

Installation Manual

C-Series Off-Highway

Magnetostrictive Linear Position Sensors

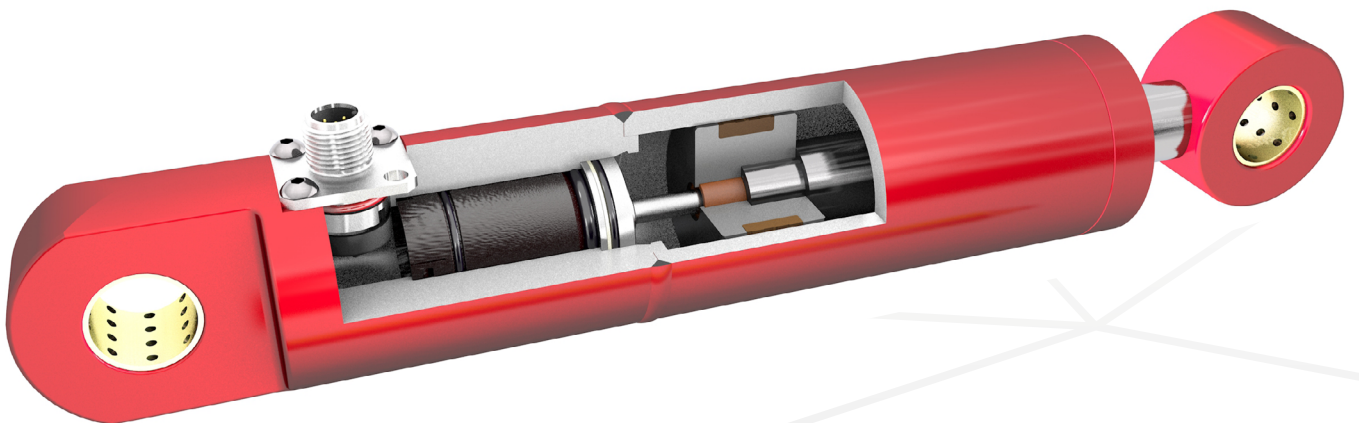


Table of contents

1. Introduction	3
1.1 Purpose and use of this manual	3
1.2 Used symbols and warnings	3
2. Safety instructions	3
2.1 Intended use	3
2.2 Foreseeable misuse	3
2.3 Installation, commissioning and operation	4
2.4 Safety instructions for use in explosion-hazardous areas	4
2.5 Warranty	4
2.6 Return	4
3. Product description and technology	5
4. Space requirements - conditions, design	6
4.1 Sensor dimensions	6
4.2 Dimensions, tolerances	7
4.3 Piston rod bore and depth	7
5. Mounting	8
5.1 Mounting sensors with M12 connection	8
5.2 Mounting sensors with cable connection and cable gland	10
5.3 Mounting sensors with single conductor and third-party connector	13
6. Cylinder handling after sensor installation	14
6.1 Washing and drying cylinders with installed sensors	14
6.1.1 Sensors with M12 connector system	14
6.1.2 Sensors with connecting cable	14
6.1.3 Sensors provided with third-party connectors	14
6.2 Painting cylinders	14
6.2.1 Electrostatic painting	14
6.2.2 Painting and electrostatic charging	15
6.2.3 Cylinders with integrated sensors and connecting cables or third-party connectors	15
6.3 Mounting / dismantling cylinders on mobile hydraulics machines	15
6.4 Electrical and electrostatic effects	15
6.5 Welding	15
6.6 Electrostatic effects	16
6.7 Compatibility of seals with hydraulic oils	16
7. Transport, intermediate storage	17

1. Introduction

1.1 Purpose and use of this manual

Before starting the operation of Temposonics® position sensors, read this documentation thoroughly and follow the safety information. Keep this manual for future reference!

The content of this technical documentation and of its appendix is intended to provide information on mounting, installation and commissioning by qualified technical personnel¹ or instructed service technicians who are familiar with the project planning and dealing with Temposonics® sensors.

1.2 Used symbols and warnings

Warnings are intended for your personal safety and for avoidance of damage to the described product or connected devices. In this documentation, safety information and warnings to avoid danger that might affect the life and health of operating or service personnel or cause material damage are highlighted by the pictogram defined below.

Symbol	Meaning
NOTICE	This symbol is used to point to situations that may lead to material damage, but not to personal injury.

2. Safety instructions

2.1 Intended use

This product may be used only for the applications defined under item 1 and only in conjunction with the third-party devices and components recommended or approved by Temposonics. As a prerequisite of proper and safe operation the product requires correct transport, storage, mounting and commissioning and must be operated with utmost care.

- The sensor systems of all Temposonics® series are intended exclusively for measurement tasks encountered in mobile hydraulic applications. The sensors are considered as system accessories and must be connected to a suitable electronic control unit.

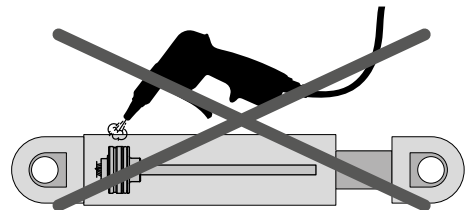
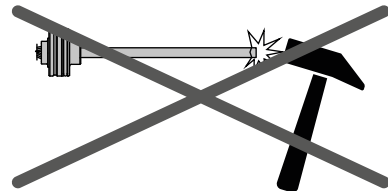
^{1/} The term "qualified technical personnel" characterizes persons who

- are familiar with the safety concepts of automation technology applicable to the particular project and
- are competent in the field of electromagnetic compatibility (EMC) or
- have received adequate training for commissioning and service operations or
- and are familiar with the operation of the device and know the information required for correct operation provided in the product documentation

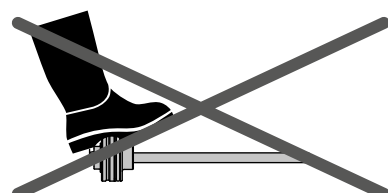
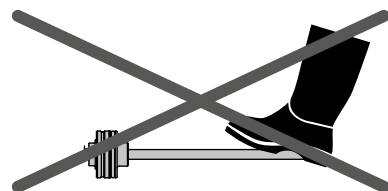
2.2 Foreseeable misuse

Foreseeable misuse	Consequence
Wrong sensor connection	The sensor will not work properly or can be damaged
Operate the sensor out of the operating temperature range	No signal output – the sensor can be damaged
Power supply is out of the defined range	Signal output is wrong/ no signal output/ the sensor will be damaged
Position measurement is influenced by an external magnetic field	Signal output is wrong
Cables are damaged	Short circuit – the sensor can be damaged/sensor does not respond
Spacers are missing/ installed in a wrong order	Error in position measurement
Wrong connection of ground/shield	Signal output is disturbed – the electronics can be damaged
Use of a magnet that is not specified by Temposonics	Error in position measurement

Do not reprocess the sensor or cylinder afterwards.
→ The sensor might be damaged.



Do not step on the sensor.
→ The sensor might be damaged.



2.3 Installation, commissioning and operation

The position sensors must be used only in technically safe conditions. To maintain this condition and to ensure safe operation, installation, connection and service, work may be performed only by qualified technical personnel.

If danger of injury to persons or of damage to operating equipment is caused by sensor failure or malfunction, additional safety measures such as plausibility checks, limit switches, EMERGENCY STOP systems, protective devices etc. are required. In the event of trouble, shut down the sensor and protect it against accidental operation.

Safety instructions for commissioning

To maintain the sensor's operability, it is mandatory to follow the instructions given below.

1. Protect the sensor against mechanical damage during installation and operation.
2. Do not open or dismantle the sensor.
3. Connect the sensor very carefully and pay attention to the polarity of connections and power supply.
4. Use only approved power supplies.
5. Ensure the sensor is operating within the defined limits for supply voltage, environmental conditions, etc.
6. Check the function of the sensor regularly and provide documentation of the checks.
7. Before applying power, ensure that nobody's safety is jeopardized by starting machines.

2.4 Safety instructions for use in explosion-hazardous areas

The sensor is not suitable for operation in explosion-hazardous areas.

2.5 Warranty

Temposonics grants a warranty period for the Temposonics® position sensors and supplied accessories relating to material defects and faults that occur despite correct use in accordance with the intended application². The Temposonics obligation is limited to repair or replacement of any defective part of the unit. No warranty can be provided for defects that are due to improper use or above average stress of the product, as well as for wear parts. Under no circumstances will Temposonics accept liability in the event of offense against the warranty rules, no matter if these have been assured or expected, even in case of fault or negligence of the company. Temposonics explicitly excludes any further warranties. Neither the company's representatives, agents, dealers nor employees are authorized to increase or change the scope of warranty.

2.6 Return

For diagnostic purposes, the sensor can be returned to Temposonics or a repair facility explicitly authorized by Temposonics. Any shipment cost is the responsibility of the sender².

NOTICE

When returning sensors, place protective caps on male and female connectors of the sensor. For pigtail cables, place the cable ends in a static shielding bag for electrostatic discharge (ESD) protection. Fill the outer packaging around the sensor completely to prevent damage during transport.

^{2/} See also applicable Temposonics terms of sales and delivery on:
www.temposonics.com

3. Product description and technology

Temposonics® sensors are designed for use in applications which may contain vibration, shocks, dust, exposure to harsh weather, and electro-magnetic disturbances.

Temposonics® MH Series sensors can replace contact-based linear sensors like potentiometers in many multipurpose applications. They are successfully used in front axle and articulated frame steering cylinders, hydraulic jacks and in steering systems for hydraulic units on agricultural and construction machinery.

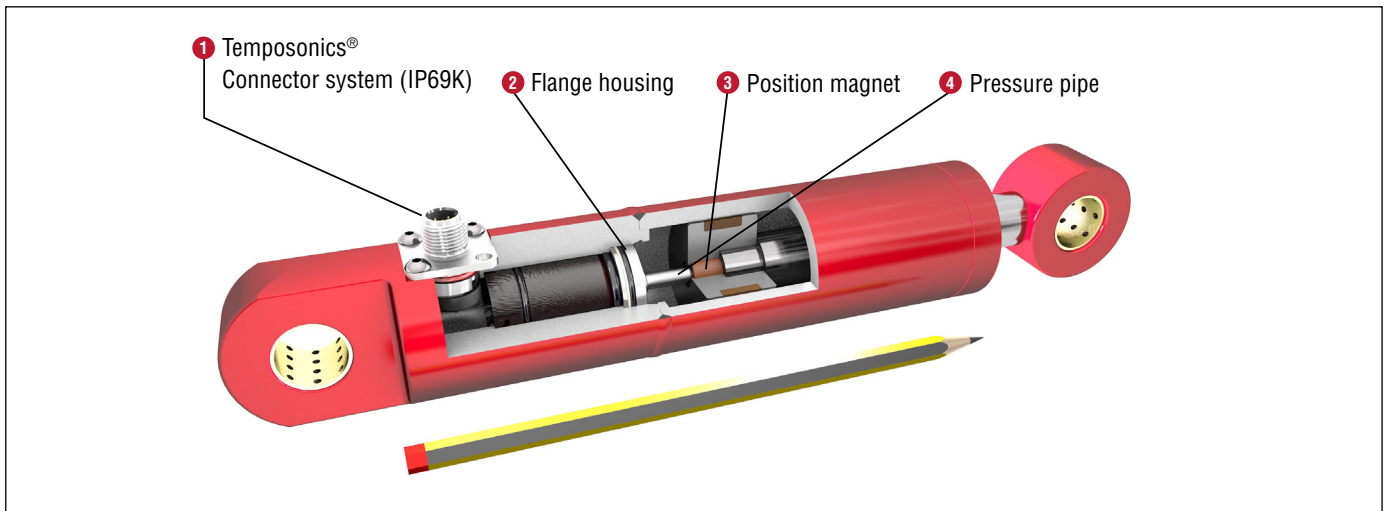


Fig. 1: C-Series Off-Highway in a cylinder (size comparison with a pencil)

Simple Mechanics

The extremely robust sensor consists of the following main parts:

1. The innovative connector system which is easy to install in a few seconds, any soldering or crimping needless, dust-and waterproof up to IP69K.
 2. The pressure flange.
 3. The pressure pipe attached to the pressure flange placed within the drilled piston rod contains the protected magnetostrictive sensing element.
 4. The magnet is the only moving part which is assembled into the piston bottom. This permanent magnet travels wear-free and contactless along the pressure pipe and measures the actual position.
- Due to small dimensions C-Series Off Highway sensors require only little space
 - Suitable for operating pressures up to 350 bar
 - Unaffected by surrounding media such as ageing or foaming oil
 - Insensitive to shock and vibration
 - Designed for all current supply voltages (12/24 VDC)
 - Temposonics® sensors offer analog (mA) output signal

Magnetostriction

Temposonics® linear sensors are based on the magnetostrictive technology. By measuring the actual position with a non-contact position magnet the sensor operates 100% wear-free. The absolute operating principle enables reliable readings without any reference

point or recalibration. A mechanical strain pulse is triggered by the travelling position magnet. The runtime of this ultrasonic wave is measured precisely and compiled into standard electronic output signals.

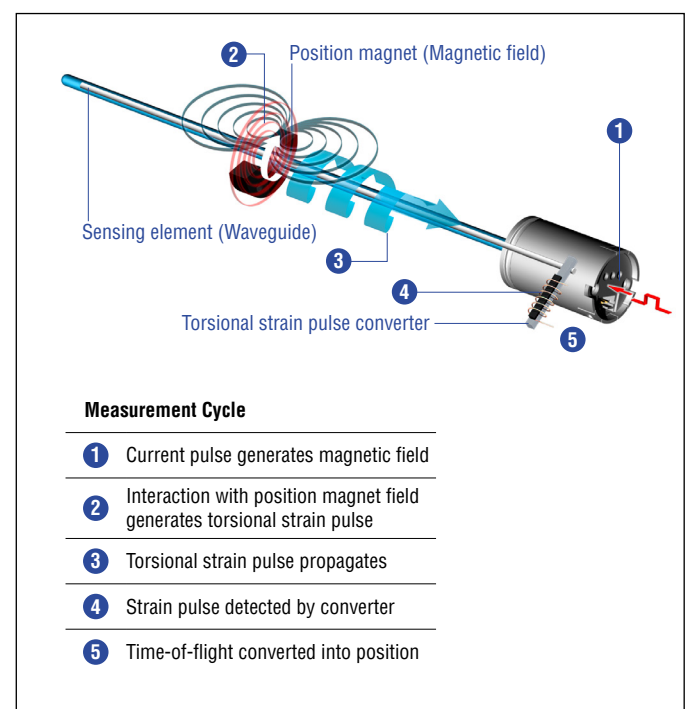


Fig. 2: Time-of-flight based magnetostrictive position sensing principle

4. Space requirements - conditions, design

4.1 Sensor dimensions

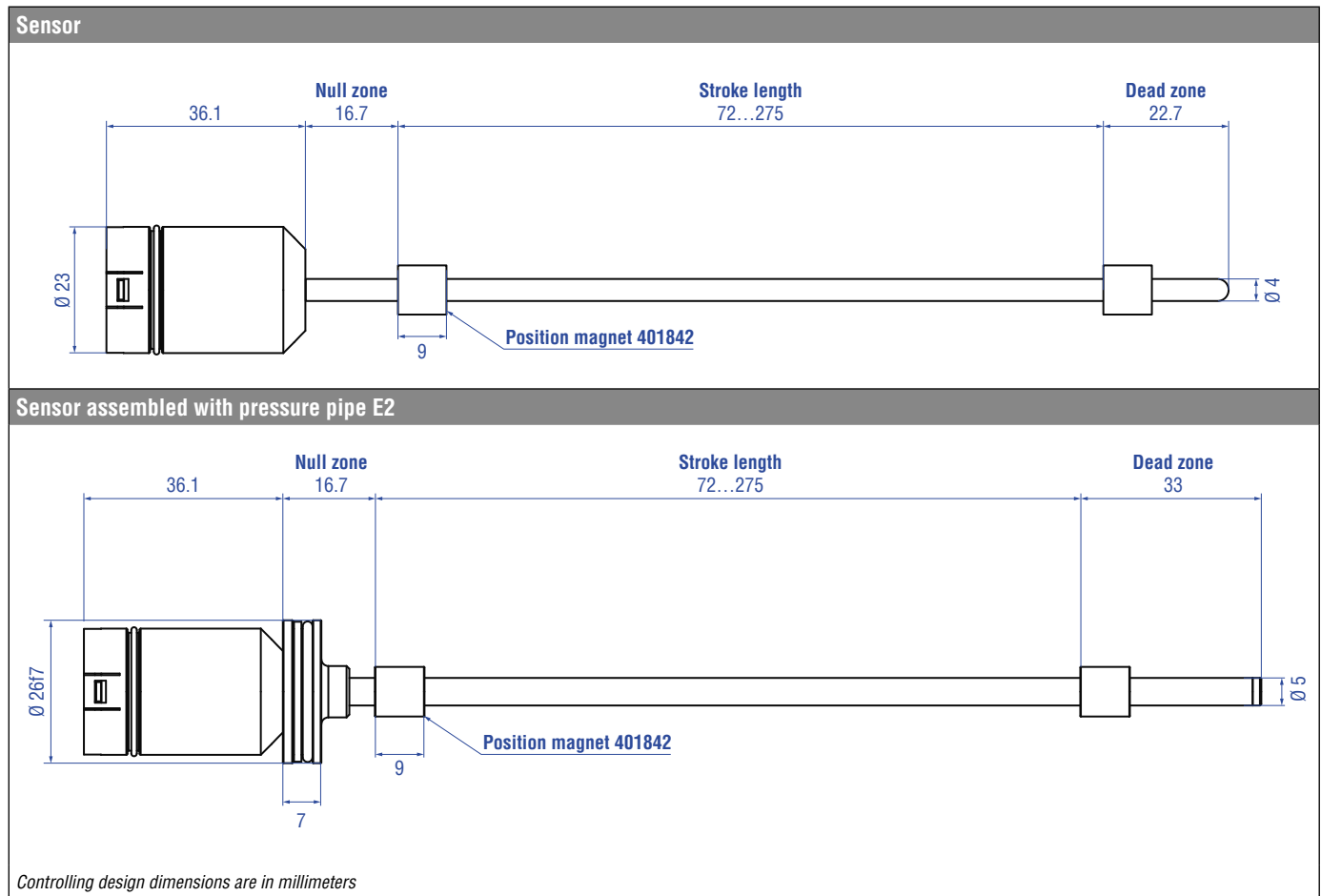


Fig. 3: Temposonics® C-Series Off-Highway sensor

4.2 Dimensions, tolerances

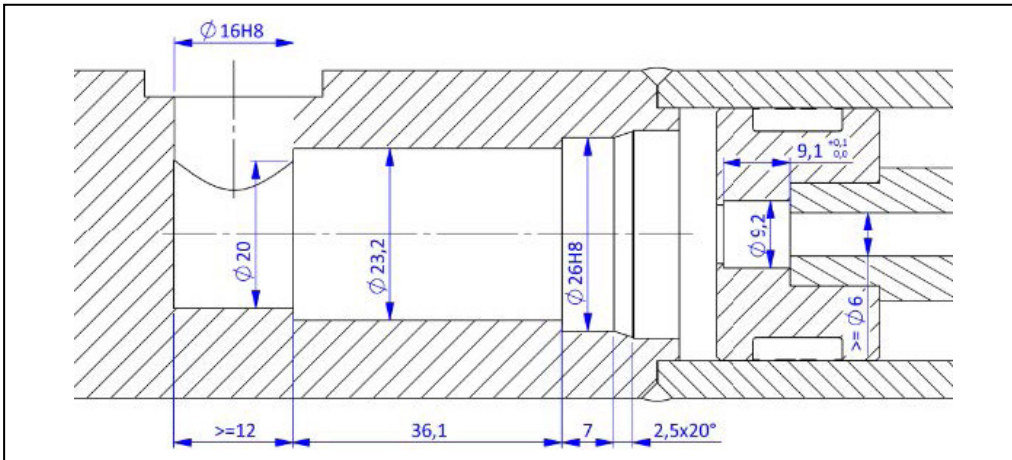


Fig. 4: Space requirements for M12 cable gland version

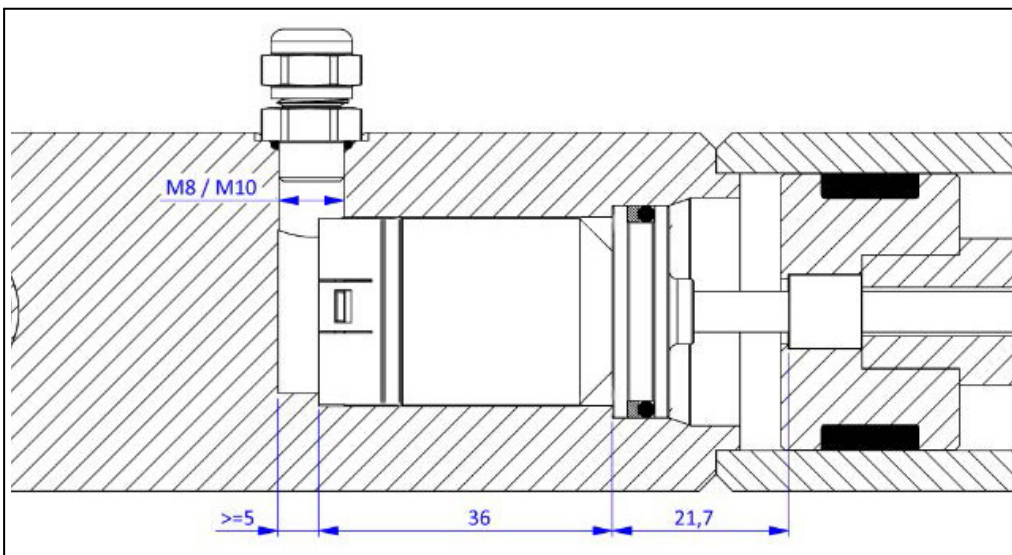


Fig. 5: Space requirements for M8/M10 cable gland version

4.3 Piston rod bore and depth

Install the magnet

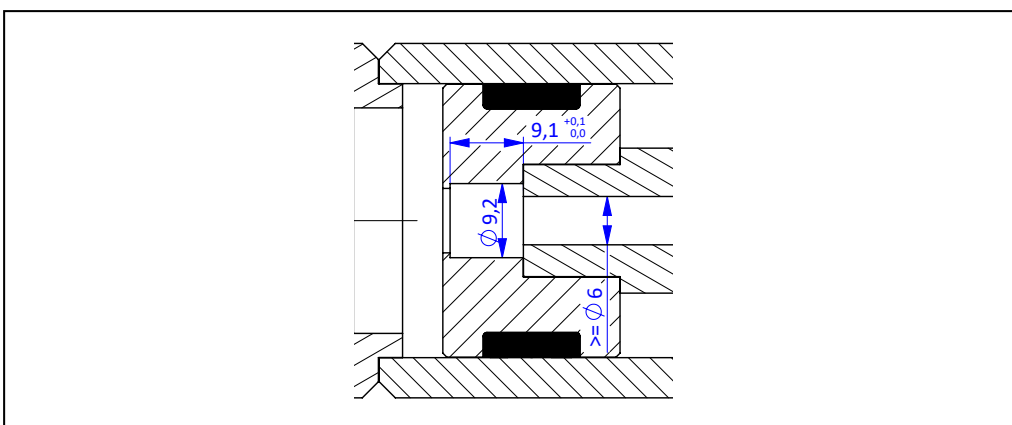
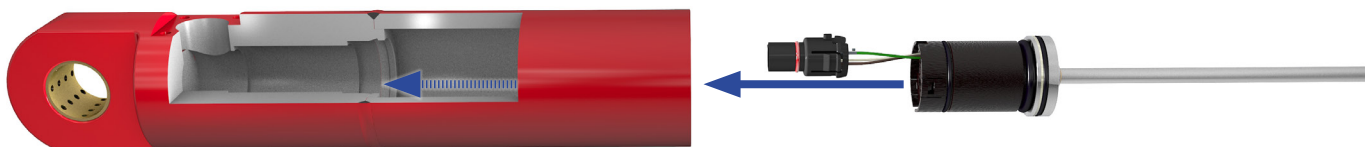


Fig. 6: Space requirements for magnet

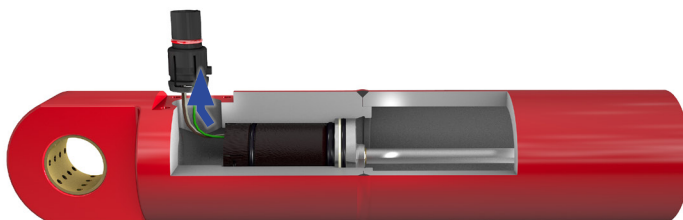
5. Mounting

5.1 Mounting sensors with M12 connection

1. Guide sensor and pressure housing into the cylinder



2. Pull the contact insert through the cylinder wall and press sensor and pressure housing into its seat



3. Take the connector flange part and...

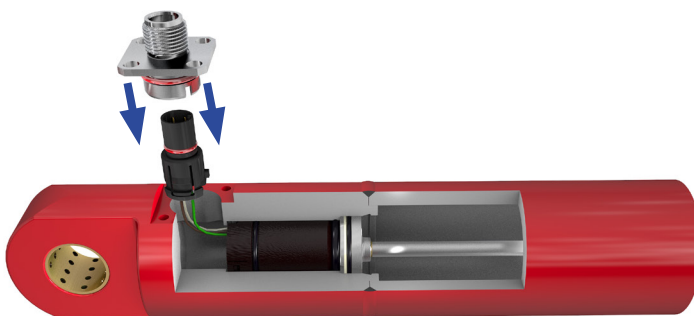
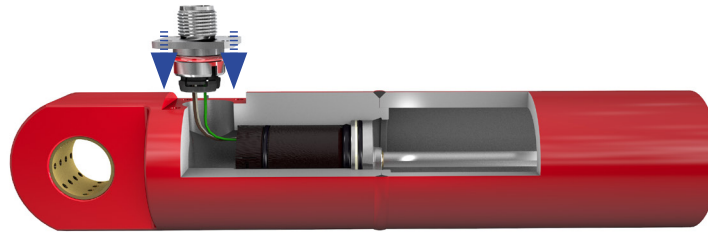
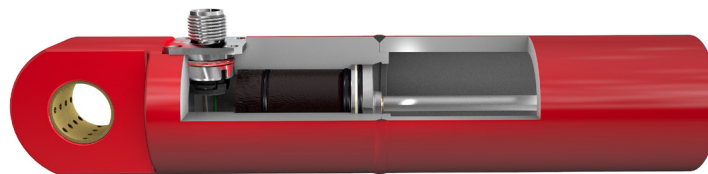


Fig. 7: Mounting sensors with M12 connection, part 1

4. ...push it on the contact insert until it 'clicks in'



5. Push carefully the whole connector system and its wires into the bore hole in the cylinder wall



6. Apply 4 metric screws M4 to fix the connector system (recommend ISO 7380-1 screws)

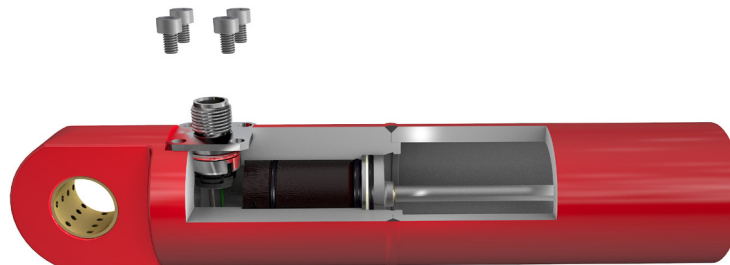


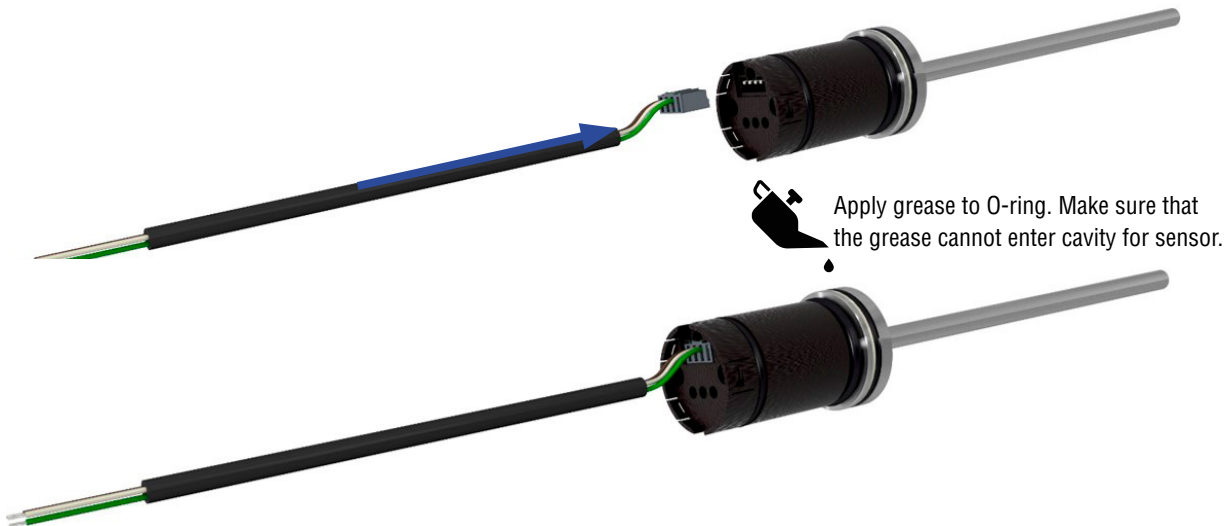
Fig. 8: Mounting sensors with M12 connection, part 2

5.2 Mounting sensors with cable connection and cable gland

When using third-party connectors with Temposonics® sensor cables, the following conditions must be met:

- The connector and cable protection must reach IP69.
- The connectors should also enclose the cable jacket, in order to prevent exposed conductors and to provide strain relief. Otherwise the conductors are not sufficiently protected against external effects.
- If a connection cable is used, use only Temposonics cable with overmolded jacket end and contact Temposonics for the correct version.
- Make sure that the polarity is correct.
- For connectors with screw terminals, cable end sleeves should be used to avoid short circuiting.
- If connectors are equipped with solder contacts, make sure that the contacts are soldered correctly.
- Crimp contacts on connectors should be gas-tight and pressed only using suitable tools. This is required to prevent corrosion. When mounting connectors, make sure protection against ESD is provided, i.e. workplaces and personnel must be protected against electrostatic charging.
- Cable glands should be protected against damage by u-shaped steel profiles (e.g. U-steel)

1. Press connector with attached cable into sensor.



2. Guide sensor and connection cable into the cylinder.

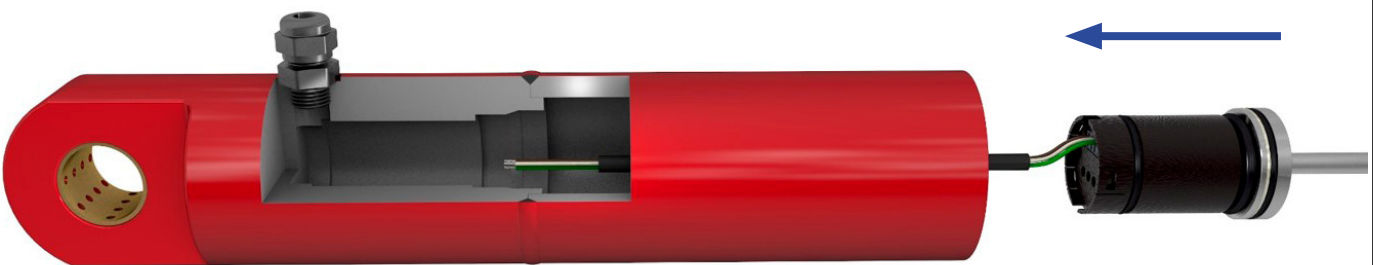
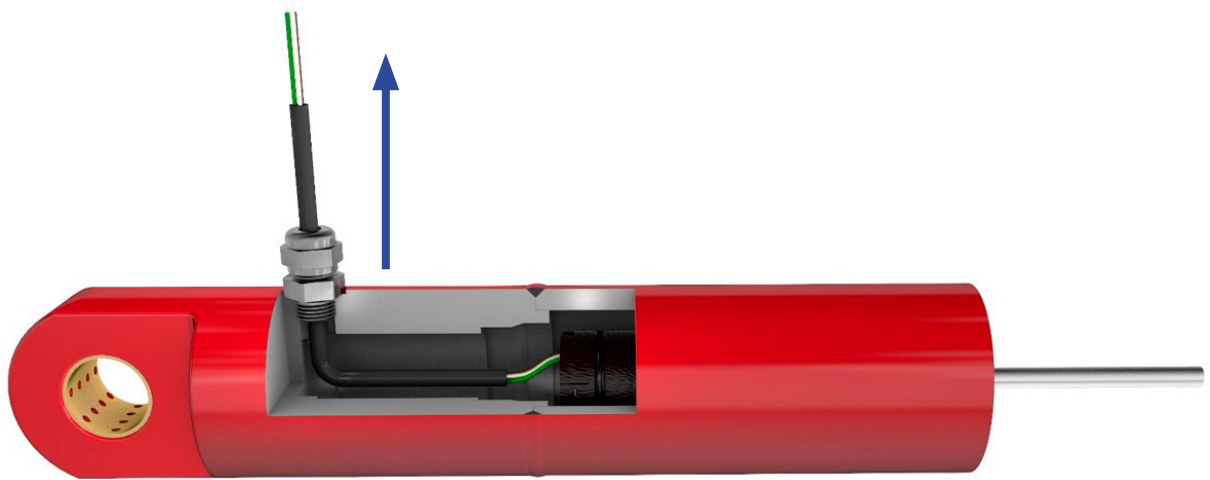


Fig. 9: Mounting sensors with cable connection and cable gland, part 1

3. Guide the connection cable through the cable gland.



4. Use an individually prepared bush (e.g. polyamide) to press the sensor into the seat. Make sure that the conductors or cables are not under strain.

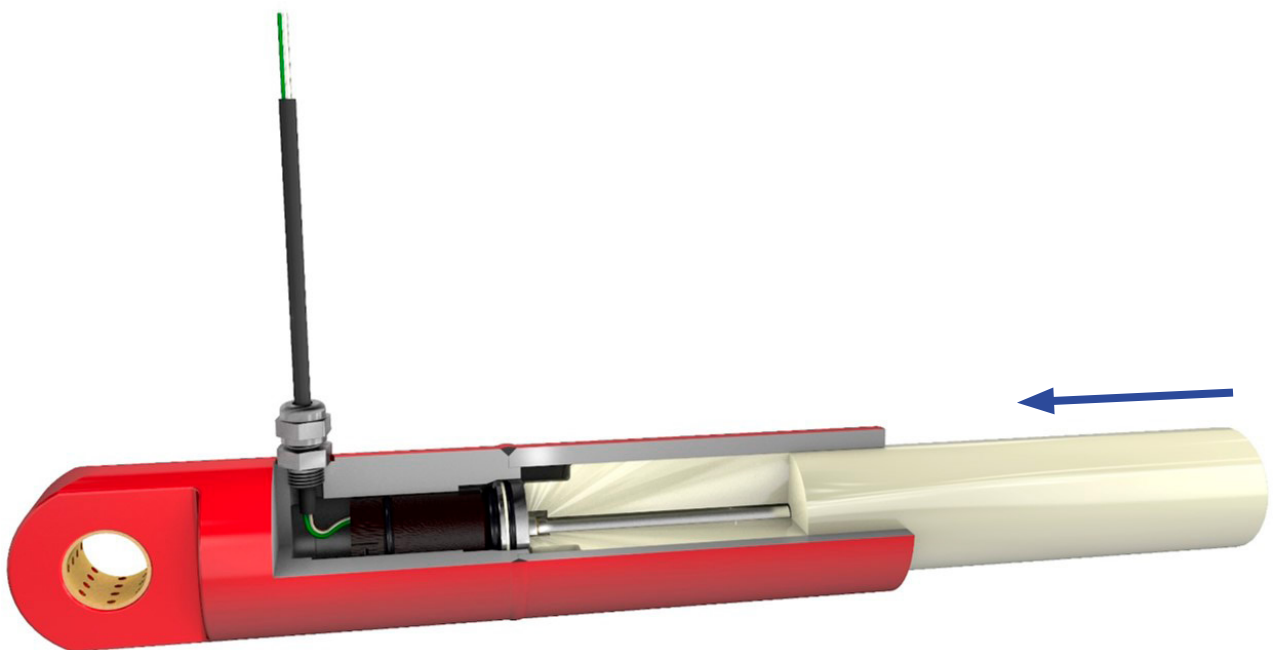
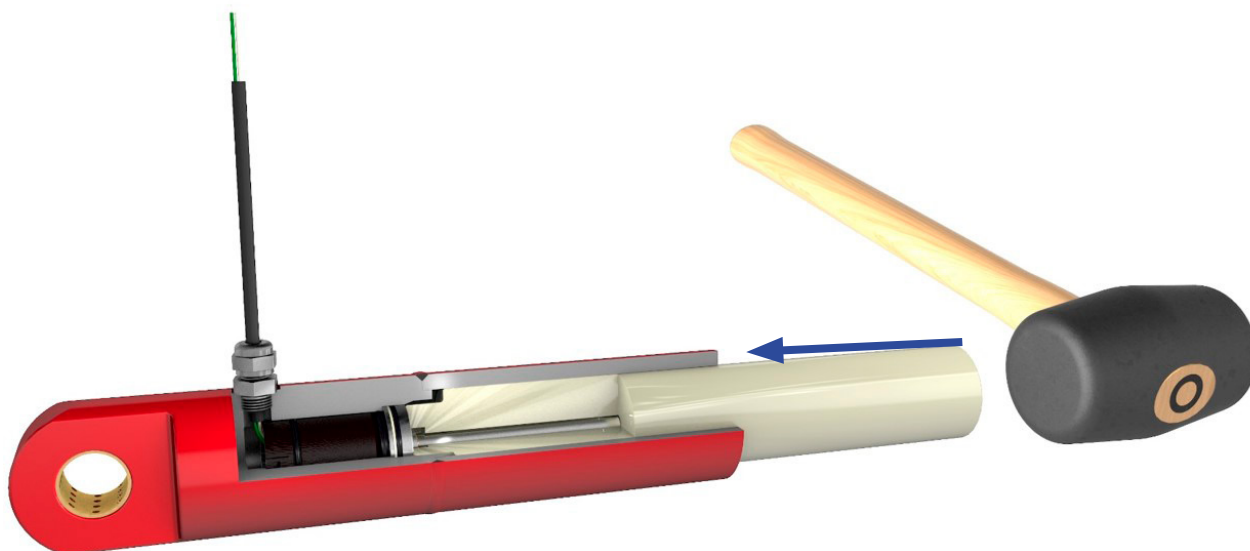


Fig. 10: Mounting sensors with cable connection and cable gland, part 2

5. Press the sensor in its seat by hand or if necessary, use only a rubber mallet to hammer the sensor in position carefully. Don't apply hard shocks. Don't press or push on the sensor rod. Never use a steel hammer.



6. Tighten the cable gland with the recommended torque according to manufacturer's specification.

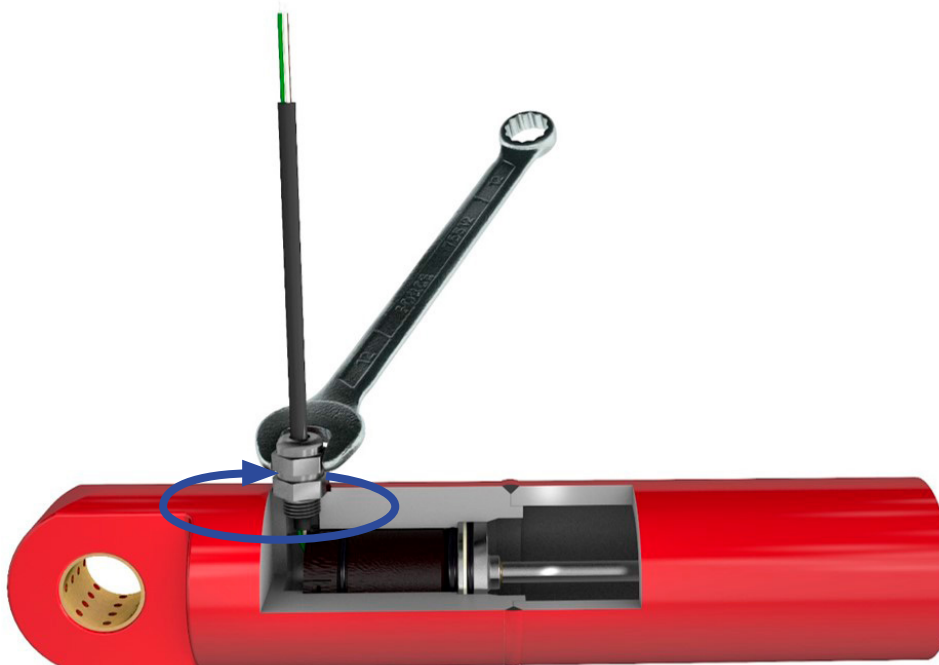


Fig. 11: Mounting sensors with cable connection and cable gland, part 3

7. Mounting of piston, rod and cylinder front head to complete the assembly.

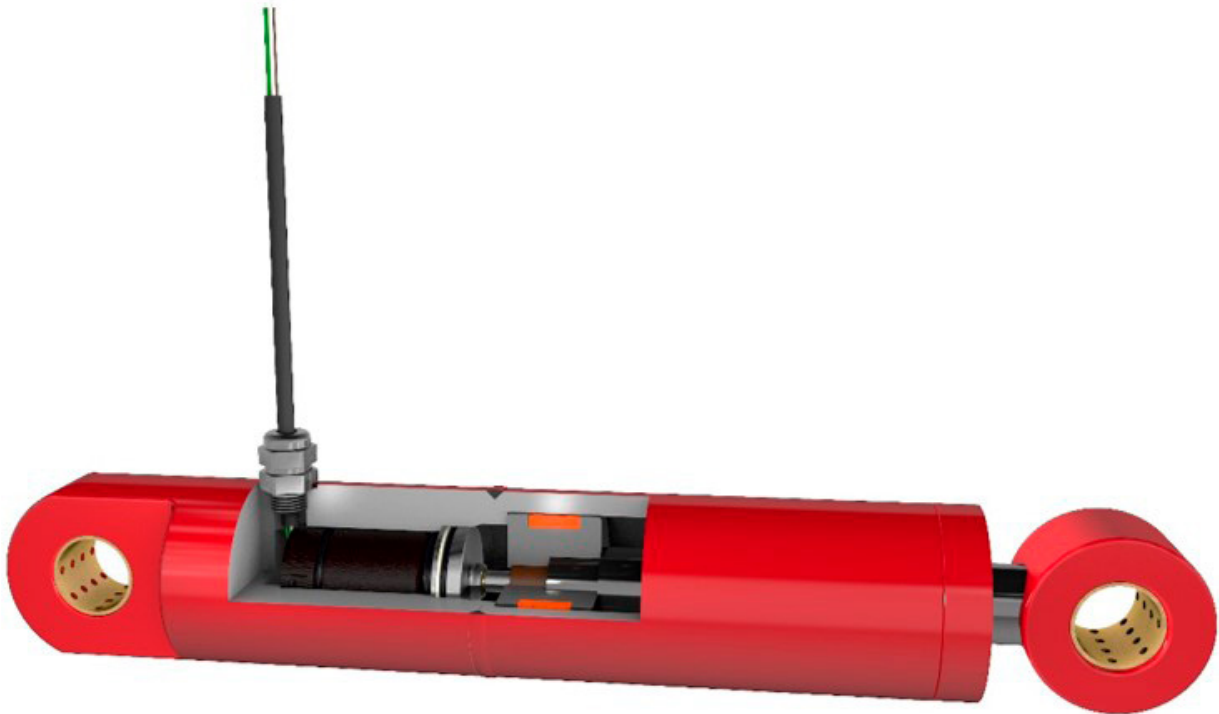


Fig. 12: Mounting sensors with cable connection and cable gland, part 4

5.3 Mounting sensors with single conductor and third-party connector

When mounting third-party connectors on sensors with single conductors, the following information should be taken into account:

- The connector protection type should be at least IP69. Make sure O-rings are fitted correctly.
- The connector housing should be completely of metal. Plastic connectors can be damaged easily, thus tightness is not ensured.
- Make sure that the polarity is correct.
- For connectors with screw terminals, cable end sleeves should be used, in order to prevent short circuiting and contact corrosion.
- End sleeves should be pressed onto the conductors in a way that all strands are clamped into the sleeve. Protruding strands can cause short circuiting!
- If connectors are provided with solder contacts, ensure that the contacts are soldered correctly and that no strands stand proud.
- Crimp contacts should be gas-tight and pressed only using special crimp tools. This is the pre-requisite to preclude corrosion of contacts.
- Most commercially available connectors are not sufficiently protected against the ingress of water running along the cable. For this reason, suitable caps should be fitted to close them after mounting.
- When mounting connectors, make sure protection against ESD is provided, i.e. workplaces and personnel must be protected against electrostatic charging.

6. Cylinder handling after sensor installation

6.1 Washing and drying cylinders with installed sensors

Frequently, hydraulic cylinders are washed or degreased before painting. For this purpose, various chemical and/or thermal methods are used, whereby cleaning agents are sprayed onto the components under high pressure up to 50 bar. During this procedure, the following measures relating to polyurethane (PUR) connecting cables and plug-in connections must be taken.

6.1.1 Sensors with M12 connector system

- When washing at low pressures up to approximately 5 bar, the plastic cap supplied with sensor and connector system is sufficient to protect the M12 connector system (part no. 403287).
- When washing at higher pressures, an M12×1 metal protective device should be used to protect the connector system against the effect of chemicals.
- The actual Temposonics connector system won't be damaged due to its high protection class, however, mating plugs which are connected might corrode due to the effect of chemicals.
- If temperatures higher than +85 °C are used for drying after washing, the connector systems should not be exposed to this temperature for more than 5 minutes.

6.1.2 Sensors with connecting cable

- Protect the connecting cables using suitable enclosures (e.g. bags) against the effect of moisture, high pressures and temperatures.
- Normally, cable entry glands meet the requirements of IP67, however, they are not pressure-tight. For this reason, they must be protected against moisture as well, in order to prevent moisture from accumulating in the connecting compartment of the cylinder.
- Temposonics connecting cables are made of PUR and relatively resistant against a large variety of chemicals and oils. However, exceptions are e.g. carbon tetrachloride, trichloroethylene, perchloroethylene, which can be ingredients of fat solvents and cleaning agents.
- Therefore, make sure that cables are protected adequately, if cleaning agents that can attack PUR are used.
- If temperatures higher than +85 °C are used for drying after washing, the connecting cables shouldn't be exposed to this temperature for more than 5 minutes.

6.1.3 Sensors provided with third-party connectors

- If third-party connectors are used, a sealed screw cap must be fitted when washing, since third-party connectors normally have only protection class IP67.
- Moreover, check if the housing of the third-party connector is sufficiently tight to resist high pressures when washing. If necessary, measures for protection of the housing should be taken.
- These connectors must be protected against the ingress of moisture as well to prevent moisture from accumulating in the connecting compartment of the cylinder.
- If temperatures higher than +85 °C are used for drying after washing, third-party connectors shouldn't be exposed to this temperature during more than 5 minutes either.

6.2 Painting cylinders

6.2.1 Electrostatic painting

Various dry and wet methods of applying paint to the component surface use electrostatic charge to paint cylinders. These methods employ very high voltages up to 100 kV, which can damage the electronics of position measuring systems. To prevent this damage, it is mandatory to take the following measures during electrostatic painting.

- Attach the cylinder to the painting frame by the barrel side of the cylinder rather than by the piston rod. The reason is that the integrated sealing and slide rings can cause electric isolation between the piston rod and the cylinder/sensor housing, i.e. low-impedance connection between the painting equipment ground and the sensor housing is not ensured.
- Clean the suspension points at the painting system and all connections used for short-circuiting conductors and connection to the painting system ground regularly and remove paint as well as other residues, in order to ensure low-impedance connection.

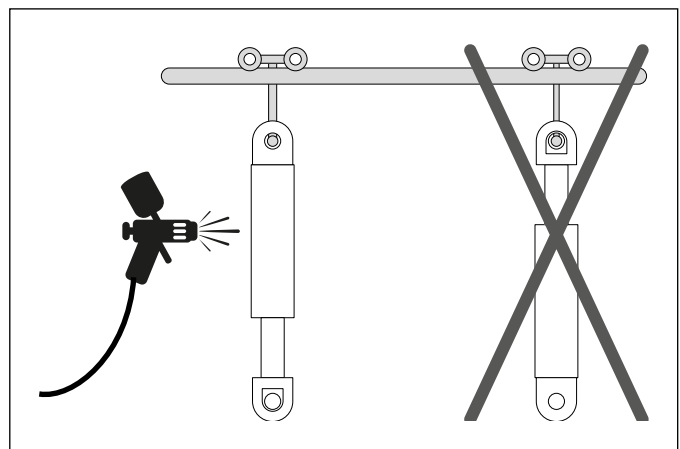


Fig. 13: Electrostatic painting

6.2.2 Painting and electrostatic charging

When using electrostatic charge for painting processes high voltages are applied to the component/cylinder surface. These applied very high voltages can damage or pre-damage the electronics of Temposonics position measuring systems integrated into cylinders. This can be prevented using the following metal protective caps.

The metal protective cap safeguards the contact pins and thus the electronics of the sensor against electrostatic effects (high voltage). It is important to note that:

- The material of the protective cap must be permanently electrically conductive.
- The cap must not be of aluminum (aluminum is subject to oxidation and can cause electric isolation).
- The metal protective cap must have an M12×1 thread.
- The cap must be screwed up to the connector flange plate.
- Make sure that no paint particles contaminate the thread or the contact pins.
- The thread of the protective cap must be clean and free from paint particles and other substances at all times.
- The metal protective cap must be tightened only so that it is hand-tight (max. 5 Nm).
- Paint particles on the cap outside are of no concern.
- Drawing examples for the protective cap are given in the attachment.

6.2.3 Cylinders with integrated sensors and connecting cables or third-party connectors

NOTICE

Electrostatic painting cannot be used for sensors with connecting cables, since the cable cannot be protected safely against the high process voltage. Safe electrostatic painting is ensured only in conjunction with the M12 connector system and the brass caps.

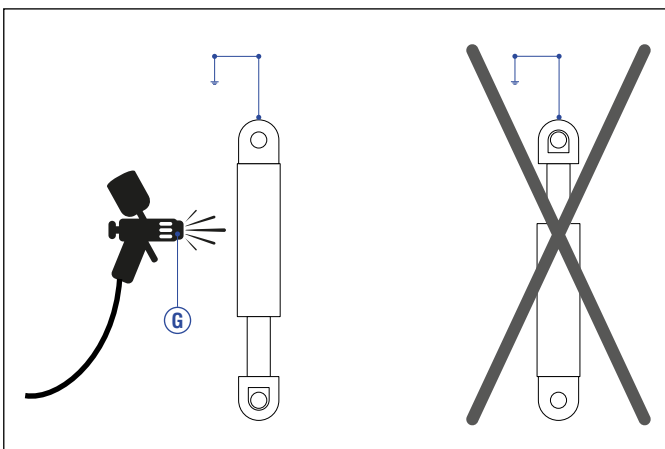


Fig. 14: Electrostatic painting of cylinders with integrated sensors

6.3 Mounting / dismantling cylinders on mobile hydraulics machines

As during transport, connectors, cables and cable ends should be protected sufficiently during mounting and dismantling. Cables conductors should not be bent or subjected to load or tensile stress. When connecting cables are installed, make sure that the insulation is not damaged by sharp edges.

NOTICE

Insulation tests

Part of the tests performed on mobile machines can be insulation tests. These tests are intended to determine the dielectric strength of the cables against the housing (insulation resistance) using high voltages. During these tests, all sensor cables must be disconnected, otherwise stray voltage over the sensor protective circuitry against ground can damage these components and cause sensor failure.

6.4 Electrical and electrostatic effects

NOTICE

As a rule: Don't perform welding work on the cylinder!

6.5 Welding

After installing the cylinder in machines, welding work on adjacent components can be necessary. If a grounding clamp is applied directly or too closely to the cylinder, welding currents can be transmitted to the sensor via the cylinder and cause burning of the sensor pipe or damage of internal sensor components. Cylinders mostly consist of two assemblies: the lower part with the cylinder pipe and the piston with the piston rod. These components are isolated electrically from each other by gaskets, bearings and slide rails. This means that, normally, no current flow is possible. With cylinders, however, the welding current may be transmitted from the piston to the cylinder pipe. In this case, an electrical connection causes the entire welding current to flow through the sensor pipe and the sensor head, thus damaging the electronics. Moreover, the cylinder and/or the gaskets are destroyed.

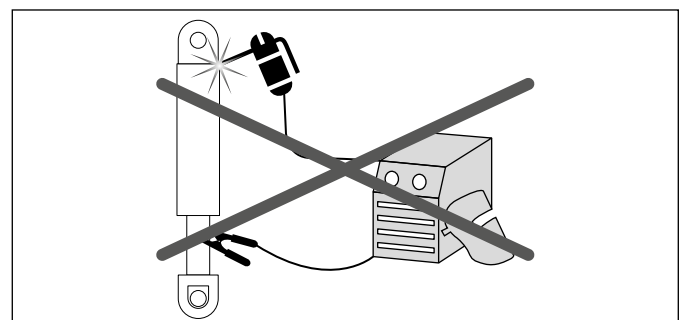


Fig. 15: Welding the cylinder with integrated sensor

NOTICE

- Cut or disconnect all sensor connections during welding.
- Never fasten the grounding point at the piston rod or at the cylinder pipe.
- Never perform welding work on a part of the cylinder, if a sensor has been installed.
- Never perform welding work near a cylinder, if a sensor has been installed.
- Due to isolating bearings, plastic slide bearings or grease in the contact points, electric potentials/voltages can build up at every bearing point of machines. Accordingly, similar effects as on hydraulic cylinders can be produced.

6.6 Electrostatic effects

Electrostatic charge is caused due to friction and separation of charge. This phenomenon is widely known and can be produced e.g. by carpets or car seats. Mostly, the charge is noticed only in the event of discharge, when the associated „shock“ occurs. The voltages due to electrostatic discharge can have very high values, for example:

- Walking over carpet floors up to 30,000 V
- Walking over synthetic floors up to 12,000 V
- Moving at the workplace up to 6,000 V

Not only the high voltages, but especially the sudden discharge and related currents (up to 50 Ampere!) can cause destruction of electrical components. The effects are similar to those occurring due to electrostatic discharge during dry painting.

Current flow curve during electrostatic discharge of a human body

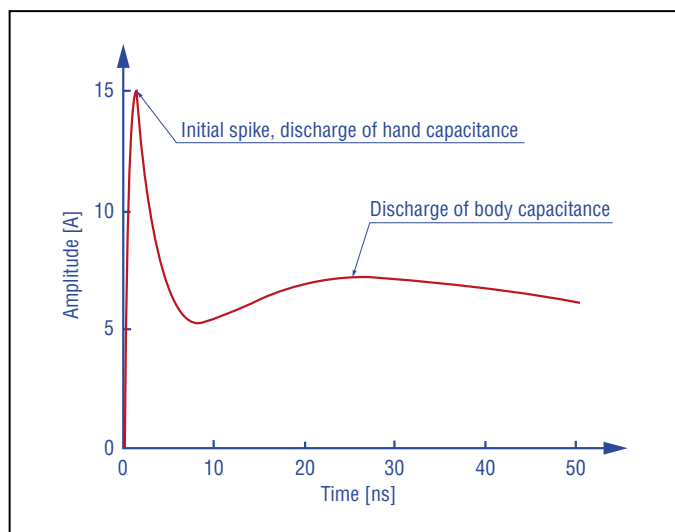


Fig. 16: Current flow curve during electrostatic discharge of a human body

To avoid electrostatic discharge, workplaces and persons working with or on electronic components must be grounded. This also applies to sensor installation into the hydraulic cylinder as well mounting procedure the cylinder to the machine.

Suitable protective measures are:

- Persons wear ribbons connected to the grounding point by means of spiral cable around their wrist. Please, contact us, if you need information on suppliers for suitable protective equipment.
- Work is only performed on diverting material, i.e. charges can be diverted gently (e.g. work plate of wood, rubber, ESD foam material).
- Avoid hard discharge. Do not deposit components on metal plates or metal film.
- Do not remove electrostatically sensitive components from the packaging without grounding.
- Caution when cutting adhesive tapes, do not tear to open.

6.7 Compatibility of seals with hydraulic oils

The sensors with a measuring rod are designed for installation in hydraulic cylinders. The seals used in the sensors come into contact with the hydraulic oil. Hydraulic oils that are moderately to not compatible with the material of the seals can damage the seal.

In general, sensors from Temposonics are equipped with seals made of NBR, FKM and PTFE. These seals can be used with hydraulic oil type HLP (according to DIN 51524-2).

Other oils, such as bio oils (e.g. HEES, HETG and HEPG), are, without prior testing, bio-oils should not be used on sensor seals. Due to the large number of different oils and their different mixing ratios, not all seal materials can be tested with the corresponding oils. These tests are very time-consuming and therefore cost-intensive. It should also be noted that the composition and mixing ratios of oil types change continuously.

If hydraulic oil other than type HLP is to be used, we recommend testing the oil-seal combination in a test laboratory. Two tests are required per oil seal combination:

- Storage in oil for 1000 hours at an oil temperature of 80 °C
- Storage in oil for 168 hours at an oil temperature of 100 °C

During these tests, the components must be extensively tested for installation dimensions.

7. Transport, intermediate storage

When transporting the cylinders, make sure that the cables and connectors are not under tensile stress. When handling/storing carelessly, connectors and cables can be squeezed easily between stacked cylinders.

Moreover, it is necessary to encapsulate the connections or exposed cable ends using an antistatic bag. For this, the original bags (part no. 403287) can be re-used. Furthermore, it is important to re-fit the dust protective caps (Temposonics material number GZ0605) on the M12 connector system (IP69K) after installation of the connector.

The cylinders storage conditions should be as dry as possible.

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