OPTISWITCH 5100 C, 5150 C Handbook

Vibrating Level Switch

Two-wire
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 5100 C, 5150 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 fulfills the legal requirements of the applicable EU guidelines. By affixing the CE marking, we confirm successful testing of the product.

2.7 **SIL conformity**
OPTISWITCH 5100 C, 5150 C fulfills the requirements on functional safety according to IEC 61508 resp. IEC 61511. You can find further information in the Safety Manual *"OPTISWITCH 5XXX"*.

2.8 **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

Scope of delivery
The scope of delivery encompasses:

- OPTISWITCH 5100 C, 5150 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

Constituent parts
The OPTISWITCH 5100 C, 5150 C consists of the components:

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

Fig. 1: OPTISWITCH 5100 C, 5150 C
1 Housing lid
2 Housing with electronics
3 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
- SIL identification (with SIL rating ex works)

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

3.2 Principle of operation

Application area
OPTISWITCH 5100 C, 5150 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 its tuning fork of only 40 mm length, OPTISWITCH 5100 C, 5150 C can also be mounted e.g. in pipelines from DN 32. The small tuning fork allows use in vessels, tanks and pipes. Thanks to its simple and robust measuring system, OPTISWITCH 5100 C, 5150 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 5100 C, 5150 C continuously monitors the following criteria via frequency evaluation:

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

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 is piezoelectrically energised and vibrates at its mechanical resonance frequency of approx. 1200 Hz. The piezos are fixed mechanically and are hence not subject to temperature shock limitations. The frequency changes when the tuning fork is covered by the medium. This change is detected by the integrated electronics module, transferred as a current value to the processing system and converted there into a switching command.

**Voltage supply**

Depending on your requirements, OPTISWITCH 5100 C, 5150 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**

The switching condition of OPTISWITCH 5100 C, 5150 C with plastic housing can be checked when the housing is closed (signal lamp). With the basic setting, products with a density ≥ 0.7 g/cm³ (0.025 lbs/in³) can be detected. The instrument can be adapted if products with lower density are to be measured.

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

- Signal lamp for indication of the switching condition (green/red)
- DIL switch for adaptation to the product density

**3.4 Storage and transport**

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 5100 C, 5150 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
- 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 5100 C, 5150 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 5100 C, 5150 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 $\geq 0.5 \text{ g/cm}^3 (0.018 \text{ lbs/in}^3)$ the density switch must be set to $\geq 0.5 \text{ g/cm}^3$.

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. 2: Vertical mounting
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. 27 mm (1.06 in)

Fig. 3: Horizontal mounting
1  Switching point

Fig. 4: 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.
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 5100 C, 5150 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.

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.

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

OPTISWITCH 5100 C, 5150 C has a defined thread starting point. This means that every OPTISWITCH 5100 C, 5150 C is in the same fork position after being screwed in. Remove therefore the supplied seal from the thread of OPTISWITCH 5100 C, 5150 C. This seal is not required when using a welded socket with O-ring in front.

Keep in mind that this welded socket is not suitable for coated instrument versions.

Screw OPTISWITCH 5100 C, 5150 C completely into the welded socket. The later position can be determined already before welding. Mark the appropriate position of the welded socket. Before welding, unscrew OPTISWITCH 5100 C, 5150 C and remove the rubber ring from the welded socket. The welded socket has a marking (notch).

Weld the socket with the notch facing upward, or in case of pipelines (DN 32 up to DN 50), aligned with the direction of flow.

Fig. 7: 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. 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. 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 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.

Inflowing medium

If OPTISWITCH 5100 C, 5150 C is mounted in the filling stream, unwanted false measurement signals can be generated. For this reason, mount OPTISWITCH 5100 C, 5150 C at a position in the vessel where no disturbances, e.g. from filling openings, agitators, etc., can occur.

Product flow

To make sure the tuning fork of OPTISWITCH 5100 C, 5150 C generates as little resistance as possible to product flow, mount the sensor so that the surfaces are parallel to the product movement.

Enamel coating

Instruments with enamel coating should be treated very carefully and shocks should be avoided. Unpack OPTISWITCH 5100 C, 5150 C directly before installation. Insert OPTISWITCH 5100 C, 5150 C carefully into the vessel opening and avoid touching any sharp vessel parts.

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 5100 C, 5150 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

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.

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

Connect the voltage supply according to the following diagrams. Take note of the general installation regulations. As a rule, connect OPTISWITCH 5100 C, 5150 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".

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. A cable outer diameter of 5 … 9 mm (0.2 … 0.35 in) ensures the seal effect of the cable gland.

If you are using cable with a different diameter or cross-section, exchange the seal or use a suitable cable gland.

In hazardous areas, use only approved cable connections for OPTISWITCH 5100 C, 5150 C.

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. 8: 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 pressure compensation (not with Ex d)
**Electronics and terminal compartment**

**Fig. 9: Electronics and terminal compartment**

1. Control lamp
2. DIL switch for sensitivity adjustment
3. Ground terminal
4. Connection terminals
5. Processing system or PLC

**Wiring plan**

We recommend connecting OPTISWITCH 5100 C, 5150 C in such a way that the switching circuit is open when there is a level signal, line break or failure (safe state).

For connection to a VEGATOR signal conditioning instrument dto. Ex, WHG. The sensor is powered by the connected VEGATOR 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 control lamp on OPTISWITCH 5100 C, 5150 C lights in general

- red - with covered tuning fork
- green - with uncovered tuning fork

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

If OPTISWITCH 5100 C, 5150 C is used in Ex areas as part of an overfill protection system according to WHG (Water Resources Act), take note of the regulations in the safety instructions and conformity certificates. If the instrument with electronics module SWE60Z EX, SWE60Z EX E1 is to be operated directly on the analogue input of a PLC, a suitable safety barrier should be connected.
Fig. 10: Wiring plan, single chamber housing
6 Setup

6.1 General information

The figures in brackets refer to the following illustrations.

Function/Configuration

With plastic housings, the switching condition of the electronics can be checked when the housing cover is closed (control lamp). With the basic setting, products with a density ≥ 0.7 g/cm³ (0.025 lbs/in³) can be detected. For products with lower density, the switch must be set to ≥ 0.5 g/cm³ (0.018 lbs/in³).

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

- Control lamp for indication of the switching condition (1)
- DIL switch for sensitivity adjustment (2)

Mode adjustment (A/B)

On the signal conditioning instrument via the signal conditioning instrument.

The switching condition can be changed with the A/B switch. You can set the required mode according to the "Function table" (A - max. detection or overfill protection, B - min. detection or dry run protection).

The switching delay can also be modified on the signal conditioning instrument.

Note:

Always immerse the tuning fork of OPTISWITCH 5100 C, 5150 C in a liquid to test its function. Do not test the function of OPTISWITCH 5100 C, 5150 C with your hand. This can damage the sensor.

6.2 Adjustment elements

Fig. 11: Oscillator SWE60Z - two-wire output

1 Control lamp (LED)
2 DIL switch for sensitivity adjustment

Signal lamp (1) Control lamp (LED) for indication of the switching condition
green = tuning fork uncovered
red = tuning fork covered
off = failure

Sensitivity adjustment (2)  
With this DIL switch (2) you can set the switching point to liquids having a density between 0.5 and 0.7 g/cm³ (0.018 - 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 ≥ 0.5 g/cm³ (0.018 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.

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.

6.3 Function table

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

<table>
<thead>
<tr>
<th>Mode on the signal conditioning instrument</th>
<th>Level</th>
<th>Signal current - Sensor</th>
<th>Signal lamp - sensor</th>
<th>Analogue - input control 1)</th>
<th>Signal lamp - signal conditioning instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode A Overflow protection</td>
<td>approx. 8 mA</td>
<td>Green</td>
<td>&gt; 3.8 mA &lt; 11.5 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mode A Overflow protection</td>
<td>approx. 16 mA</td>
<td>Red</td>
<td>&gt; 12.5 mA &lt; 21.6 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mode B Dry run protection</td>
<td>approx. 16 mA</td>
<td>Red</td>
<td>&gt; 12.5 mA &lt; 21.6 mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Electronics directly evaluated via the analogue input of a control system (without signal conditioning instrument)
6 Setup

<table>
<thead>
<tr>
<th>Mode on the signal conditioning instrument</th>
<th>Level</th>
<th>Sensor Signal conditioning instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode B</td>
<td>approx. 8 mA</td>
<td>&gt; 3.8 mA</td>
</tr>
<tr>
<td>Dry run protection</td>
<td>Green</td>
<td>&lt; 11.5 mA</td>
</tr>
<tr>
<td>Fault message (mode A/B)</td>
<td>any</td>
<td>≤ 3.6 mA</td>
</tr>
<tr>
<td></td>
<td>approx. 1.8 mA</td>
<td>≥ 21 mA</td>
</tr>
</tbody>
</table>

6.4 Proof test (WHG, SIL)

The OPTISWITCH 5100 C, 5150 C is qualified for use in measuring chains of level SIL2 according to IEC 61508 (redundant, level SIL3) and is approved according to WHG.

WRA

The implementation of the proof test according to WHG is stipulated in the general type approval, item 8.

Take note of these higher-ranking approvals if OPTISWITCH 5100 C, 5150 C Ex is used as part of an overfill protection system according to WHG.

The following instrument combinations meet the requirements according to WHG:

OPTISWITCH 5100 C, 5150 C Ex with
- Oscillator SW E60Z EX
- Signal conditioning instrument SU 501 (Ex) or SPLC (safety-oriented PLC)

SIL

The measuring system can be used for level detection of liquids and meets the special requirements of safety technology.

This is possible up to SIL2 in a single channel architecture (1oo1D), and up to SIL3 in a multiple channel, redundant architecture.

The following instrument combinations meet the requirements according to SIL:

OPTISWITCH 5100 C, 5150 C Ex with
- Oscillator SW E60Z EX
- Signal conditioning instrument SU 501 (Ex) or SPLC (safety-oriented PLC)
Implementation - Function test

The following options are available for carrying out the proof test:

**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.

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.

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- 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.

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.

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. Push the mode switch (min./max.) on the signal conditioning instrument.

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.

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. Push the mode switch (min./max.) on the signal conditioning instrument.
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.

3 Short interruption of the supply line to the sensor

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. Push the mode switch (min./max.) on the signal conditioning instrument.

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 5100 C, 5150 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. Push the mode switch (min./max.) on the signal conditioning instrument.
   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.

**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 5100 C, 5150 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
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 s)

**Test procedure**
After releasing the button or after a brief line break.
### 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>0.6 s (±0.2 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.

OPTISWITCH 5100 C, 5150 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 5100 C, 5150 C signals &quot;covered&quot; without being submerged (overfill protection)</td>
<td>Operating voltage too low</td>
<td>Check operating voltage</td>
</tr>
<tr>
<td>OPTISWITCH 5100 C, 5150 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>Control lamp off</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>
7.3 Exchanging the electronics

If the electronics module is defective, it can be replaced by the user.

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

In general, all electronics modules of series SW60 can be interchanged. If you want to use an electronics module with a different signal output, you carry out the complete setup. You find the necessary, suitable operating instruction on our homepage.

Note:
Keep in mind that enamelled instrument versions need special electronics modules. These electronics modules are called SW60E or SW60E1.

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 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

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 316L, Alloy C22 (2.4602)
- Process fitting - flange 316L, 316L with Alloy C22 (2.4602) coating, steel enamelled, 316L with ECTFE coating, 316L with PFA coating
- Process seal KlingerSil C-4400
- Tuning fork 316L, Alloy C22 (2.4602)
- Extension tube: ø 21.3 mm (0.839 in) 316L, Alloy C22 (2.4602), Alloy C22 (2.4602) enamelled, 316L with ECTFE coating, 316L with PFA coating

Sensor length

- Length OPTISWITCH 5100 C, 5150 C See chapter "Supplement - Dimensions"

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
- Optical fibre in housing cover PMMA (Makrolon)
- Ground terminal 316L
- Cable gland PA, stainless steel, brass
- Sealing, cable gland NBR
- Blind plug, cable gland PA
- Temperature adapter (optional) 316L

Second Line of Defense (optional)\(^4\)

- 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

\(^4\) or gas-tight leadthrough
Glass potting: Borosilicate glass - Schott no. 8421
Contacts: 1.4101
Helium leak rate: < 10^-6 mbar l/s
Pressure resistance: PN 64
Instrument weight (depending on process fitting): 0.8 … 4 kg (0.18 … 8.82 lbs)

Layer thickness:
- Enamel: approx. 0.8 mm (0.031 in)
- ECTFE: approx. 0.5 mm (0.02 in)
- PFA: approx. 0.5 mm (0.02 in)

Surface quality:
- Standard: R_a approx. 3 µm (1.18^-4 in)
- Hygienic version 3A (OPTISWITCH 5150 C): R_a < 0.8 µm (3.15^-5 in)

Process fittings:
- Pipe thread, cylindrical (DIN 3852-A): G¾ A, G1
- American pipe thread, conical (ASME B1.20.1): ¾ NPT, 1 NPT
- Flanges: DIN from DN 25, ASME from 1"
- hygienic fittings: Slotted nut DN 40 PN 40, Clamp 1" DIN 32676 ISO 2852/316L, Clamp 2" DIN 32676 ISO 2852/316L, conus DN 25 PN 40, Tuchenhagen Varivent DN 50 PN 10

Max. torque - process fitting:
- Thread G¾ A, ¾ NPT: 75 Nm (55 lbf ft)
- Thread G1, 1 NPT: 100 Nm (73 lbf ft)

High voltage test (enamel): max. 5 KV
Gas-tight leadthrough (optional):
- Leakage rate: < 10^-6 mbar l/s
- Pressure resistance: PN 64

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
Output: Two-wire output
Output signal:
- empty (uncovered): 8 mA
- full (covered): 16 mA
- Fault message: < 1.8 mA
Possible signal conditioning instruments: SU 501 (Ex)
Modes (adjustable via the signal conditioning instrument)
- A  Max. detection or overflow/overfill protection
- B  Min. detection or dry run protection

**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 %
- 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
- Superimposed pressure  1 mPa s
- Sensor installation  Vertically from top
- Density selection switch  ≥ 0.7 g/cm³

**Measuring accuracy**

Deviation  ± 1 mm (0.04 in)

**Influence of the process temperature on the switching point**

![Diagram](image)

*Fig. 37: Influence of the process temperature on the switching point*

1  Shifting of the switching point in mm (in)
2  Process temperature in °C (°F)
3  Switching point at reference conditions (notch)
4  Tuning fork
Influence of the product density on the switching point

![Graph showing the influence of product density on switching point.](image)

**Fig. 38: 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 ≥ 0.5 g/cm³ (0.018 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

![Graph showing the influence of process pressure on switching point.](image)

**Fig. 39: 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**: approx. 500 ms (on/off)
- **Measuring frequency**: approx. 1200 Hz
### Ambient conditions

<table>
<thead>
<tr>
<th>Description</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature on the housing</td>
<td>-40 ... +70 °C (-40 ... +158 °F)</td>
</tr>
<tr>
<td>Storage and transport temperature</td>
<td>-40 ... +80 °C (-40 ... +176 °F)</td>
</tr>
</tbody>
</table>

### Process conditions

**Measured variable**
- Limit level of liquids

**Process pressure**
- -1 ... 64 bar/-100 ... 6400 kPa (-14.5 ... 928 psig)

The process pressure is dependent on the process fitting, for example Clam p or flange (see the following diagrams).

**Maximum allowable operating pressure**
- 100 bar/10000 kPa (1450 psig) or 1.5 times process pressure

The function of the instrument is ensured up to an operating pressure of 100 bar/10000 kPa (1450 psig) at a maximum process temperature of +50 °C (+122 °F) (only with threaded versions).

**Process temperature (thread or flange temperature)**
- OPTISWITCH 5100 C, 5150 C of 316L/Alloy C22 (2.4602)
  - Limit level of liquids
  - -50 ... +150 °C (-58 ... +302 °F)

**Process temperature (thread or flange temperature) with temperature adapter (option)**
- OPTISWITCH 5100 C, 5150 C of 316L/Alloy C22 (2.4602)
  - -50 ... +250 °C (-58 ... +482 °F)

- OPTISWITCH 5100 C, 5150 C enamelled
  - -50 ... +200 °C (-58 ... +392 °F)

- OPTISWITCH 5100 C, 5150 C with ECTFE coating
  - -50 ... +150 °C (-58 ... +302 °F)

- OPTISWITCH 5100 C, 5150 C with PFA coating
  - -50 ... +250 °C (-58 ... +482 °F)

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**Fig. 40: Ambient temperature - Process temperature**

1. Process temperature in °C (°F)
2. Ambient temperature in °C (°F)
3. Temperature range with temperature adapter
Fig. 41: Process temperature - Process pressure with switch position ≥ 0.7 g/cm³ (sensitivity switch)

1 Process pressure in bar (psig)
2 Process temperature in °C (°F)

Fig. 42: Process temperature - Process pressure with switch position ≥ 0.5 g/cm³ (sensitivity switch)

1 Process pressure in bar (psig)
2 Process temperature in °C (°F)

Viscosity - dynamic 0.1 … 10000 mPa s (requirement: with density 1)
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); 0.5 … 2.5 g/cm³ (0.018 … 0.09 lbs/in³) by switching over

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)
Electromechanical data

Cable entry/plug\(^5\)

- Single chamber housing
  - 1 x cable gland M20 × 1.5 (cable: ø 5 ... 9 mm), 1 x blind plug M20 × 1.5
  - or:
    - 1 x closing cap ½ NPT, 1 x blind plug ½ NPT
  - or:
    - 1 x plug (depending on the version), 1 x blind stopper M20 × 1.5

Screw terminals for wire cross-section up to 1.5 mm\(^2\) (AWG 16)

Adjustment elements

Sensitivity switch

- ≥ 0.5 g/cm\(^3\) 0.5 ... 2.5 g/cm\(^3\) (0.018 ... 0.09 lbs/in\(^3\))
- ≥ 0.7 g/cm\(^3\) 0.7 ... 2.5 g/cm\(^3\) (0.025 ... 0.09 lbs/in\(^3\))

Voltage supply

Operating voltage (via the signal conditioning instrument)

- Non-Ex instrument 12 ... 36 V DC
- Ex-d instrument (ATEX, FM, CSA) 12 ... 36 V DC
- Ex-ia instrument (ATEX) 12 ... 29 V DC
- Ex-ia instrument (FM, CSA) 12 ... 31 V DC

Electrical protective measures

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

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.

\(^5\) Depending on the version M12 x 1, according to ISO 4400, Harting, 7/8" FF.
9.2 Dimensions

OPTISWITCH 5100 C, 5150 C, housing

Fig. 43: Housing versions

1 Plastic housing
2 Stainless steel housing, electropolished
3 Stainless steel housing, precision casting
4 Aluminium housing
Fig. 44: OPTISWITCH 5100 C, 5150 C

1. Thread
2. Clamp
3. Cone DN 25
4. Slotted nut DN 40
5. Flange
6. Tuchenhagen Varivent
OPTISWITCH 5100 C, 5150 C, options

Fig. 45: Options
1  Gas-tight leadthrough
2  Temperature adapter
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

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