm (depending on type)
Pressure pipe	Ø 7 mm or 10 mm (depending on type)
O-ring	Ø 40.87 mm x 3.53 mm
Support ring	Ø 42.6 mm x 48 x 1.4 mm
M12 flange	EN 61076-2-101 DM 20 x 20 mm - 14 mm hole pattern
3-wire cable	Ø 3.2 mm, 3 x 0.32 mm^2 (AWG22), stripped 300 ... 10,000 mm (depending on type)

Material	
Pressure pipe	Stainless steel 1.4306, AISI 304L
Electronics housing	Stainless steel 1.4305, AISI 303
O-ring	NBR 70
Support ring	PTFE
M12 male connector insert	Glass fiber reinforced polyamide, nickel-/gold-plated brass contacts
M12 flange	Stainless steel with O-ring (NBR70)

Ambient data	
EMC	EU Directive 2014/30/EU CE marking EU Directive 2009/64/EU Agricultural machinery
Generic standards	
Immunity as per EN 61000-6-2	EN 61000-4-3 High-frequency electromagnetic fields EN 61000-4-4 Conducted fast transients (burst) EN 61000-4-5 Conducted emission voltage (surge) Class2 EN 61000-4-6 Conducted high-frequency signals EN 61000-4-8 Magnet fields
Radiated emissions as per EN 61000-6-3	CISPR25 High-frequency radiated interference
Immunity Agricultural and forestry machines (ISO 14982) Construction machines (EN 13309/ ISO13766)	ISO 11452-2 High-frequency electromagnetic fields ISO 11452-4 Bulk Current Injection ISO 11452-5 Strip Line Method
Radiated emission Agricultural and forestry machines (ISO 14982) Construction machines (EN 13309/ ISO13766)	CISPR25 High-frequency radiated interference
Transient pulses	ISO 7637-2 Test pulse 1/ 2a/2b /3a/3b /4 /5a/5b
ESD (air and contact discharge)	EN 61000-4-2 ISO/TR 10605

Enclosure rating	
Housing without electrical connection	ISO 16750-4: EN 60529 IP67 30 min - 1 m
Housing with cable connector	ISO 16750-4: EN 60529 IP67 30 min - 1 m
M12 male connector	ISO 16750-4: ISO 20653 IP69K with coupling on; Spraying: 30 sec. / 100 bar / 80 °C

Temperature ranges	
Operating temperature (operating condition) Allowing for fluid temperature and intrinsic heating of the electronics	- 40 °C ... +105 °C
Ambient temperature (fluid)	- 30 °C ... +95 °C
Permissible relative humidity	EN60068-2-30: 90% r.H. (condensation not permitted)
Storage	- 20 °C ... +85 °C (r.H. 55%)

Resistance to shocks	
Drop test	ISO 16750-3: IEC 60068-2-31
Single shock	ISO 16750-3: IEC 60068-2-27: 100 g, 11 ms
Continuous shocks, 1,000 shocks per spatial axis	ISO 16750-3: IEC 60068-2-27: 50 g, 11 ms

Resistance to vibrations		
(Ø 10 mm pressure pipe)		
Sine	ISO 16750-3: IEC 60068-2-6	10 ... 55 Hz (3.5 mm pp) 55 ... 2,000 Hz 20 g (24 hrs)
Sine-on-random	ISO 16750-3: IEC 60068-2-80	100 ... 440 Hz 11.3 g (r.m.s.) 10 ... 2,000 Hz 18.1 g (r.m.s.)
Random	ISO 16750-3: IEC 60068-2-64	10 Hz ... 2,000 Hz 20 g (r.m.s.) (48 hrs) Resonance peaks removed

Hydraulic pressure		
	Pressure pipe, Ø 10 mm	Pressure pipe, Ø 7 mm
Operating pressure P_N	400 bar	320 bar
Max. overload pressure during operation (P_Nx1.2)	480 bar	380 bar
Max. test pressure in cylinder (P_Nx1.5)	600 bar	480 bar

10.2 Dimensions of sensor

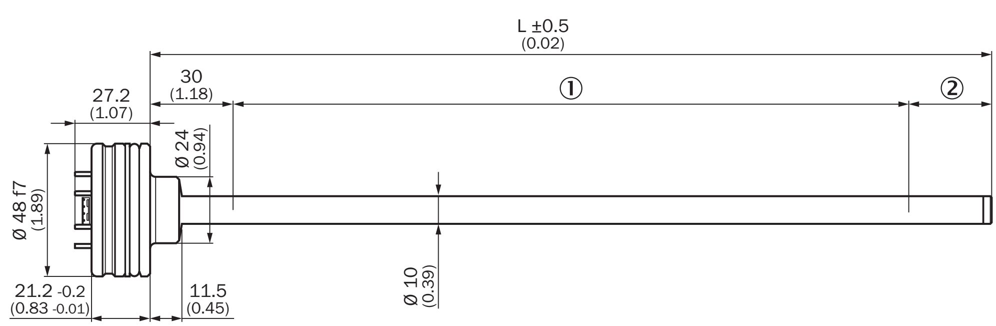


Figure 22: MAX48 overall dimensions

① Measuring range

② Damping

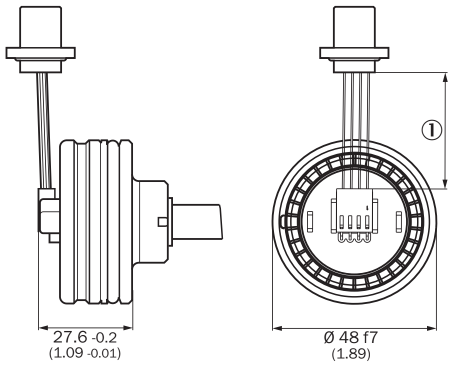


Figure 23: MAX48 dimensions on connection side - M12

① Wire / cable length

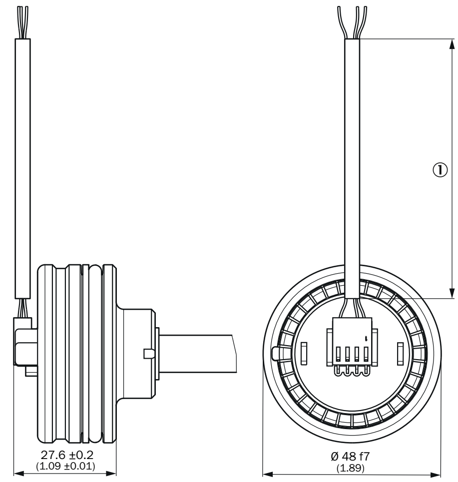


Figure 24: MAX48 dimensions on connection side - 3-wire

10.3 Dimensions of position magnet

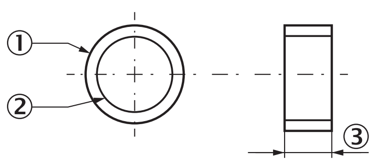


Figure 25: Dimensional drawing for position magnet

① Outer diameter
② Inner diameter
③ Height

Table 18: Dimensions of position magnet

Outer diameter	17.4 mm ± 0.1
Inner diameter	12.0 mm ± 0.1
Height	10.6 mm ± 0.1

Max. surface pressure or mechanical load, e.g., by spring washers: 40 N/mm^2 in the axial direction.

11 Annex

11.1 Accessories

For installing the M12 connector system

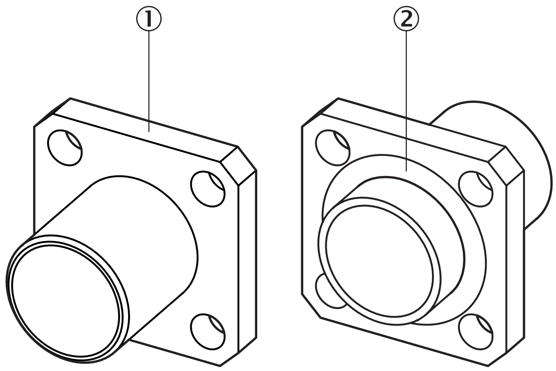


Figure 26: Accessories for M12 connector system

① M12 flange
② O-ring

For installing the position magnet

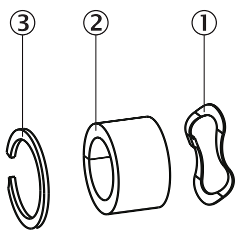


Figure 27: Circlip / corrugated washer / position magnet

① Corrugated spring washer
② Position magnet
③ Circlip

To protect against ingress of cleaning agents into the electronics when washing cylinders with an in-built MAX linear encoder

Brass cap for ingress protection when washing cylinders with an in-built linear encoder. Please contact SICK to obtain the relevant drawing.

11.2 CE Declaration of Conformity

The CE Declaration of Conformity and other certificates can be downloaded from the Internet at:

www.sick.com/MAX48

8021473/2017-08-08/en

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