

Operating Instructions OPTISWITCH 4000 C

- contactless electronic switch



Document
ID: 42373

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1 About this document

1.1 Function

This operating instructions manual provides all the information you need for mounting, connection and setup as well as important instructions for maintenance and fault rectification. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

1.2 Target group

This operating instructions manual is directed to trained specialist personnel. The contents of this manual should be made available to these personnel and put into practice by them.

1.3 Symbolism used



Information, tip, note

This symbol indicates helpful additional information.



Caution: If this warning is ignored, faults or malfunctions can result.

Warning: If this warning is ignored, injury to persons and/or serious damage to the instrument can result.

Danger: If this warning is ignored, serious injury to persons and/or destruction of the instrument can result.



Ex applications

This symbol indicates special instructions for Ex applications.



List

The dot set in front indicates a list with no implied sequence.



Action

This arrow indicates a single action.



Sequence of actions

Numbers set in front indicate successive steps in a procedure.



Battery disposal

This symbol indicates special information about the disposal of batteries and accumulators.

2 For your safety

2.1 Authorised personnel

All operations described in this operating instructions manual must be carried out only by trained specialist personnel authorised by the plant operator.

During work on and with the device the required personal protective equipment must always be worn.

2.2 Appropriate use

The OPTISWITCH 4000 C is a sensor for point level detection.

You can find detailed information on the application range in chapter "*Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden.

2.3 Warning about incorrect use

Inappropriate or incorrect use of the instrument can give rise to application-specific hazards, e.g. vessel overfill or damage to system components through incorrect mounting or adjustment.

2.4 General safety instructions

This is a high-tech instrument requiring the strict observance of standard regulations and guidelines. The user must take note of the safety instructions in this operating instructions manual, the country-specific installation standards as well as all prevailing safety regulations and accident prevention rules.

The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for trouble-free operation of the instrument.

During the entire duration of use, the user is obliged to determine the compliance of the necessary occupational safety measures with the current valid rules and regulations and also take note of new regulations.

2.5 Safety label on the instrument

The safety approval markings and safety tips on the device must be observed.

2.6 CE conformity

The device fulfills the legal requirements of the applicable EC guidelines. By affixing the CE marking, we confirm successful testing of the product.

3 Product description

3.1 Configuration

Scope of delivery

The scope of delivery encompasses:

- OPTISWITCH 4000 C point level switch
- Test magnet
- Documentation
 - this operating instructions manual
 - if necessary, certificates

Constituent parts

The OPTISWITCH 4000 C consists of the components:

- Housing with electronics
- Process fitting with tuning fork



Fig. 1: OPTISWITCH 4000 C

Type plate

The nameplate contains the most important data for identification and use of the instrument:

- Article number
- Serial number
- Technical data
- Article numbers, documentation

Application area**3.2 Principle of operation**

OPTISWITCH 4000 C is a point level sensor with tuning fork for point level detection.

It is designed for industrial use in all areas of process technology and can be used in liquids.

Typical applications are overfill and dry run protection. With a tuning fork of only 38 mm length, OPTISWITCH 4000 C can be also mounted e.g. in pipelines from DN 25. The small tuning fork allows use in vessels, tanks and pipes. Thanks to its simple and robust measuring system, OPTISWITCH 4000 C is virtually unaffected by the chemical and physical properties of the liquid.

It functions even under difficult conditions such as turbulence, air bubbles, foam generation, buildup, strong external vibration or changing products.

Function monitoring

The electronics module of OPTISWITCH 4000 C continuously monitors via frequency evaluation the following criteria:

- Strong corrosion or damage on the tuning fork
- Loss of vibration
- Line break to the piezo drive

If a malfunction is detected or in case of power failure, the electronics takes on a defined switching condition, i.e. the contactless electronic switch opens (safe condition).

Functional principle

The tuning fork is piezoelectrically energised and vibrates at its mechanical resonance frequency of approx. 1100 Hz. When the tuning fork is submerged in the product, the frequency changes. This change is detected by the integrated electronics module and converted into a switching command.

Voltage supply

OPTISWITCH 4000 C is a compact instrument, i.e. it can be operated without external evaluation system. The integrated electronics evaluates the level signal and outputs a switching signal. With this switching signal, a connected device can be operated directly (e.g. a warning system, a pump etc.).

The data for power supply are specified in chapter "*Technical data*".

3.3 Adjustment

The switching status of OPTISWITCH 4000 C can be checked with closed housing (signal lamp). Products with a density $> 0.7 \text{ g/cm}^3$ (0.025 lbs/in^3) can be detected.

3.4 Storage and transport**Packaging**

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test based on ISO 4180.

The packaging of standard instruments consists of environment-friendly, recyclable cardboard. For special versions, PE foam or PE

foil is also used. Dispose of the packaging material via specialised recycling companies.

Transport

Transport must be carried out in due consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection

The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

Storage

Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media
- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see chapter "*Supplement - Technical data - Ambient conditions*"
- Relative humidity 20 ... 85 %

4 Mounting

4.1 General instructions

Suitability for the process conditions

Make sure that all parts of the instrument coming in direct contact with the process, especially the sensor element, process seal and process fitting, are suitable for the existing process conditions, such as process pressure, process temperature as well as the chemical properties of the medium.

You can find the specifications in chapter "*Technical data*" and on the nameplate.

Switching point

Generally, OPTISWITCH 4000 C can be mounted in any position. Just install the instrument so that the tuning fork is at the height of the requested switching point. Keep in mind that the switching point can vary depending on the installation position.

The switching point refers to the medium water ($1 \text{ g/cm}^3/0.036 \text{ lbs/in}^3$). Please keep in mind that the switching point of the instrument shifts when the medium has a density differing from water.

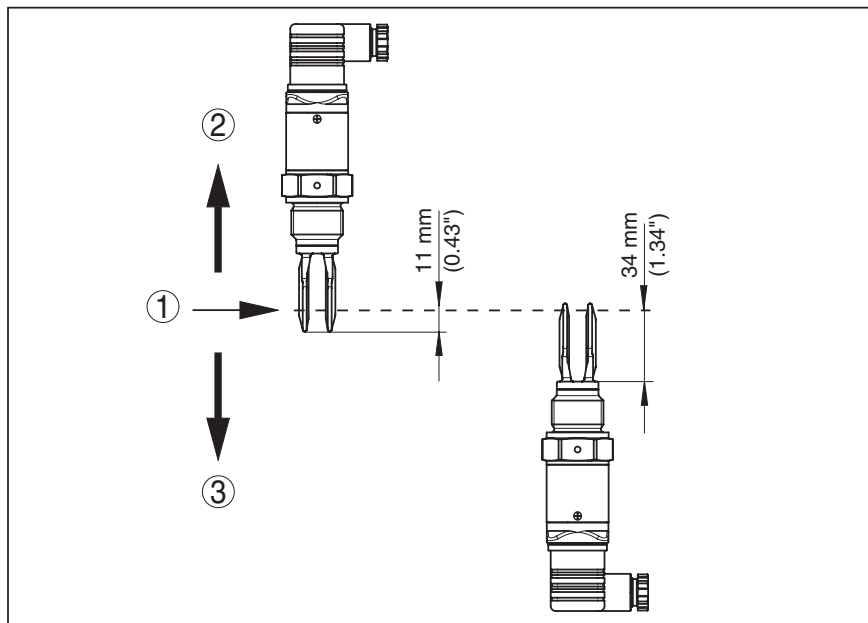


Fig. 2: Vertical mounting

- 1 Switching point in water
- 2 Switching point with lower density
- 3 Switching point with higher density

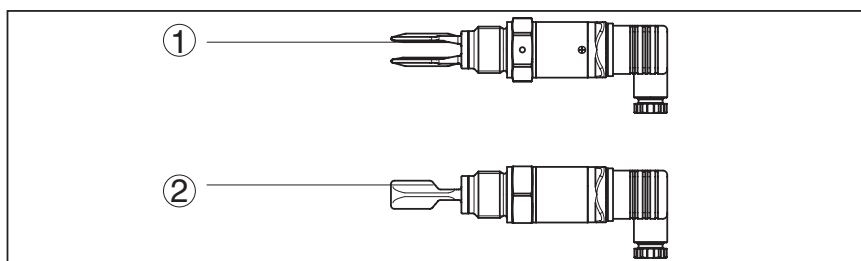


Fig. 3: Horizontal mounting

- 1 Switching point
- 2 Switching point (recommended mounting position, particularly for adhesive products)

Moisture

Use the recommended cables (see chapter "Connecting to power supply") and tighten the cable gland.

You can give your OPTISWITCH 4000 C additional protection against moisture penetration by leading the connection cable downward in front of the cable entry. Rain and condensation water can thus drain off. This applies mainly to outdoor mounting as well as installation in areas where high humidity is expected (e.g. through cleaning processes) or on cooled or heated vessels.

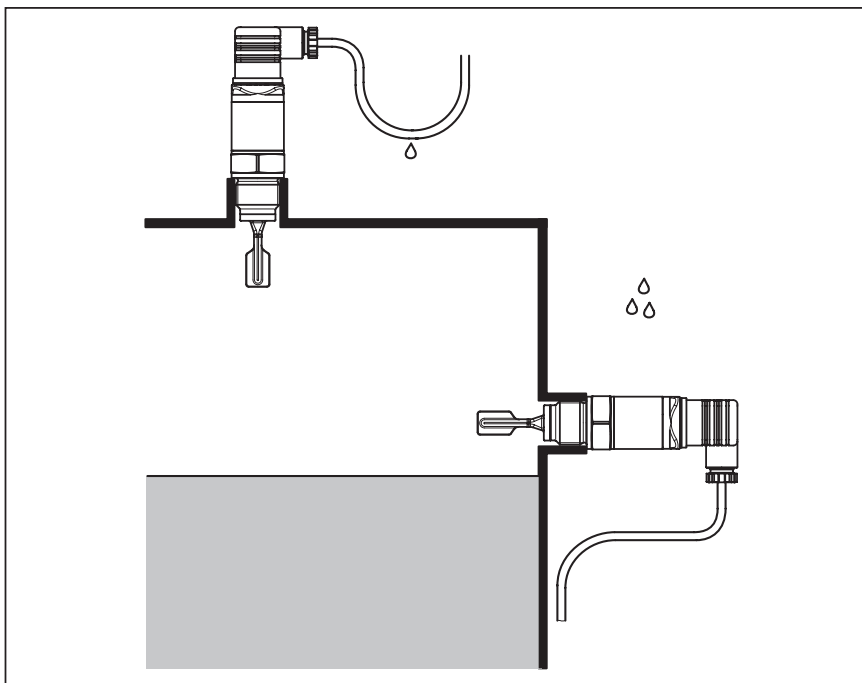


Fig. 4: Measures against moisture penetration

Transport

Do not hold OPTISWITCH 4000 C on the tuning fork.

Pressure/Vacuum

The process fitting must be sealed if there is gauge or low pressure in the vessel. Before use, check if the seal material is resistant against the measured product and the process temperature.

The max. permissible pressure is specified in chapter "Technical data" or on the type label of the sensor.

Handling

The vibrating level switch is a measuring instrument and must be treated accordingly. Bending the vibrating element will destroy the instrument.

**Warning:**

The housing must not be used to screw the instrument in! Applying tightening force can damage internal parts of the housing.

Use the hexagon above the thread for screwing in.

4.2 Mounting instructions**Welded socket**

For threaded versions of OPTISWITCH 4000 C in combination with a mounting boss with O-ring in front and welding marking.

OPTISWITCH 4000 C with thread sizes $\frac{3}{4}$ " and 1" have a defined thread runout. This means that every OPTISWITCH 4000 C is in the same position after being screwed in. Remove therefore the supplied flat seal from the thread of OPTISWITCH 4000 C. This flat seal is not required when using a welded socket with front-flush seal.

Before welding, unscrew OPTISWITCH 4000 C and remove the rubber ring from the welded socket.

The welded socket is provided with a marking (notch). For horizontal mounting, weld the socket with the notch facing upward or downward; in pipelines (DN 25 to DN 50) aligned with the direction of flow.

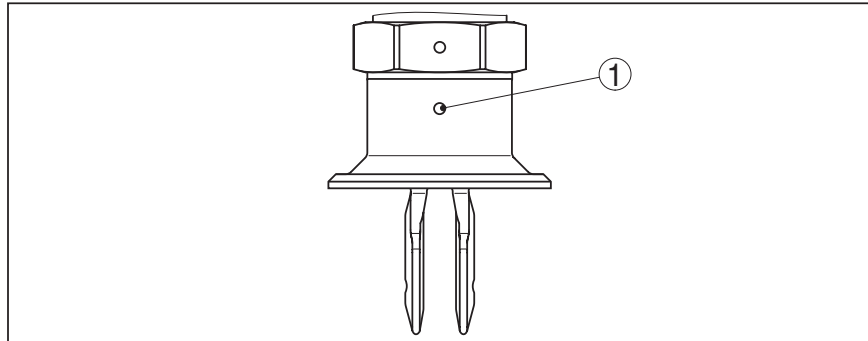


Fig. 5: Marking on the welded socket

1 Marking

Adhesive products

In case of horizontal mounting in adhesive and viscous products, the surfaces of the tuning fork should be vertical in order to reduce buildup on the tuning fork. The position of the tuning fork is indicated by a marking on the hexagon of OPTISWITCH 4000 C. With this, you can check the position of the tuning fork when screwing it in. When the hexagon touches the seal, the thread can still be turned by approx. half a turn. This is sufficient to reach the recommended installation position.

In adhesive and viscous products, the surfaces of the tuning fork should protrude into the vessel to avoid buildup. Therefore sockets for flanges and mountings bosses should not exceed a certain length.

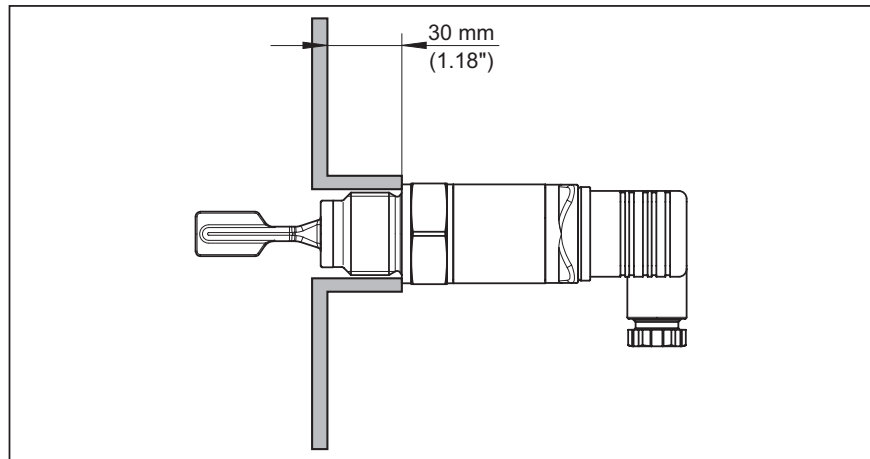


Fig. 6: Adhesive products

Inflowing medium

If OPTISWITCH 4000 C is mounted in the filling stream, unwanted false measurement signals can be generated. For this reason, mount OPTISWITCH 4000 C at a position in the vessel where no disturbances, e.g. from filling openings, agitators, etc., can occur.

Flows

To make sure the tuning fork of OPTISWITCH 4000 C generates as little resistance as possible to product flow, mount the sensor so that the surfaces are parallel to the product movement.

5 Connecting to power supply

5.1 Preparing the connection

Note safety instructions

Always keep in mind the following safety instructions:

- Connect only in the complete absence of line voltage

Connection cable

The instrument is connected with standard two-wire cable without screen. If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used.

Use cable with round cross section. Depending on the plug connection, you have to select the outer diameter of the cable respectively so that the seal effect of the cable gland is ensured.

- Valve plug ISO 4400, \varnothing 4.5 ... 7 mm
- Valve plug ISO 4400 with IDC crimping technology, \varnothing 5.5 ... 8 mm

Cable glands

Use cable with a round wire cross section and tighten the cable gland.

When mounting outdoors, on cooled vessels or in moist areas in which cleaning is made with steam or high pressure, the sealing of the cable gland is very important.

5.2 Wiring plan

Housing overview

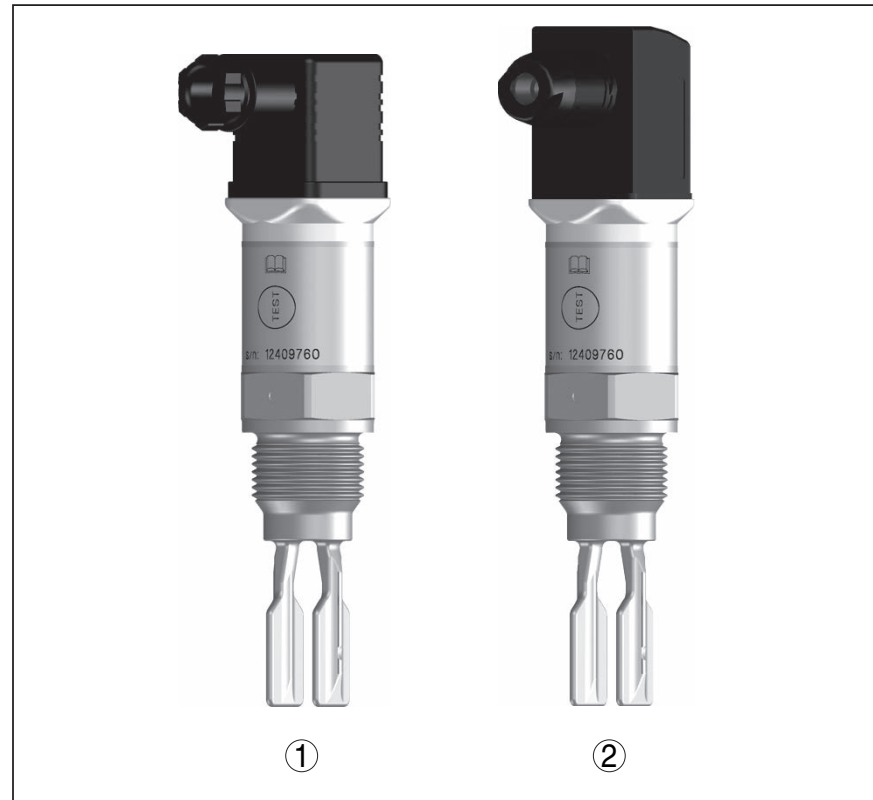


Fig. 7: Overview of the connection versions

1 Valve plug ISO 4400

2 Valve plug ISO 4400 with IDC method of termination

Plug versions**Valve plug ISO 4400**

For this plug version, standard cable with round wire cross-section can be used. Cable diameter 4.5 ... 7 mm, protection IP 65.

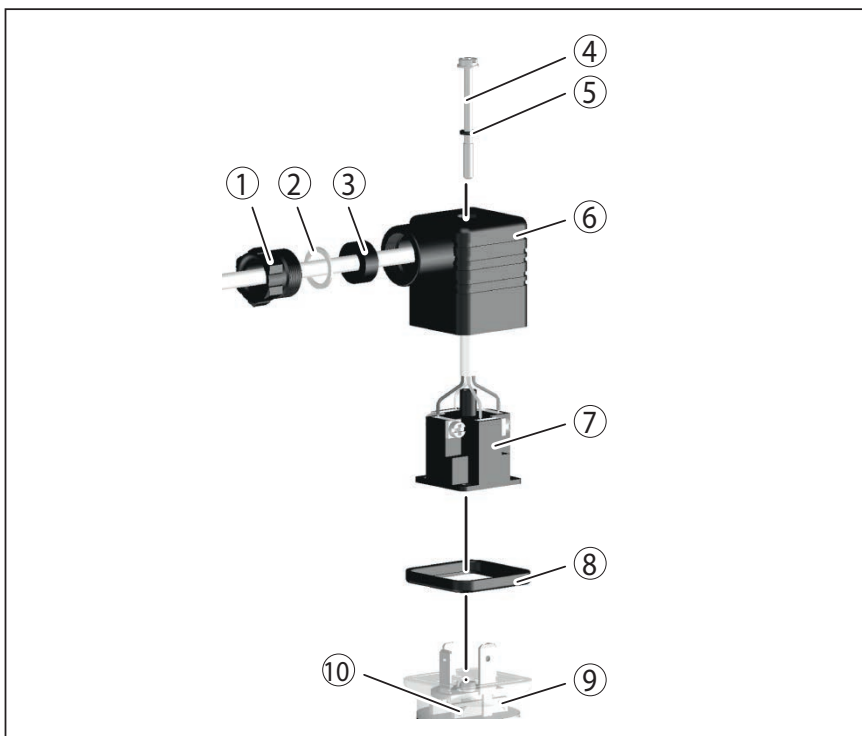


Fig. 8: Connection, valve plug ISO 4400

- 1 Pressure screw
- 2 Pressure disc
- 3 Seal ring
- 4 Fixing screw
- 5 Seal washer
- 6 Plug housing
- 7 Plug insert
- 8 Profile seal
- 9 Control lamp
- 10 OPTISWITCH 4000 C

Valve plug ISO 4400 with IDC method of termination

For this plug version you can use standard cable with round wire cross-section. The inner conductors do not have to be stripped. The plug connects the conductors automatically when screwing in. Cable diameter 5.5 ... 8 mm, protection IP 67.

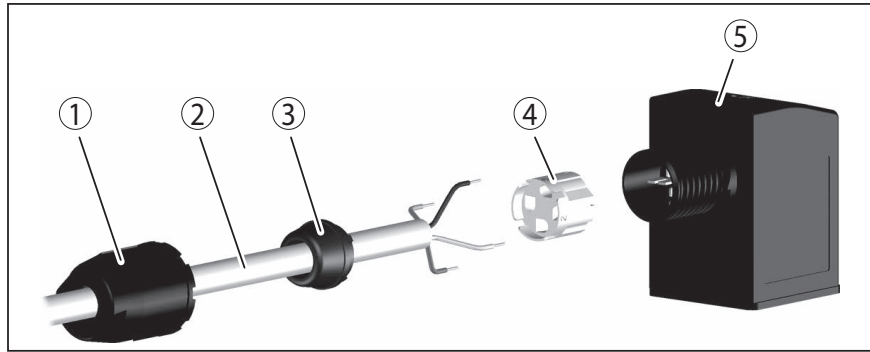


Fig. 9: Connection, valve plug ISO 4400 with IDC crimping technology

- 1 Compression nut
- 2 Cable
- 3 Seal ring
- 4 Terminal insert
- 5 Plug housing

Contactless electronic switch

We recommend connecting OPTISWITCH 4000 C in such a way that the switching circuit is open when there is a level signal, line break or failure (safe condition).



Warning:

The instrument must not be operated without an intermediately connected load, because the electronics would be destroyed if connected directly to the mains. It is not suitable for connection to low voltage PLC inputs.

Examples for typical applications:

- Load resistance at 24 V DC: 88 ... 1800 Ω
- Rated power, relay 253 V AC: > 2.5 VA
- Rated power, relay 24 V AC: > 0.5 VA

For direct control of relays, contactors, magnet valves, warning lights, horns etc.

Domestic current is temporarily lowered below 1 mA after switching off the load so that contactors, whose holding current is lower than the constant domestic current of the electronics (3 mA), are reliably switched off.

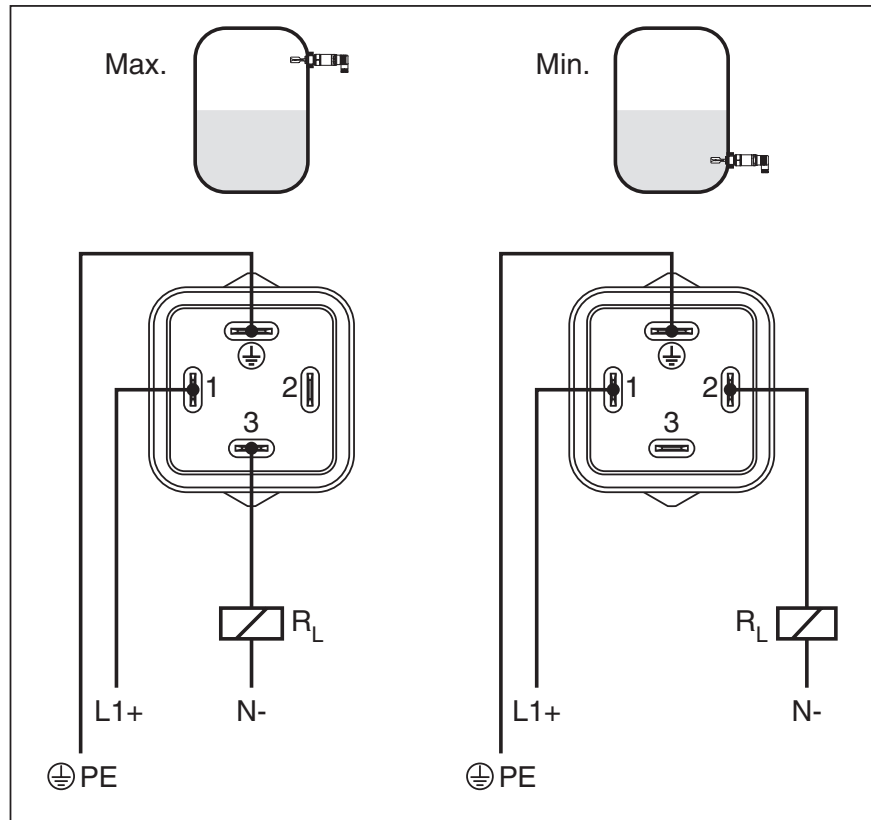


Fig. 10: Wiring plan, contactless electronic switch with valve plug ISO 4400

PE Protective ground

RL Load resistance (contactor, relay, etc.)

6 Setup

6.1 Indication of the switching status

The switching status of the electronics can be checked via the signal lamps (LEDs) integrated in the upper part of the housing.

The signal lamps have the following meaning:

- Green lights - voltage supply connected
- Yellow lights - vibrating element covered
- Red lights briefly - function test during instrument start (for 0.5 s)
- Red lights - shortcircuit or overload in the load circuit (sensor output high-impedance)
- Red flashes - Error on the vibrating element or the electronics (sensor output high impedance)

6.2 Simulation

The OPTISWITCH 4000 C has an integrated function for simulation of the output signal which can be activated magnetically. Please proceed as follows:

- Hold the test magnet (accessory) against the circle symbol with the label "TEST" on the instrument housing

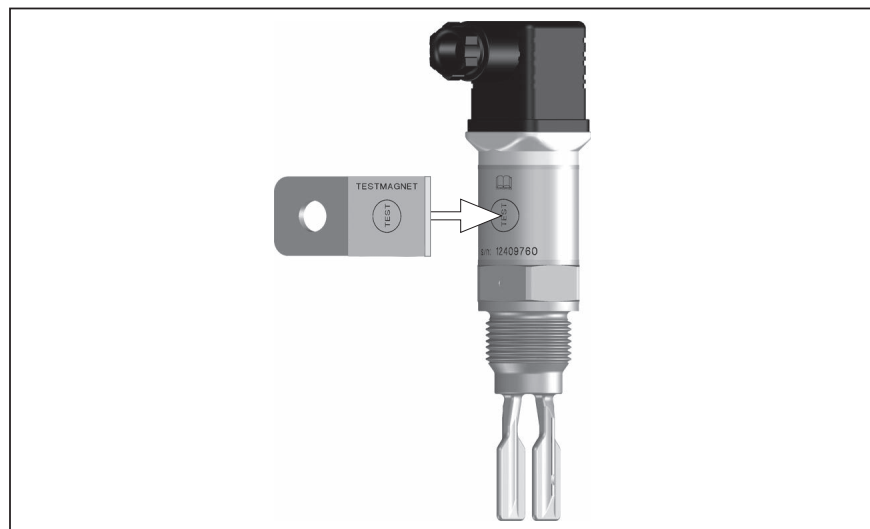


Fig. 11: Simulation of the output signal

The test magnet changes the current switching condition of the instrument. You can check the change on the signal lamp. Please note that all connected device are activated during the simulation.

If OPTISWITCH 4000 C does not switch over after several tests with the test magnet, you have to check the plug connection and the connection cable and try it again. If there is no switching function, the electronics will be defective. In this case you have to exchange the electronics or return the instrument to our repair department.

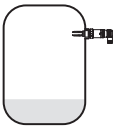

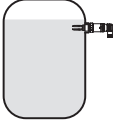


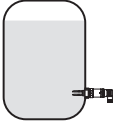


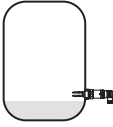





Caution:

It is absolutely necessary that you remove the test magnet from the instrument housing after the simulation.

6.3 Function chart

The following chart provides an overview of the switching conditions depending on the set mode and the level.

	Level	Switching status	Control lamp Yellow - coverage	Control lamp Green - voltage indication	Control lamp Red - fault signal
Mode max.		closed	○		○
Mode max.		open			○
Mode min.		closed			○
Mode min.		open	○		○
Fault	any	open	any		

7 Maintenance and fault rectification

7.1 Maintenance

If the instrument is used properly, no special maintenance is required in normal operation.

7.2 Rectify faults

Reaction when malfunctions occur

The operator of the system is responsible for taking suitable measures to rectify faults.

Failure reasons

OPTISWITCH 4000 C offers maximum reliability. Nevertheless, faults can occur during operation. These may be caused by the following, e.g.:

- Sensor
- Process
- Voltage supply
- Signal processing

Fault rectification

The first measure to be taken is to check the output signal. In many cases, the causes can be determined this way and the faults rectified.

Checking the switching signal

Error	Cause	Rectification
Green signal lamp off	Voltage supply interrupted.	Check the voltage supply and the cable connection
	Electronics defective	Exchange the instrument or send it in for repair
Red signal lamp lights (switching output high-impedance)	Error with the electrical connection	Connect the instrument according to the wiring plan
	Shortcircuit or overload	Check the electrical connection
Red signal lamp flashes (switching output high-impedance)	Vibrating frequency out of specification	Check the vibrating element on build-up and remove it
	Buildup on the vibrating element	Check the vibrating element and the sensor if there is buildup and remove it
	Vibrating element damaged	Check if the vibrating element is damaged or extremely corroded

Reaction after fault rectification

Depending on the reason for the fault and the measures taken, the steps described in chapter "Set up" may have to be carried out again.

7.3 Instrument repair

If a repair is necessary, please proceed as follows:

On our homepage in the Internet under

<http://www.krohne-mar.com/fileadmin/>

[media-lounge/PDF-Download/Specimen_e.pdf](#)

you can download a return form.

By doing this you help us carry out the repair quickly and without having to call back for needed information.

- Print and fill out one form per instrument
- Clean the instrument and pack it damage-proof
- Attach the completed form and possibly also a safety data sheet to the instrument

8 Dismounting

8.1 Dismounting steps

**Warning:**

Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel, high temperatures, corrosive or toxic products etc.

Take note of chapters "*Mounting*" and "*Connecting to power supply*" and carry out the listed steps in reverse order.

8.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the parts to be easily separable.

WEEE directive 2002/96/EG

This instrument is not subject to the WEEE directive 2002/96/EG and the respective national laws. Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points. These may be used only for privately used products according to the WEEE directive.

Correct disposal avoids negative effects on humans and the environment and ensures recycling of useful raw materials.

Materials: see chapter "*Technical data*"

If you have no way to dispose of the old instrument properly, please contact us concerning return and disposal.

9 Supplement

9.1 Technical data

General data

Material 316L corresponds to 1.4404 or 1.4435

Materials, wetted parts

- | | |
|--------------------|-----------------|
| – Tuning fork | 316L |
| – Process seal | Klingsil C-4400 |
| – Process fittings | 316L |

Materials, non-wetted parts

- | | |
|-----------|----------------------|
| – Housing | 316L and plastic PEI |
|-----------|----------------------|

Weight approx. 250 g (9 oz)

Process fittings

- | | |
|--|--|
| – Pipe thread, cylindrical (DIN 3852-A) | G $\frac{1}{2}$, G $\frac{3}{4}$, G1 |
| – American pipe thread, conical (ASME B1.20.1) | $\frac{1}{2}$ NPT, $\frac{3}{4}$ NPT, 1 NPT |
| – hygienic fittings | Clamp 1", Clamp 1 $\frac{1}{2}$ ", Clamp 2", PN 16 DIN 32676, ISO 2852/316L, bolting DN 25 PN 40, bolting DN 40 PN 40, bolting DN 50 PN 25, SMS DN 38 PN 6 |

Max. torque - process fitting

- | | |
|--|--------------------|
| – Thread G $\frac{1}{2}$, $\frac{1}{2}$ NPT | 50 Nm (37 lbf ft) |
| – Thread G $\frac{3}{4}$, $\frac{3}{4}$ NPT | 75 Nm (55 lbf ft) |
| – Thread G1, 1 NPT | 100 Nm (73 lbf ft) |

Surface quality

- | | |
|--------------------|---|
| – Standard | R _a < 3.2 µm (1.26 ⁻⁴ in) |
| – Hygienic version | R _a < 0.8 µm (3.15 ⁻⁵ in) |

Measuring accuracy

- | | |
|---------------------|---|
| Hysteresis | approx. 2 mm (0.08 in) with vertical installation |
| Switching delay | approx. 500 ms (on/off) |
| Measuring frequency | approx. 1100 Hz |

Ambient conditions

- | | |
|------------------------------------|----------------------------------|
| Ambient temperature on the housing | -40 ... +70 °C (-40 ... +158 °F) |
| Storage and transport temperature | -40 ... +80 °C (-40 ... +176 °F) |

Process conditions

- | | |
|--------------------------------|--|
| Process pressure | -1 ... 64 bar/-100 ... 6400 kPa (-14.5 ... 928 psig) |
| Process temperature - Standard | -40 ... +100 °C (-40 ... +212 °F) |

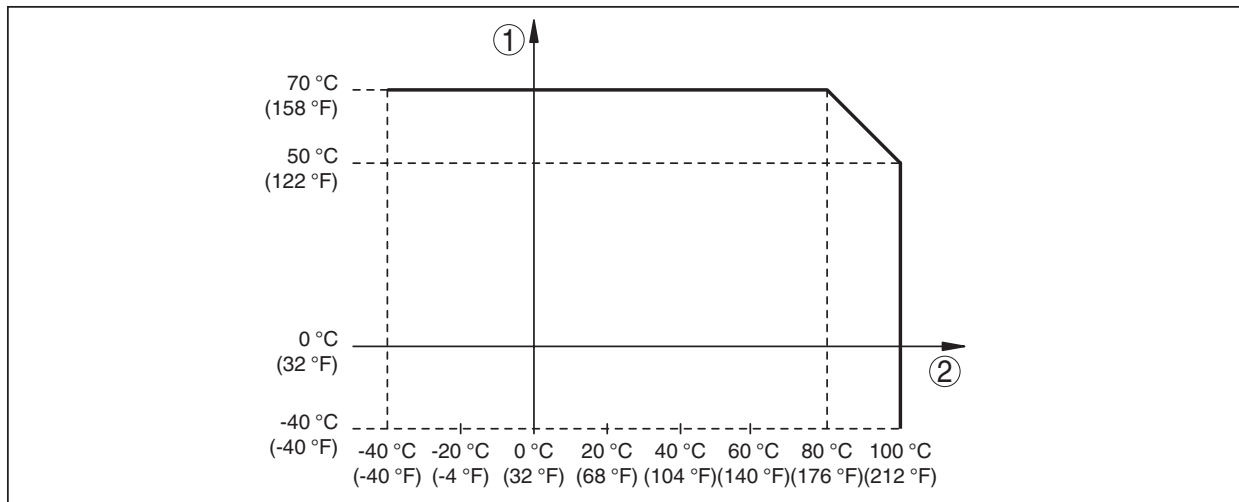


Fig. 30: Dependency ambient temperature to process temperature

- 1 Ambient temperature in °C (°F)
2 Process temperature in °C (°F)

Process temperature - High temperature -40 ... +150 °C (-40 ... +302 °F)
version (option)

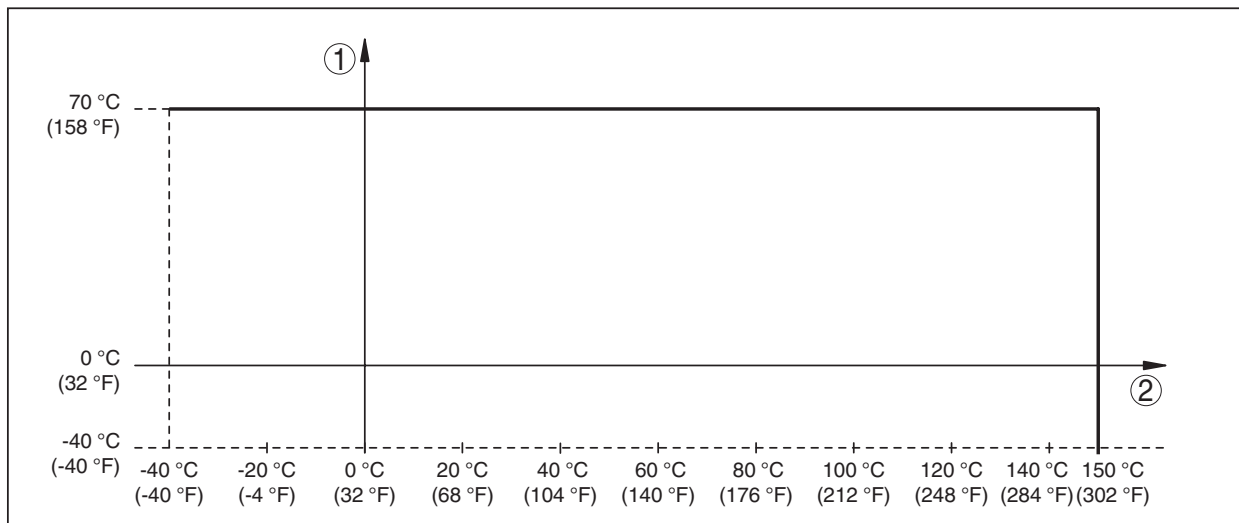


Fig. 31: Dependency ambient temperature to process temperature

- 1 Ambient temperature in °C (°F)
2 Process temperature in °C (°F)

Viscosity - dynamic 0.1 ... 10000 mPa s
Flow velocity max. 6 m/s (with a viscosity of 10000 mPa s)
Density 0.7 ... 2.5 g/cm³ (0.025 ... 0.09 lbs/in³)

Adjustment

Plug connections	Specification see "Connecting to power supply"
Signal lamps (LED)	
– Green	Voltage supply on
– Yellow	Vibrating element covered
– Red	Fault

Output variable

Output	Contactless electronic switch
Modes min / max (changeover by electrical connection)	
– Max.	Max. detection or overflow/overflow protection
– Min.	Min. detection or dry run protection

Voltage supply

Operating voltage	20 ... 253 V AC/DC
Power consumption	max. 0.5 W
Load current	
– Min.	10 mA
– Max.	250 mA

Electromechanical data

Valve plug ISO 4400	
– Wire cross-section	1.5 mm ² (0.06 in ²)
– Outer cable diameter	4.5 ... 7 mm (0.18 ... 0.28 in)
Valve plug ISO 4400 with IDC method of termination	
– Wire cross-section	for wire cross-section of 0.5 ... 1 mm ² (0.02 ... 0.04 in ²)
– Single-wire diameter	> 0.1 mm (0.004 in)
– Wire diameter	1.6 ... 2 mm ² (0.06 ... 0.08 in ²)
– Outer cable diameter	5.5 ... 8 mm (0.22 ... 0.31 in)
– Connection frequency	10 x (on the same cross-section)

Electrical protective measures

Protection rating	
– Valve plug ISO 4400	IP 65
– Valve plug ISO 4400 with IDC method of termination	IP 67
Overvoltage category	III
Protection class	I

Approvals

Depending on the version, instruments with approvals can have different technical data. For these instruments, please note the corresponding approval documents. They are included in the scope of delivery.

9.2 Dimensions

OPTISWITCH 4000 C, standard version - thread G $\frac{1}{2}$, $\frac{1}{2}$ NPT

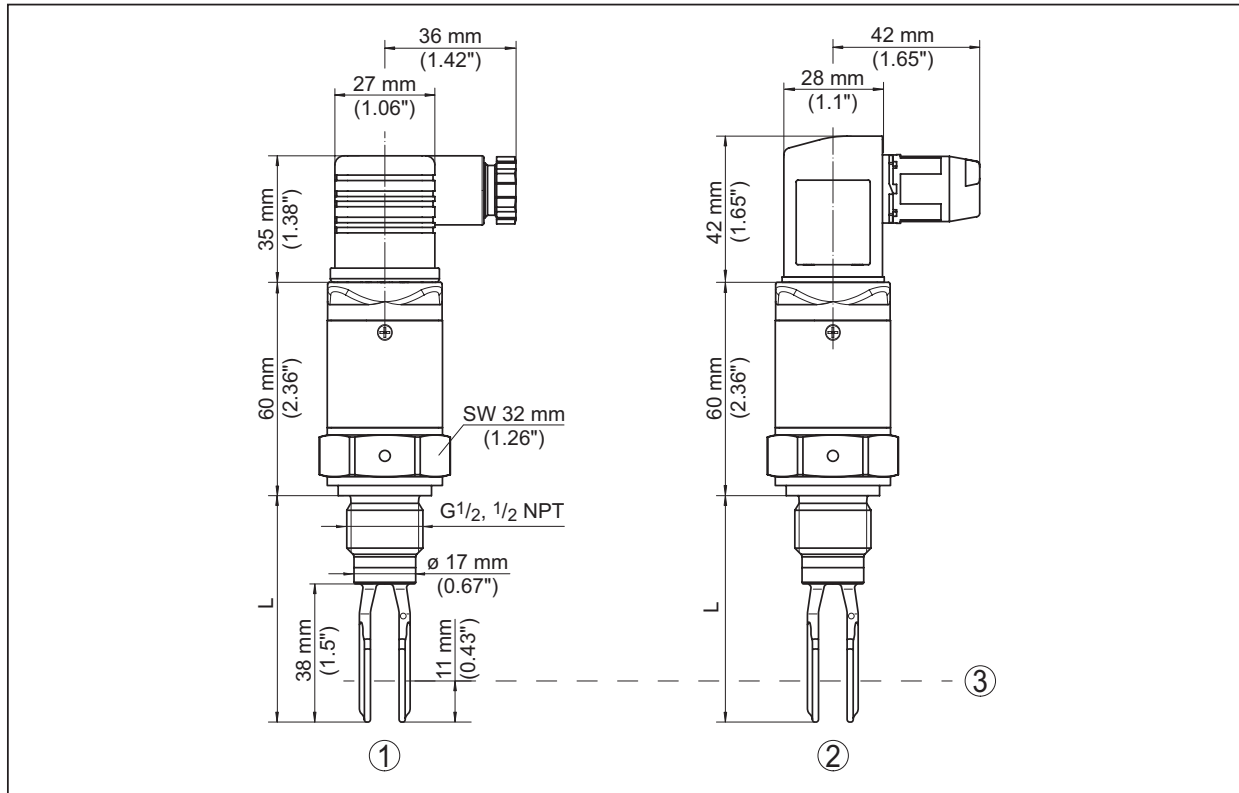


Fig. 32: OPTISWITCH 4000 C, standard version - thread G $\frac{1}{2}$, $\frac{1}{2}$ NPT

- 1 Thread G $\frac{1}{2}$ (DIN ISO 228/1), $\frac{1}{2}$ NPT (valve plug ISO 4400)
- 2 Thread G $\frac{1}{2}$ (DIN ISO 228/1), $\frac{1}{2}$ NPT (valve plug ISO 4400 with DC method of termination)
- 3 Switching point
- L Length with G $\frac{1}{2}$ (DIN ISO 228/1), $\frac{1}{2}$ NPT: 62 mm (2.44 in)

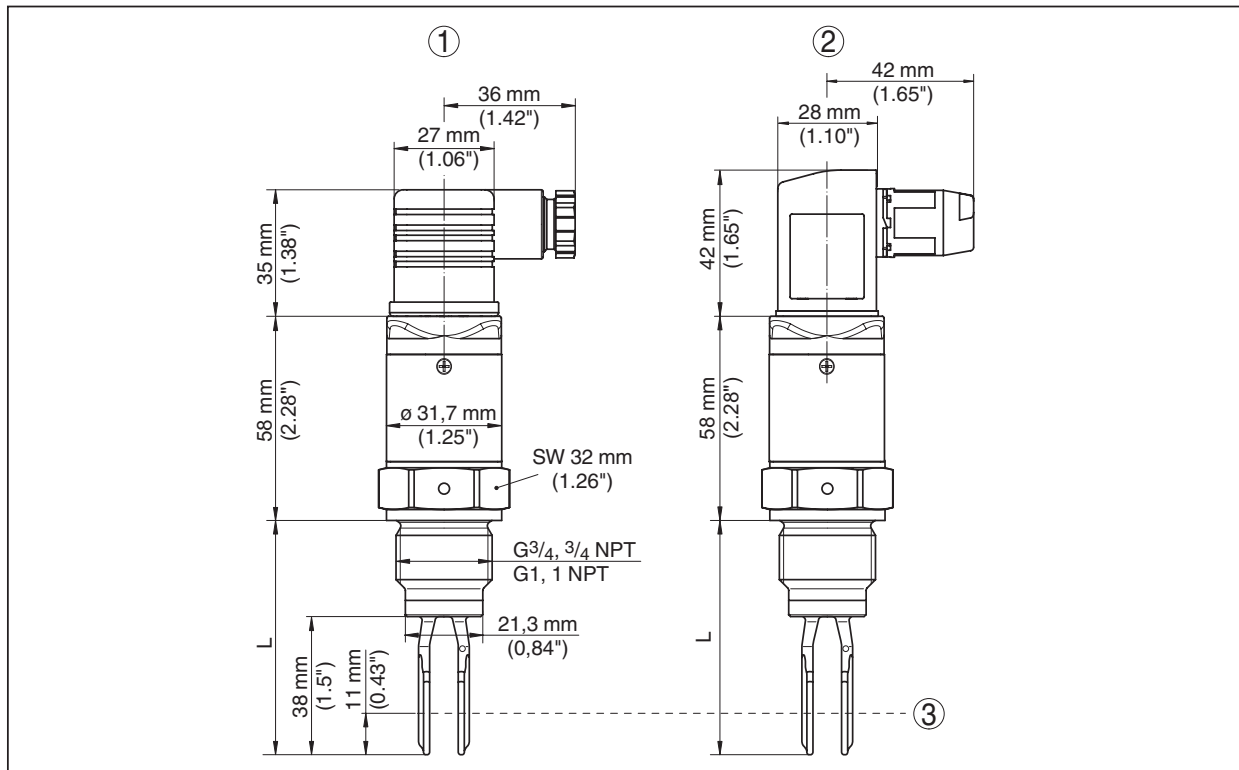
OPTISWITCH 4000 C, standard version - thread G $\frac{3}{4}$, G1 / $\frac{3}{4}$ NPT, 1 NPT

Fig. 33: OPTISWITCH 4000 C, standard version - thread G $\frac{3}{4}$, G1 / $\frac{3}{4}$ NPT, 1 NPT

- 1 Thread G $\frac{3}{4}$, G1 (DIN ISO 228/1), $\frac{3}{4}$ NPT or 1 NPT (valve plug ISO 4400)
- 2 Thread G $\frac{3}{4}$, G1 (DIN ISO 228/1), $\frac{3}{4}$ NPT or 1 NPT (valve plug ISO 4400 with IDC crimping technology)
- 3 Switching point
- L Length with G $\frac{3}{4}$ (DIN ISO 228/1), $\frac{3}{4}$ NPT: 64 mm (2.5 in)
- L Length with G1 (DIN ISO 228/1), 1 NPT: 67 mm (2.64 in)

OPTISWITCH 4000 C, high temperature version

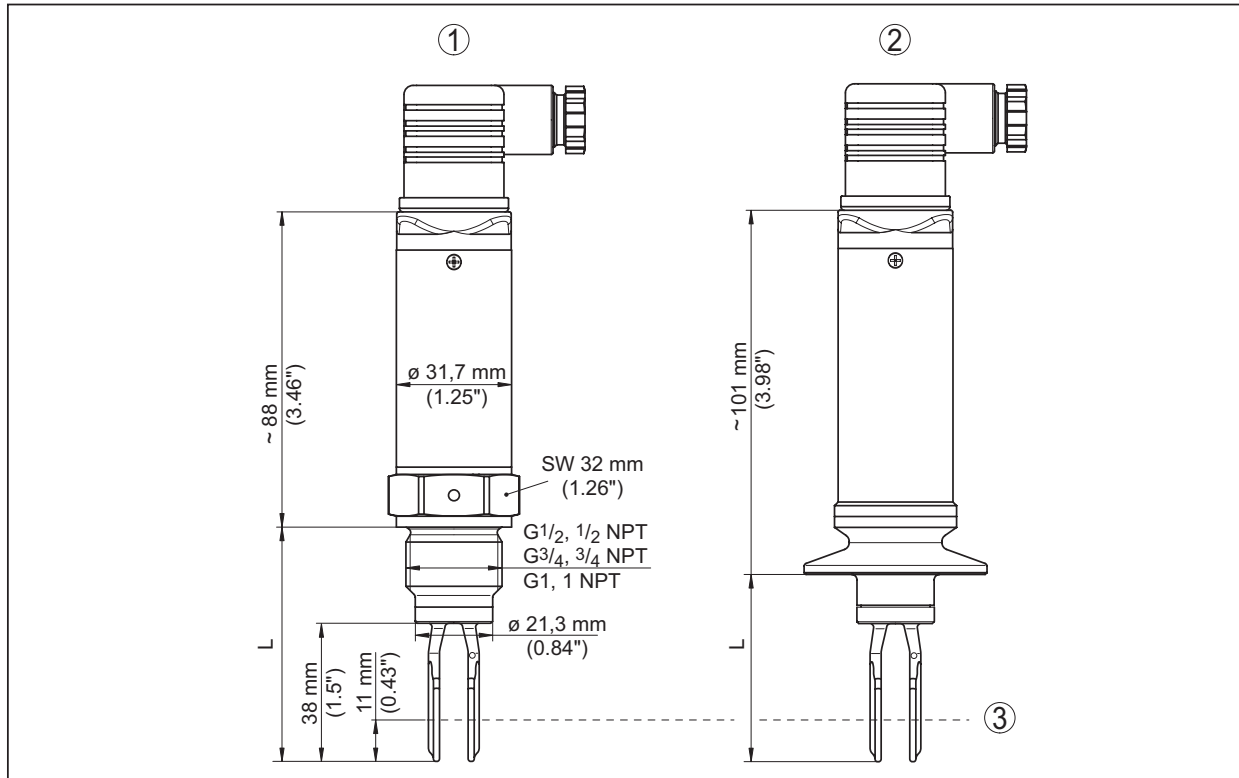


Fig. 34: OPTISWITCH 4000 C, high temperature version

- 1 Thread $G1/2, G3/4, G1$ (DIN ISO 228/1), $1/2'' \text{ NPT}$, $3/4 \text{ NPT}$ or 1 NPT (valve plug ISO 4400)
- 2 Clamp (valve plug ISO 4400)
- 3 Switching point
- L Length with $G1/2$ (DIN ISO 228/1), $1/2 \text{ NPT}$: 62 mm (2.44 in)
- L Length with $G3/4$ (DIN ISO 228/1), $3/4 \text{ NPT}$: 64 mm (2.5 in)
- L Length with $G1$ (DIN ISO 228/1), 1 NPT : 67 mm (2.64 in)
- L Length with Clamp: 53 mm (2.1 in)

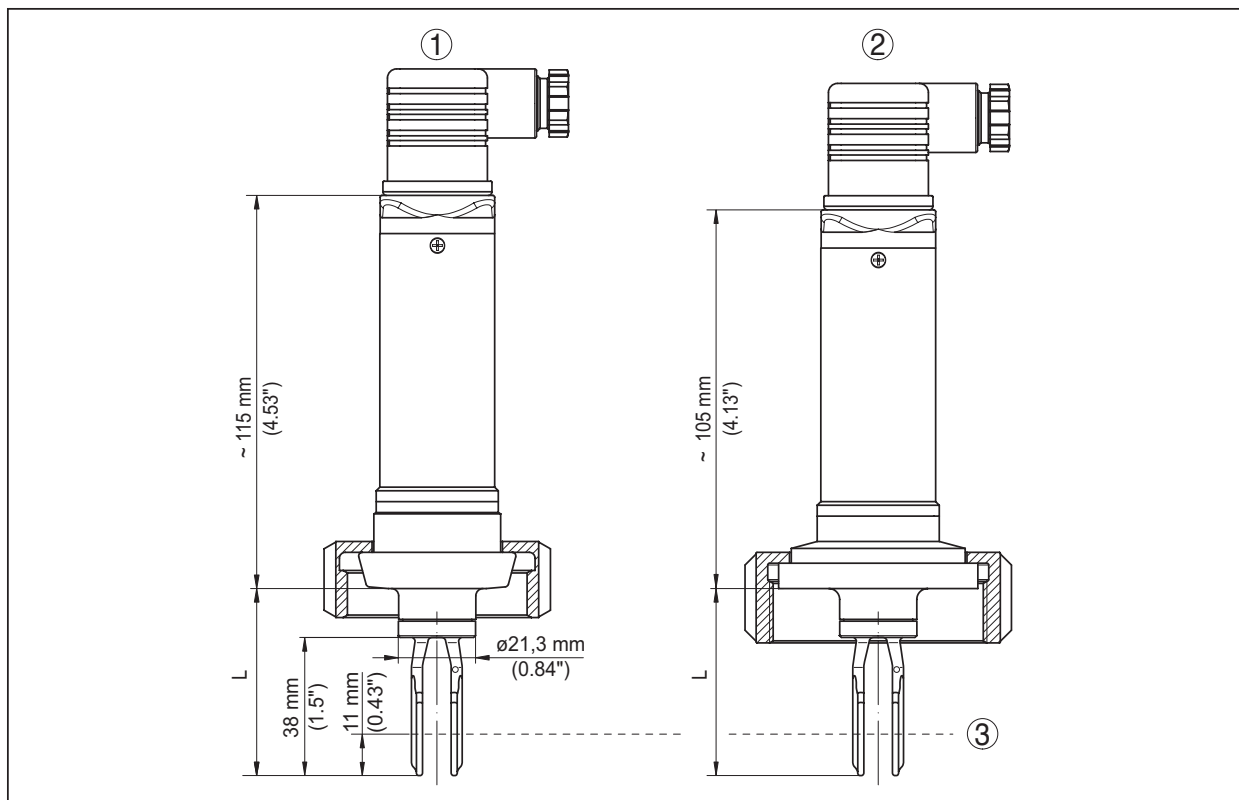
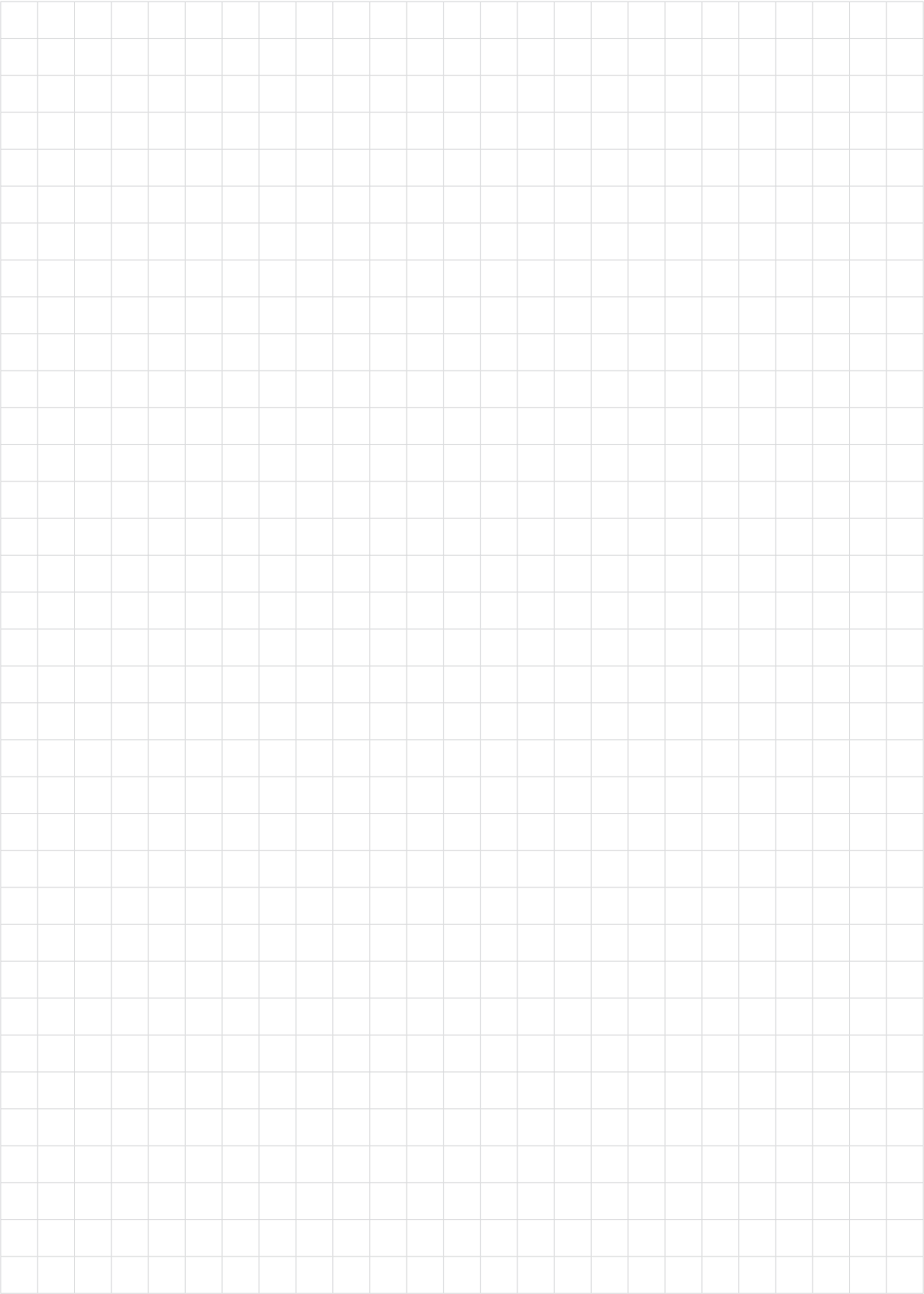


Fig. 35: OPTISWITCH 4000 C, high temperature version

- 1 Bolting (valve plug ISO 4400)
- 2 SMS 1145 (valve plug ISO 4400)
- 3 Switching point
- L Length with bolting: 53 mm (2.1 in)
- L Length with SMS 1145: 53 mm (2.1 in)



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