Vibrating Level Switch

Two-wire 8/16 mA

With SIL qualification
Contents

1 About this document
  1.1 Function ......................................................................................................................... 3
  1.2 Target group .................................................................................................................... 3
  1.3 Symbols used .................................................................................................................... 3

2 For your safety
  2.1 Authorised personnel ....................................................................................................... 4
  2.2 Appropriate use ................................................................................................................ 4
  2.3 Warning about incorrect use ............................................................................................ 4
  2.4 General safety instructions ............................................................................................... 4
  2.5 Safety label on the instrument .......................................................................................... 5
  2.6 EU conformity ................................................................................................................... 5
  2.7 Safety instructions for Ex areas ....................................................................................... 5

3 Product description
  3.1 Configuration .................................................................................................................... 6
  3.2 Principle of operation ....................................................................................................... 8
  3.3 Adjustment ....................................................................................................................... 8
  3.4 Storage and transport ...................................................................................................... 9
  3.5 Accessories ..................................................................................................................... 9

4 Mounting
  4.1 General instructions ......................................................................................................... 11
  4.2 Mounting instructions ..................................................................................................... 13

5 Connecting to power supply
  5.1 Preparing the connection ............................................................................................... 17
  5.2 Connection procedure ..................................................................................................... 17
  5.3 Wiring plan, single chamber housing ............................................................................. 18

6 Setup
  6.1 General information ....................................................................................................... 21
  6.2 Adjustment elements ....................................................................................................... 22
  6.3 Function table .................................................................................................................. 23
  6.4 Proof test (WHG, SIL) ................................................................................................... 24

7 Maintenance and fault rectification
  7.1 Maintenance .................................................................................................................... 30
  7.2 Rectify faults .................................................................................................................. 30
  7.3 Exchanging the electronics ............................................................................................. 31
  7.4 Instrument repair ............................................................................................................ 31

8 Dismount
  8.1 Dismounting steps ......................................................................................................... 32
  8.2 Disposal .......................................................................................................................... 32

9 Supplement
  9.1 Technical data ............................................................................................................... 33
  9.2 Dimensions ..................................................................................................................... 39
  9.3 Trademark ....................................................................................................................... 42

Editing status: 2017-01-16
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 Symbols 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.

- SIL applications
  This symbol indicates instructions for functional safety which must be taken into account particularly for safety-relevant 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 5300 C is a sensor for point level detection.
You can find detailed information about the area of application 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 state-of-the-art instrument complying with all prevailing regulations and guidelines. The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for the 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.
The safety instructions in this operating instructions manual, the national installation standards as well as the valid safety regulations and accident prevention rules must be observed by the user.
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.
The safety approval markings and safety tips on the device must also be observed.
2.5 Safety label on the instrument
The safety approval markings and safety tips on the device must be observed.

2.6 EU conformity
The device fulfils the legal requirements of the applicable EU guidelines. By affixing the CE marking, we confirm successful testing of the product.

2.7 Safety instructions for Ex areas
Please note the Ex-specific safety information for installation and operation in Ex areas. These safety instructions are part of the operating instructions manual and come with the Ex-approved instruments.
3 Product description

3.1 Configuration

The scope of delivery encompasses:

- OPTISWITCH 5300 C point level switch
- Documentation
  - This operating instructions manual
  - Safety Manual "Functional safety (SIL)" (optional)
  - Ex-specific "Safety instructions" (with Ex versions)
  - If necessary, further certificates

The OPTISWITCH 5300 C consists of the components:

- Housing lid
- Housing with electronics
- Process fitting with tuning fork

Fig. 1: OPTISWITCH 5300 C - compact version with plastic housing

1 Housing lid
2 Housing with electronics
3 Temperature adapter
4 Process fitting
Type label

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

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

In addition to the type label outside on the instrument, you find the serial number also inside the instrument.
3.2 Principle of operation

OPTISWITCH 5300 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. It is particularly suitable for applications with high temperatures up to 450 °C (842 °F) and high process pressure up to 160 bar (2320 psig).

Typical applications are overfill and dry run protection. The small tuning fork allows use in all kinds of tanks and vessels. Thanks to its simple and rugged measuring system, OPTISWITCH 5300 C is virtually unaffected by the chemical and physical properties of the liquid.

It functions even under difficult conditions such as turbulence, foam generation, buildup, external vibration or changing products. The OPTISWITCH 5300 C is not suitable for use in pipelines.

Function monitoring

The electronics module of OPTISWITCH 5300 C continuously monitors the following criteria via frequency evaluation:

- Strong corrosion or damage on the tuning fork
- Loss of vibration
- Break in the vibration drive circuit

If one of these faults is detected, the electronics signals it via a defined current to the signal conditioning instrument. The connection cable to the sensor is also monitored for line break and short-circuit.

Functional principle

The tuning fork vibrates at its mechanical resonance frequency of approx. 1400 Hz. When the tuning fork is submerged in the product, the frequency changes. This change is detected by the integrated electronics module, passed on to the processing system as a current value and converted there into a switching command.

Voltage supply

Depending on your requirements, OPTISWITCH 5300 C with two-wire electronics can be connected to different signal conditioning instruments. Compatible signal conditioning instruments are listed in chapter “Technical data”.

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

3.3 Adjustment

With the factory setting, products with a density ≥ 0.7 g/cm³ (0.025 lbs/in³) can be detected. The instrument can be adapted to products with lower density.

On the electronics module you will find the following display and adjustment elements:

- Signal lamp for indication of the operating status (green)
- Control lamp for indication of the switching status (yellow)
- Control lamp for fault indication (red)
- DIL switch for sensitivity adjustment
- Mode switch for selecting the switching behaviour (min./max.)
- Test key
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 carton material. The sensing element is additionally protected with a cardboard cover. For special versions, PE foam or PE foil is also used. Please dispose of the packaging material through 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 %

3.5 Accessories

Flanges
Screwed flanges are available in different versions according to the following standards: DIN 2501, EN 1092-1, BS 10, ASME B 16.5, JIS B 2210-1984, GOST 12821-80.

You can find additional information in the supplementary instructions manual "Flanges according to DIN-EN-ASME-JIS".

Electronics module
The electronics module SW E60 is a replacement part for level switches OPTISWITCH 5300 C.

You can find information in the operating instructions manual of the electronics module.

Plug connector
For connecting the sensors with a separator to voltage supply or signal processing, the sensors are also available with plug connectors.

The following plug connectors are available:
- M12 x 1
- ISO 4400
3 Product description

- Harting HAN 7D
- Harting HAN 8D
- Amphenol-Tuchel
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

In general, OPTISWITCH 5300 C can be installed in any position. The instrument only has to be mounted in such a way that the tuning fork is at the height of the desired switching point.

The tuning fork has lateral markings (notches) that indicate the switching point with vertical mounting. The switching point applies to water in conjunction with the basic setting of the density switch \( \geq 0.7 \text{ g/cm}^3 (0.025 \text{ lbs/in}^3)\). When mounting OPTISWITCH 5300 C, make sure that this marking is at the height of the requested switching point. Keep in mind that the switching point of the instrument will shift if the medium has a density other than water - water is \(1 \text{ g/cm}^3 (0.036 \text{ lbs/in}^3)\). For products \(\leq 0.7 \text{ g/cm}^3 (0.025 \text{ lbs/in}^3)\) and \(\geq 0.47 \text{ g/cm}^3 (0.017 \text{ lbs/in}^3)\) the density switch must be set to \(\geq 0.47 \text{ g/cm}^3\).

Keep in mind that foams with a density \(\geq 0.45 \text{ g/cm}^3 (0.016 \text{ lbs/in}^3)\) are detected by the sensor. This can lead to erroneous switchings, particularly when the sensor is used for dry run protection.

![Fig. 3: Vertical mounting](image)

1 Switching point approx. 13 mm (0.51 in)
2 Switching point with lower density
3 Switching point with higher density
4 Switching point approx. 33 mm (1.3 in)
Fig. 4: Horizontal mounting
1  Switching point
2  Marking on top with threaded versions, marking aligned to flange holes with flange versions

Fig. 5: Horizontal installation (recommended mounting position, particularly for adhesive products)
1  Switching point
2  Marking with screwed version, facing up

In the case of flange versions, the fork is aligned as follows.

Fig. 6: Fork position with flange versions
1  Marking with flange version, facing up

**Moisture**

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

You can give your instrument 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.
Transport

Caution:
Do not hold OPTISWITCH 5300 C on the tuning fork. Particularly with flange or tube versions, the tuning fork can be damaged just by the weight of the instrument. Transport coated instruments very carefully and avoid touching the tuning fork.

Remove the packaging or the protective cover just before installation.

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.

Cable entries - NPT thread

Metric threads
In the case of instrument housings with metric thread, the cable glands are screwed in at the factory. They are sealed with plastic plugs as transport protection.

You have to remove these plugs before electrical connection.

NPT thread
In the case of instrument housings with self-sealing NPT threads, it is not possible to have the cable entries screwed in at the factory. The free openings for the cable glands are therefore covered with red dust protection caps as transport protection.

Prior to setup you have to replace these protective caps with approved cable glands or close the openings with suitable blind plugs.

4.2 Mounting instructions

The thread and the seal on the threaded version of OPTISWITCH 5300 C correspond to DIN 3852 part 2, screwed plug Form A.

Use screw-in openings or screw-in sleeves according to DIN 3852 part 2.
Make sure that with instruments with 1" NPT thread, the screw-in opening on the vessel has an inside diameter of at least 29.5 mm (1.16 in).

To mount the sensor, proceed as follows:

1. Screw the OPTISWITCH 5300 C into the mounting boss up to the stop. You can determine the later position already before welding.

2. Mark the position of the OPTISWITCH 5300 C on the mounting boss.

3. Mark the respective position of the mounting boss on the vessel.
   In case of lateral mounting, make sure the mark on the spanner flat of OPTISWITCH 5300 C points upwards.

4. Remove the OPTISWITCH 5300 C from the mounting boss before welding.

5. Weld the mounting boss according to your 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. On the screwed version you will find a marking on the hexagon. With this, you can check the position of the tuning fork when screwing it in.

In the case of flange versions, the fork is aligned with the flange holes.

When used in adhesive and viscous products, the tuning fork should protrude into the vessel to avoid buildup. For that reason, sockets for flanges and mounting bosses should be avoided when mounting horizontally.

**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.

**Note:**

Seal for instruments with process fitting thread

The thread and the seal form on the mounting boss correspond to DIN 3852, part 2, screwed plug Form A.

We recommend using a temperature and medium-resistant seal for dismounting the instrument for maintenance and revision purposes.

**Mounting in the vessel insulation**

Instruments for high temperatures have a temperature adapter between process fitting and electronics housing. This is used for thermal decoupling of the electronics from high process temperatures.

**Information:**

The temperature adapter may be embedded in the vessel insulation only up to max. 50 mm (1.97 in). Only then is a reliable temperature decoupling guaranteed.
Fig. 8: Mounting the instrument on insulated vessels.

1  Temperature isolation - max. 50 mm (1.97 in)
2  Ambient temperature on the housing

Inflowing medium

If OPTISWITCH 5300 C is mounted in the filling stream, unwanted false measurement signals can be generated. For this reason, mount OPTISWITCH 5300 C at a position in the vessel where no disturbances, e.g. from filling openings, agitators, etc., can occur.

This applies particularly to instrument types with long extension tube.

Fig. 9: Inflowing medium

Product flow

To make sure the tuning fork of OPTISWITCH 5300 C generates as little resistance as possible to product flow, mount the sensor so that the surfaces are parallel to the product movement.
**Agitators**

Due to the effects of agitators, equipment vibration or similar, the level switch can be subjected to strong lateral forces. For this reason, do not use an overly long extension tube (optional) for OPTISWITCH 5300 C, instead check if it is possible to mount a short level switch OPTISWITCH 5300 C on the side of the vessel in horizontal position.

Extreme vibration caused by the process or the equipment, e.g. agitators or turbulence in the vessel, can cause a long extension tube of OPTISWITCH 5300 C to vibrate in resonance. This leads to increased stress on the upper weld joint. Should a longer tube version be necessary, you can provide a suitable support directly above the tuning fork to secure the extension tube.

This measure applies mainly to applications in Ex areas of category 1G or WHG as well as to ship classifications. Make sure that the tube is not subject to bending stress due to this measure.

![Fig. 10: Lateral suppot of OPTISWITCH 5300 C](image)

**Gas-tight leadthrough**

The second seal of the gas-tight leadthrough (option) prevents an uncontrolled leakage of the medium. The service life of the gas-tight leadthrough depends on the chemical resistance of the materials. See "Technical data".

**Caution:**

If it is determined (e.g. via an error message from OPTISWITCH 5300 C) that medium has already penetrated into the vibrating element, the instrument must be exchanged immediately.
5 Connecting to power supply

5.1 Preparing the connection

Note safety instructions

Always keep in mind the following safety instructions:

Warning:
Connect only in the complete absence of line voltage.

- The electrical connection must only be carried out by trained personnel authorised by the plant operator.
- Always switch off power supply, before connecting or disconnecting the instrument.

Take note of safety instructions for Ex applications

In hazardous areas you must take note of the respective regulations, conformity and type approval certificates of the sensors and power supply units.

Voltage supply

Connect the voltage supply according to the following diagrams. Take note of the general installation regulations. As a rule, connect OPTISWITCH 5300 C to vessel ground (PA), or in case of plastic vessels, to the next ground potential. On the side of the instrument housing there is a ground terminal between the cable entries. This connection serves to drain off electrostatic charges. In Ex applications, the installation regulations for hazardous areas must be given priority.

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

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 for instruments with housing and cable gland. To ensure the seal effect of the cable gland (IP protection rating), find out which cable outer diameter the cable gland is suitable for.

- 5 ... 9 mm (0.20 ... 0.35 in)
- 6 ... 12 mm (0.24 ... 0.47 in)
- 10 ... 14 mm (0.40 ... 0.55 in)

Use a cable gland fitting the cable diameter.

In hazardous areas, use only approved cable connections for OPTISWITCH 5300 C.

Connection cable for Ex applications

Take note of the corresponding installation regulations for Ex applications.

Cover all housing openings conforming to standard according to EN 60079-1.

5.2 Connection procedure

With Ex instruments, the housing cover may only be opened if there is no explosive atmosphere present.

Proceed as follows:
1. Unscrew the housing lid
2. Loosen compression nut of the cable gland and remove blind plug
3. Remove approx. 10 cm (4 in) of the cable mantle, strip approx. 1 cm (0.4 in) of insulation from the ends of the individual wires
4. Insert the cable into the sensor through the cable entry
5. Open the terminals with a screwdriver
6. Insert the wire ends into the open terminals according to the wiring plan
7. Tighten the terminals with a screwdriver
8. Check the hold of the wires in the terminals by lightly pulling on them
9. Tighten the compression nut of the cable entry gland. The seal ring must completely encircle the cable
10. Screw the housing lid back on

The electrical connection is finished.

5.3 Wiring plan, single chamber housing

The following illustrations apply to the non-Ex as well as to the Ex-d version.

Housing overview

Fig. 11: Material versions, single chamber housing

1 Plastic (not with Ex d)
2 Aluminium
3 Stainless steel, precision casting
4 Stainless steel, electropolished (not with Ex d)
5 Filter element for air pressure compensation
We recommend connecting OPTISWITCH 5300 C according to the closed-circuit principle, i.e. the switching circuit is open when there is a level signal, line break or fault (safe state).

For connection to a suitable signal conditioning instrument. The sensor is powered by the connected signal conditioning instrument. Further information is available in chapter "Technical data", "Ex-technical data" are available in the supplied "Safety information manual".

The wiring example is applicable for all suitable signal conditioning instruments.

The yellow control lamp on the OPTISWITCH 5300 C lights depending on the adjusted mode.

Take note of the operating instructions manual of the signal conditioning instrument. Suitable signal conditioning instruments are listed in chapter "Technical data".

If OPTISWITCH 5300 C is used in Ex areas, take note of the regulations in the safety instructions and conformity certificates. If the instrument is to be operated directly on the analogue input of a PLC, a suitable safety barrier should be connected.
Fig. 13: Wiring plan, single chamber housing

1 Signal conditioning instrument
6 Setup

6.1 General information
The figures in brackets refer to the following illustrations.

Function/Configuration

In the basic setting, products with a density $\geq 0.7 \text{ g/cm}^3$ (0.025 lbs/in$^3$) can be detected. For products with lower density, you have to set the switch to $\geq 0.47 \text{ g/cm}^3$ (0.017 lbs/in$^3$).

Optionally the instrument can be supplied instead of $\geq 0.47 \text{ g/cm}^3$ also with a min. density range of $\geq 0.42 \text{ g/cm}^3$ (0.015 lbs/in$^3$).

On the electronics module you will find the following display and adjustment elements:

- Signal lamps (1, 2, 3)
- DIL switch for mode setting - min./max. (4)
- DIL switch for sensitivity adjustment (5)
- Test key (6)

Mode adjustment (min./max.)
On the signal conditioning instrument SU 501 Ex, via the signal conditioning instrument.

The switching condition can be changed with the min./max. switch. You can set the required mode according to the "Function table" (max. - max. detection or overfill protection, min. - min. detection or dry run protection). The switching delay can also be modified on the signal conditioning instrument (SU 501 Ex signal conditioning instrument).

If you want to carry out the mode adjustment via the signal conditioning instruments, you have to set the mode switch on the electronics module of OPTISWITCH 5300 C to "max."

Note:
Always immerse the tuning fork of OPTISWITCH 5300 C in a liquid to test its function. Do not test the function of OPTISWITCH 5300 C with your hand. This can damage the sensor.
6.2 Adjustment elements

Fig. 14: Electronics module - Two-wire output

1. Signal lamp - red (LED)
2. Signal lamp - yellow (LED)
3. Signal lamp - green (LED)
4. DIL switch for mode adjustment
5. DIL switch for sensitivity adjustment
6. Test key

Control lamp (1) - fault indication (red)

The instrument monitors the vibrating frequency, electronics temperature and internal instrument functions.

- Red LED lights = fault
- Reaktion on the output

Signal lamp (2) - Switching condition (yellow)

Control lamp for indication of the switching status.

With the mode setting (4), the switching condition and hence the function of the signal lamp can be changed.

- Yellow LED lights = 8 mA
- Yellow LED off = 16 mA

Signal lamp (3) - Operating condition (green)

- Green LED lights = operating voltage on
Mode setting (4)

With the mode adjustment (min./max.) you can determine the output current.

**Note:**

When using a signal conditioning instrument, always set the mode switch (4) to max. mode.

In this case, you select the requested mode according to the "Function table" (max. - max. detection or overfill protection, min. - min. detection or dry run detection) on the signal conditioning instrument.

When used on a control system, the following values apply:

- Mode min./max.
  - Vibrating element uncovered - 8 mA ±1.5 mA
  - Vibrating element covered - 16 mA ±1.5 mA

Sensitivity adjustment (5)

With this DIL switch (5) you can set the switching point to liquids having a density between 0.47 and 0.7 g/cm³ (0.017 - 0.025 lbs/in³). With the basic setting, liquids with a density of ≥ 0.7 g/cm³ (0.025 lbs/in³) can be detected. In liquids with lower density, you must set the switch to ≥ 0.47 g/cm³ (0.017 lbs/in³). The specifications for the position of the switching point relate to water - density value 1 g/cm³ (0.036 lbs/in³). In products with a different density, the switching point will shift in the direction of the housing or tuning fork end depending on the density and type of installation.

Optionally the instrument can be also supplied with a min. density range of ≥ 0.42 g/cm³ (0.015 lbs/in³). In this case, the max. permissible process pressure is limited to 25 bar (363 psig).

**Note:**

Keep in mind that foams with a density ≥ 0.45 g/cm³ (0.016 lbs/in³) are detected by the sensor. This can lead to erroneous switchings, particularly when the sensor is used for dry run protection.

**Note:**

In case of intense boiling or bubbling processes as well as extreme outgassing, the density of the gas/product mixture at the product surface can be so low that it can't be detected by the sensor. This can cause erroneous switchings.

Test key (6)

With key (6) you can activate the test process. You interrupt the voltage supply as long as you are pressing the key. The test process will be carried out after releasing the key.

6.3 Function table

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

**Note:**

Keep in mind that the mode switch of OPTISWITCH 5300 C must be always set to "max.".
<table>
<thead>
<tr>
<th>Mode on the signal conditioning instrument</th>
<th>Level</th>
<th>Signal current - Sensor</th>
<th>Signal lamp - green Voltage supply</th>
<th>Signal lamp - yellow Switching status</th>
<th>Signal lamp - red Fault message</th>
<th>Analogue - input control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode max. Overflow protection</td>
<td>approx. 8 mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 3.8 mA &lt; 11.5 mA</td>
</tr>
<tr>
<td>Mode max. Overflow protection</td>
<td>approx. 16 mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 12.5 mA &lt; 21 mA</td>
</tr>
<tr>
<td>Mode min. Dry run protection</td>
<td>approx. 8 mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 3.8 mA &lt; 11.5 mA</td>
</tr>
<tr>
<td>Mode min. Dry run protection</td>
<td>approx. 16 mA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 12.5 mA &lt; 21 mA</td>
</tr>
<tr>
<td>Failure of the supply voltage Mode (max./ min.)</td>
<td>any</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fault message Mode (max./ min.)</td>
<td>any</td>
<td>approx. 3.6 mA</td>
<td></td>
<td></td>
<td></td>
<td>≤ 3.6 mA ≥ 21 mA</td>
</tr>
</tbody>
</table>

### 6.4 Proof test (WHG, SIL)

To find out possible undetected, dangerous failures, a proof test must be carried out in adequate time intervals to check the safety function. It is the user’s responsibility to choose the type of testing. You will find further instructions in the Safety Manual.

**Implementation - Function test**

The following options are available for carrying out the proof test (WHG, SIL):

1. **Filling the vessel up to the switching point**
   If this does not cause any problems, you can fill the vessel up to the switching point and monitor the correct sensor reaction.

2. **Dismounting of the sensor and immersion in the original medium**
   You can dismount the sensor for test purposes and check its proper functioning by immersing it in the original product.
3 Short interruption of the supply line to the sensor
The recurring proof test according to IEC 61508 can be carried out through a short interruption (> 2 seconds) of the supply line to the sensor. This starts a test sequence.

The correctness of the subsequent switching conditions on the indications of the SPLC must be monitored. The sensor must neither be dismounted nor triggered by filling the vessel.

- Short interruption of the power supply
- Test key on SU 501 Ex - by monitoring the switching sequence of the test process

You can carry out the function test with the outputted current values also directly via a safety PLC or a process control system.

Procedure
1. Carry out the function test according to the above description (1 Short interruption of the supply line to the sensor.
   Separate the instrument briefly (> 2 s) from voltage supply or push the test key.
   Check the results of the test.
   Make sure the connected downstream devices are activated during the function test.

2. Set the mode switch (min./max.)
   Check if the switching status changes (signal lamp - switching status). By doing so, you can check the function of the measuring system.
   If this is not the case, then there is a fault in the measuring system.
   Make sure the connected downstream devices are activated during the function test.

3. Fill the vessel up to the switching point.
   Check if the switching status changes (signal lamp - switching status). By doing so, you can check the function of the measuring system.
   If this is not the case, then there is a fault in the measuring system.
   Make sure the connected downstream devices are activated during the function test.

You can find the coverage of the test in the Safety Manual.

2 Dismounting of the sensor and immersion in the original medium
You can dismount the sensor for test purposes and check its function by immersing the vibrating element in the original medium.

Procedure
1. Carry out the function test according to the above description (1 Short interruption of the supply line to the sensor.

1 Filling the vessel up to the switching point
If this does not cause any problems, you can fill the vessel up to the switching point and monitor the correct sensor reaction.
Separate the instrument briefly (> 2 s) from voltage supply or push the test key.

Check the results of the test.

Make sure the connected downstream devices are activated during the function test.

2. Set the mode switch (min./max.)

Check if the switching status changes (signal lamp - switching status). By doing so, you can check the function of the measuring system.

If this is not the case, then there is a fault in the measuring system.

Make sure the connected downstream devices are activated during the function test.

3. Dismount the instrument and immerse the vibrating element up to the switching point in the original medium.

Check if the switching status changes (signal lamp - switching status). By doing so, you can check the function of the measuring system.

If this is not the case, then there is a fault in the measuring system.

Make sure the connected downstream devices are activated during the function test.

You can find the coverage of the test in the Safety Manual.

This test is valid if you cannot change the vessel filling or cannot dismount the sensor.

This function test can be carried out with measurement setups in conjunction with the two-wire electronics module.

The recurring proof test according to IEC 61508 can be carried out through a short interruption (> 2 seconds) of the supply line to the sensor.

By doing so, a test procedure is started. The correctness of the subsequent switching conditions on the indications of the SPLC must be monitored.

**a. Short interruption of the supply line to the sensor**

You can carry out the function test with the outputted current values also directly via a safety PLC or a process control system.

1. Separate the instrument briefly (> 2 s) from voltage supply.

Check if all three switching conditions change in the correct sequence and the specified duration. By doing so, you can check the function of the measuring system.

You can find the test procedure under "Implementation - Function test".

Make sure the connected downstream devices are activated during the function test.

2. Set the mode switch (min./max.)
Check if the switching status changes (signal lamp - switching status). By doing so, you can check the function of the measuring system.

If this is not the case, then there is a fault in the measuring system.

Make sure the connected downstream devices are activated during the function test.

b. Pushing the test key
An integrated test key is lowered in the front plate of the signal conditioning instrument or in the electronics module of the OPTISWITCH 5300 C. Push the test key for > 2 seconds with a suitable object.

1. Push the test key.
   Check if all three switching conditions change in the correct sequence and the specified duration. By doing so, you can check the function of the measuring system.
   You can find the test procedure under "Implementation - Function test".
   Make sure the connected downstream devices are activated during the function test.

2. Set the mode switch (min./max.)
   Check if the switching status changes (signal lamp - switching status). By doing so, you can check the function of the measuring system.
   If this is not the case, then there is a fault in the measuring system.
   Make sure the connected downstream devices are activated during the function test.

You can find the coverage of the test in the Safety Manual.

**Implementation - Function test**
If you are using a signal conditioning instrument of type SU 501 Ex for this purpose, you can also carry out the test with the integrated test key. The test key is recessed in the front plate of the signal conditioning instrument. Push the test key for > 2 seconds with a suitable object (screwdriver, pen, etc.).

When the OPTISWITCH 5300 C is connected to a processing system or an SPLC, you have to interrupt the connection cable to the sensor for > 2 seconds. The switching delay must be set to 0.5 s.

After releasing the test key or interrupting the connection cable to the sensor, the complete measuring system can be checked on correct function. The following operating conditions are simulated during the test:

- Fault message
- Empty signal
- Full signal
Fig. 37: Flow chart of the function test (mode "max.")

1. Fault message
2. Empty signal
3. Full signal

Check if all three switching conditions occur in the correct sequence and the stated time period. If this is not the case, there is a fault in the measuring system (see also the operating instructions manual of the signal conditioning instrument). Keep in mind that connected instruments are activated during the function test. By doing this, you can check the correct function of the measuring system.

Note:
Keep in mind that the starting time $t_A$ of the voltage supply can extend the time up to the first switching (e.g. type SU 501 Ex: $+1 \, \text{s}$)

Test procedure
After releasing the button or after a brief line break.

<table>
<thead>
<tr>
<th>Sensor current - Sensor</th>
<th>Level relay A - overfill protection</th>
<th>Signal lamp A - Overfill protection</th>
<th>Level relay B - dry run protection</th>
<th>Signal lamp B - Dry run protection</th>
<th>Fail safe relay</th>
<th>Control lamp - Fault signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fault signal approx. 1.5 s (±0.5 s) + $t_A$</td>
<td>&lt; 3.6 mA</td>
<td>currentless</td>
<td>currentless</td>
<td>currentless</td>
<td>currentless</td>
<td></td>
</tr>
<tr>
<td>2. Empty signal 1.5 s (±0.5 s)</td>
<td>8 mA (±1.5 mA)</td>
<td>energized</td>
<td>currentless</td>
<td>currentless</td>
<td>energized</td>
<td></td>
</tr>
<tr>
<td>3. Full signal 1.5 s (±0.5 s)</td>
<td>16 mA (±1.5 mA)</td>
<td>currentless</td>
<td>energized</td>
<td>energized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Return to current operating condition</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

$^{(1)}$ Starting time of the voltage supply
Test assessment (SPLC)

Test passed

<table>
<thead>
<tr>
<th>Status</th>
<th>Current value</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>False signal</td>
<td>&lt; 3.6 mA</td>
<td>1.5 s (±0.5 s)</td>
</tr>
<tr>
<td>Uncovered</td>
<td>8 mA (±1.5 mA)</td>
<td>1.5 s (±0.5 s)</td>
</tr>
<tr>
<td>Covered</td>
<td>16 mA (±1.5 mA)</td>
<td>1.5 s (±0.5 s)</td>
</tr>
</tbody>
</table>
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
The operator of the system is responsible for taking suitable measures to rectify faults.

Reaction when malfunction occurs

Causes of malfunction
OPTISWITCH 5300 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 take is to check the output signal. In many cases, the causes can be determined this way and the faults quickly rectified.

Checking the switching signal

<table>
<thead>
<tr>
<th>Error</th>
<th>Reason</th>
<th>Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPTISWITCH 5300 C signals &quot;covered&quot; without being submerged (overflow protection)</td>
<td>Operating voltage too low</td>
<td>Check operating voltage</td>
</tr>
<tr>
<td>OPTISWITCH 5300 C signals &quot;uncovered&quot; when being submerged (dry run protection)</td>
<td>Electronics defective</td>
<td>Press the mode switch on the signal conditioning instrument. If the instrument then changes the mode, the vibrating element may be covered with buildup or mechanically damaged. Should the switching function in the correct mode still be faulty, return the instrument for repair.</td>
</tr>
<tr>
<td>Unfavourable installation location</td>
<td>Mount the instrument at a location in the vessel where no dead zones or air bubbles can form.</td>
<td></td>
</tr>
<tr>
<td>Buildup on the vibrating element</td>
<td>Check the vibrating element and the sensor for buildup and remove the buildup if there is any.</td>
<td></td>
</tr>
<tr>
<td>Wrong mode selected</td>
<td>Set the correct mode on the signal conditioning instrument (overflow protection, dry run protection). Wiring should be carried out according to the idle current principle.</td>
<td></td>
</tr>
<tr>
<td>Red control lamp lights up</td>
<td>Error on the vibrating element</td>
<td>Check if the vibrating element is damaged or extremely corroded.</td>
</tr>
<tr>
<td></td>
<td>Interference on the electronics module</td>
<td>Exchanging the electronics module</td>
</tr>
<tr>
<td></td>
<td>Instrument defective</td>
<td>Exchange the instrument or send it in for repair</td>
</tr>
</tbody>
</table>
7 Maintenance and 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 Exchanging the electronics
If the electronics module is defective, it can be replaced by the user.

With SIL qualified instrument, only a respective electronics module with SIL qualification must be used.

In Ex applications, only instruments and electronics modules with appropriate Ex approval may be used.

You can find all the information you need to carry out an electronics exchange in the handbook of the new electronics module.

7.4 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 Dismount

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.

With Ex instruments, the housing cover may only be opened if there is no explosive atmosphere present.

8.2 Disposal

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

Note for approved instruments

The technical data in the respective safety instructions are valid for approved instruments (e.g. with Ex approval). These data can differ from the data listed herein, for example regarding the process conditions or the voltage supply.

General data

Material 316L corresponds to 1.4404 or 1.4435

Materials, wetted parts

- Process fitting - thread (up to 100 bar) Inconel 718
- Process fitting - thread (up to 160 bar) Inconel 718
- Process fitting - flange 316L
- Process seal On site
- Tuning fork Inconel 718
- Extension tube: ø 21.3 mm (0.839 in) up to 100 bar (optional) 316L
- Extension tube: ø 21.3 mm (0.839 in) up to 160 bar (optional) Alloy C22 (2.4602)

Materials, non-wetted parts

- Plastic housing plastic PBT (Polyester)
- Aluminium die-cast housing Aluminium die-casting AlSi10Mg, powder-coated - basis: Polyester
- Stainless steel housing, precision casting 316L
- Stainless steel housing, electropolished 316L
- Seal between housing and housing lid Silicone SI 850 R, NBR silicone-free
- Ground terminal 316L
- Cable gland PA, stainless steel, brass
- Sealing, cable gland NBR
- Blind plug, cable gland PA
- Temperature adapter (ø 33.7 mm) 316L

Second Line of Defense (optional)\(^2\)

- The Second Line of Defense (SLOD) is a second level of the process separation in the form of a gas-tight feedthrough in the lower part of the housing, preventing product from penetrating into the housing.
- Supporting material 316L
- Material Ceramic Al\(_2\)O\(_3\) (99.5 %)

\(^2\) Or gas-tight leadthrough.
− Contacts Kovar (gold-plated)
− Helium leak rate < 10⁻⁸ mbar l/s
− Pressure resistance PN 160

Sensor length - Compact version
− Alloy C22 (2.4602) 74 mm (2.91 in)
− Inconel 718 74 mm (2.91 in)

Sensor length (L) - Tube version
− 316L, Alloy C22 (2.4602) 260 … 3000 mm (10.24 … 118.1 in)
− Inconel 718 260 … 3000 mm (10.24 … 118.1 in)

Weight
− Instrument weight (depending on process fitting) approx. 0.8 … 4 kg (0.18 … 8.82 lbs)
− Tube extension approx. 1100 g/m (11.8 oz/ft)

Surface quality Ra approx. 3 µm (1.18⁻⁴ in)

Process fittings
− Pipe thread, cylindrical (DIN 3852, part 2, Form A) G1
− Pipe thread, conical (ASME B1.20.1) 1 NPT, core diameter of the internal thread > 28.5 mm (1.12 in)
− Flanges DIN EN from DN 50, ASME from 1½”

Max. torque - process fitting
− Thread G1, 1 NPT max. 285 Nm (210 lbf ft)³)

Torque for NPT cable glands and Conduit tubes
− Plastic housing max. 10 Nm (7.376 lbf ft)
− Aluminium/Stainless steel housing max. 50 Nm (36.88 lbf ft)

### Output variable

<table>
<thead>
<tr>
<th>Output</th>
<th>Two-wire output</th>
</tr>
</thead>
</table>

Possible signal conditioning instruments
- SU 501 Ex

Output signal
- Mode min. Vibrating element uncovered: 16 mA ±1.5 mA, vibrating element covered: 8 mA ±1.5 mA
- Mode max. Vibrating element uncovered: 8 mA ±1.5 mA, vibrating element covered: 16 mA ±1.5 mA
- Fault message < 3.6 mA

Modes (switchable) Min./Max.

### Accuracy (according to DIN EN 60770-1)

Reference conditions and actuating variables according to DIN EN 61298-1
- Ambient temperature +18 … +30 °C (+64 … +86 °F)
- Relative humidity 45 … 75 %

³) Depending on the mounting boss of the vessel.
- Air pressure: 860 ... 1060 mbar/86 ... 106 kPa (12.5 ... 15.4 psig)
- Product temperature: +18 ... +30 °C (+64 ... +86 °F)
- Product density: 1 g/cm³ (0.036 lbs/in³) (water)
- Product viscosity: 1 mPa s
- Superimposed pressure: 0 kPa
- Sensor installation: Vertically from top
- Density selection switch: ≥ 0.7 g/cm³

**Measuring accuracy**

| Deviation | ± 1 mm (0.04 in) |

**Influence of the product density on the switching point**

Fig. 47: Influence of the product density on the switching point

1. Shifting of the switching point in mm (in)
2. Product density in g/cm³ (lb/in³)
3. Switch position ≥ 0.47 g/cm³ (0.017 lb/in³)
4. Switch position ≥ 0.7 g/cm³ (0.025 lb/in³)
5. Switching point at reference conditions (notch)
6. Tuning fork
Influence of the process pressure to the switching point

Fig. 48: Influence of the process pressure to the switching point
1 Shifting of the switching point in mm (in)
2 Process pressure in bar (psig)
3 Switching point at reference conditions (notch)
4 Tuning fork

Repeatability 0.1 mm (0.004 in)
Hysteresis approx. 2 mm (0.08 in) with vertical installation
Switching delay
  - Standard approx. 1 s (on/off)
  - Optional - can be ordered factory-made 1 ... 60 s (on/off)
Measuring frequency approx. 1400 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
Measured variable Limit level of liquids
Process pressure
  - Instrument version up to 100 bar (1450 psig)
    -1 ... 100 bar/-100 ... 10000 kPa (-14.5 ... 1450 psig)
The process pressure is dependent on the process fitting, e.g. flange (see the following diagrams)
  - Instrument version up to 160 bar (2320 psig)
    -1 ... 160 bar/-100 ... 16000 kPa (-14.5 ... 2320 psig)
The process pressure is dependent on the process fitting, e.g. flange (see the following diagrams)
Fig. 49: Process temperature - Process pressure - Version up to 100 bar (1450 psig)
1  Process pressure in bar (psig)
2  Process temperature in °C (°F)

Fig. 50: Process temperature - Process pressure - Version up to 160 bar (2321 psig)
1  Process pressure in bar (psig)
2  Process temperature in °C (°F)

Process temperature (thread or flange temperature)
- OPTISWITCH 5300 C of 316L/Alloy C22 (2.4602)/Inconel 718 (2.4668)

Fig. 51: Ambient temperature - Process temperature
1  Ambient temperature in °C (°F)
2  Process temperature in °C (°F)

Viscosity - dynamic 0.1 ... 1000 mPa s (requirement: with density 1)
Flow velocity max. 6 m/s (with a viscosity of 1000 mPa s)
Density  
0.7 ... 2.5 g/cm³ (0.025 ... 0.09 lbs/in³); 0.47 ... 2.5 g/cm³ (0.017 ... 0.09 lbs/in³) by switching over
Optionally also ≥ 0.42 g/cm³ (0.015 lbs/in³)\(^4\)

Vibration resistance

- Instrument housing  
1 g at 5 ... 200 Hz according to EN 60068-2-6 (vibration with resonance)

- Sensor  
1 g with 5 ... 200 Hz according EN 60068-2-6 (vibration at resonance) with sensor length up to 50 cm (19.69 in)
With a sensor length > 50 cm (19.69 in) you have to fix the extension tube with a suitable support. See mounting instructions.

Electromechanical data - version IP 66/IP 67 and IP 66/IP 68; 0.2 bar

Cable entry/plug\(^5\)

- Single chamber housing  
- 1 x cable entry M20 x 1.5 (use seal according to the cable diameter), 1 x blind plug M20 x 1.5
or:
- 1 x closing cap ½ NPT, 1 x blind plug ½ NPT
or:
- 1\(\frac{1}{4}\)x plug (depending on the version), 1\(\frac{1}{4}\)x blind stopper M20\(\times\)1.5

Spring-loaded terminals  
for wire cross-section up to 1.5 mm² (AWG 16)

Adjustment elements

Mode switch  
- Max.  
Max. detection or overflow/overfill protection
- Min.  
Min. detection or dry run protection

Sensitivity switch

- ≥ 0.47 g/cm³  
0.47 ... 2.5 g/cm³ (0.017 ... 0.09 lbs/in³)
- ≥ 0.7 g/cm³  
0.7 ... 2.5 g/cm³ (0.025 ... 0.09 lbs/in³)

Test key  
To activate the test process

Voltage supply

Operating voltage (via the signal conditioning instrument)

- Non-Ex instrument  
9.6 ... 35 V DC
- Ex-d instrument (ATEX, FM, CSA)  
9.6 ... 35 V DC
- Ex-ia instrument (ATEX, FM, CSA)  
9.6 ... 30 V DC

Electrical protective measures

Protection rating  
IP 66/IP 67 (NEMA Type 4X)
Protection class  
II

\(^4\) Max. permissible process pressure: 25 bar (363 psig)
\(^5\) Depending on the version M12 x 1, according to ISO 4400, Harting, 7/8" FF.
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

Housing in protection IP 66/IP 67 and IP 66/IP 68; 0.2 bar

Fig. 52: Housing versions in protection IP 66/IP 67 and IP 66/IP 68; 0.2 bar

1 Plastic single chamber
2 Stainless steel single chamber (electropolished)
3 Stainless steel single chamber (precision casting)
4 Aluminium - single chamber
Fig. 53: OPTISWITCH 5300 C, compact version

1 Sealing surface
OPTISWITCH 5300 C, tube version

Fig. 54: OPTISWITCH 5300 C, tube version

L  Sensor length - see Technical data - General data
1  Sealing surface
9.3 Trademark
All the brands as well as trade and company names used are property of their lawful proprietor/originator.
KROHNE product overview

- Electromagnetic flowmeters
- Variable area flowmeters
- Ultrasonic flowmeters
- Mass flowmeters
- Vortex flowmeters
- Flow controllers
- Level meters
- Temperature assemblies
- Pressure transmitters
- Analysis products
- Products and systems for the oil and gas industry

KROHNE Messtechnik GmbH & Co. KG
Ludwig-Krohne-Straße 5
D-47058 Duisburg
Tel.: +49 (0) 203 301 0
Tel.: +49 (0) 203 301 10389
info@krohne.de

The current list of all KROHNE contacts and addresses can be found at:
www.krohne.com