

Operating Instructions

OPTISWITCH 5100 C, 5150 C

with transistor output



Variable area flowmeters

Vortex flowmeters

Flow controllers

Electromagnetic flowmeters

Ultrasonic flowmeters

Mass flowmeters

Level measuring instruments

Communications engineering

Engineering systems & solutions

Switches, counters, displays and recorders

Heat metering

Pressure and temperature

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1 About this document

1.1 Function

This operating instructions manual has all the information you need for quick setup and safe operation of OPTISWITCH 5100 C, 5150 C. Please read this manual before you start setup.

1.2 Target group

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

1.3 Symbolism used



Information, tip, note

This symbol indicates helpful additional information.



Caution, warning, danger

This symbol informs you of a dangerous situation that could occur. Ignoring this cautionary note can impair the person and/or the instrument.



Ex applications

This symbol indicates special instructions for Ex applications.



List

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



Action

This arrow indicates a single action.



Sequence

Numbers set in front indicate successive steps in a procedure.

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 operator. For safety and warranty reasons, any internal work on the instruments must be carried out only by personnel authorised by the manufacturer.

2.2 Appropriate use

OPTISWITCH 5100 C, 5150 C is a sensor for level detection.

Detailed information on the application range of OPTISWITCH 5100 C, 5150 C is available in chapter Product description.

2.3 Warning about misuse

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

OPTISWITCH 5100 C, 5150 C is a high-tech instrument requiring the strict observance of standard regulations and guidelines. The user must take note of the safety instructions in this operating instructions manual, the country-specific installation standards (e.g. the VDE regulations in Germany) as well as all prevailing safety regulations and accident prevention rules.

2.5 CE conformity

OPTISWITCH 5100 C, 5150 C is in CE conformity with EMC (89/336/EWG), fulfils the NAMUR recommendation NE 21 and is in CE conformity with NSR (73/23/EWG).

Conformity has been judged acc. to the following standards:

- EMC:
 - Emission EN 61326/A1: 1998 (class B)
 - Susceptibility EN 61326: 1997/A1: 1998
- NSR: EN 61010-1: 1993

2.6 SIL conformity

OPTISWITCH 5100 C, 5150 C meets the requirements to the functional safety acc. to IEC 61508/IEC 61511. Further information is available in chapter "Functional safety".

2.7 Safety information 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 level sensor
- Documentation
 - this operating instructions manual
 - Ex-specific safety instructions (with Ex versions) and, if necessary, further certificates

Components

OPTISWITCH 5100 C, 5150 C consists of the following components:

- Housing cover
- Housing with electronics
- process fitting with tuning fork

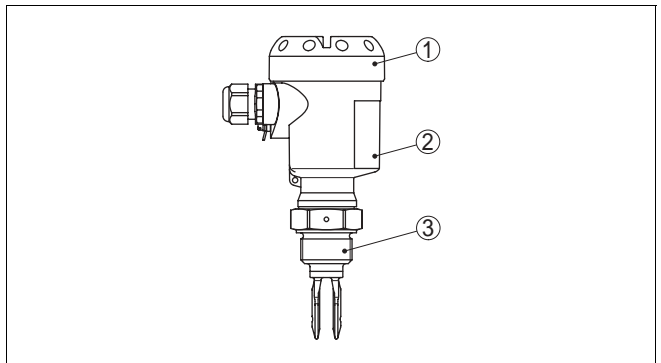


Fig. 1: OPTISWITCH 5100 C, 5150 C - with plastic housing

- 1 Housing cover
- 2 Housing with electronics
- 3 Process fitting

3.2 Principle of operation

Area of application

OPTISWITCH 5100 C, 5150 C is a level sensor with tuning fork for level detection.

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

Typical applications are overflow and dry run protection. With a tuning fork of only 40 mm length, OPTISWITCH 5100 C, 5150 C can be also mounted, e.g. in pipelines from DN 25. The small tuning fork allows the 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 also under difficult conditions such as turbulence, air bubbles, foam generation, buildup, strong external vibration or changing products.

Fault monitoring

The electronics module of OPTISWITCH 5100 C, 5150 C monitors continuously the following criteria via the frequency evaluation:

- strong corrosion or damage of the tuning fork
- no vibration
- line break to the piezo drive

If a fault is detected or in case the power supply fails, the electronics takes on a defined switching condition, i.e. the output transistor blocks (safe condition).

OPTISWITCH 5100 C, 5150 C fulfills the requirements of IEC 61508 and 61511 of SIL2 (see Supplement).

Physical 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 subjected to temperature shock limitations. The frequency changes if the tuning fork is covered by the medium. This change is detected by the integrated oscillator and converted into a switching command.

Power supply

OPTISWITCH 5100 C, 5150 C is a compact instrument, i.e. it can be operated without external evaluation system. The integrated electronics evaluates the level signal and outputs a switching signal. With this switching signal, a connected device can be operated directly (e.g. a warning system, a PLC, a pump etc.).

The exact range of the power supply is stated in the Technical data in the Supplement.

3.3 Adjustment

The switching condition of OPTISWITCH 5100 C, 5150 C with plastic housing can be checked when the housing is closed (LED display). In the basic adjustment, products with a density

$>0.7 \text{ g/cm}^3$ ($>0.025 \text{ lbs/in}^3$) can be detected. The instrument can be adapted if products with lower density should be measured.

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

- LED for indication of the switching status (green/red)
- DIL switch for switching point adaptation
- Mode switch to select the switching condition (A/B)

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 acc. to DIN 55439.

The packaging of standard instruments consists of environment-friendly, recyclable cardboard. In addition, the sensor is provided with a protective cover of ABS. For special versions PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

Storage and transport temperature

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

4 Mounting

4.1 General instructions

Switching point

In general, OPTISWITCH 5100 C, 5150 C can be mounted in any position. The instrument must be mounted in any position. The instrument must be mounted in such a way that the tuning fork is at the height of the requested switching point.

The tuning fork has lateral markings (notches), marking the switching point with vertical mounting. The switching point refers to water with the basic setting of the sensitivity switch $\geq 0.7 \text{ g/cm}^3$ ($\geq 0.025 \text{ lbs/in}^3$). 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 is shifted if the medium has a density other than water - water $= 1.0 \text{ g/cm}^3$ ($= 0.036 \text{ lbs/in}^3$). For products $< 0.7 \text{ g/cm}^3$ ($< 0.025 \text{ lbs/in}^3$) and $> 0.5 \text{ g/cm}^3$ ($> 0.018 \text{ lbs/in}^3$) the density switch must be set to $\geq 0.5 \text{ g/cm}^3$.

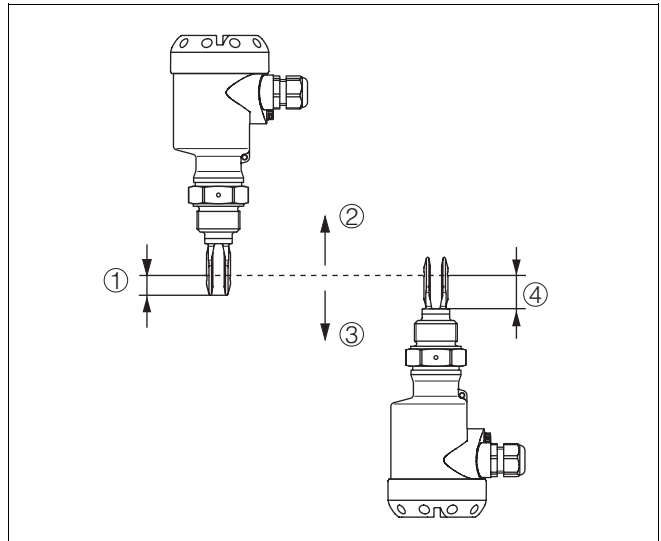


Fig. 2: Vertical mounting

- 1 Switching point approx. 13 mm (ca. 0.51 in)
- 2 Switching point with lower density
- 3 Switching point with higher density
- 4 Switching point approx. 27 mm (approx. 1.06 in)

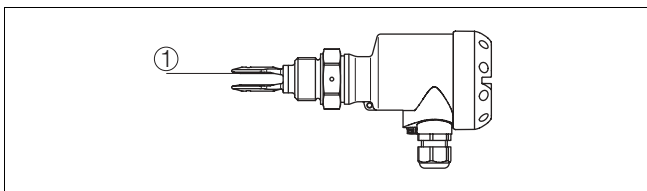


Fig. 3: Horizontal mounting
1 Switching point

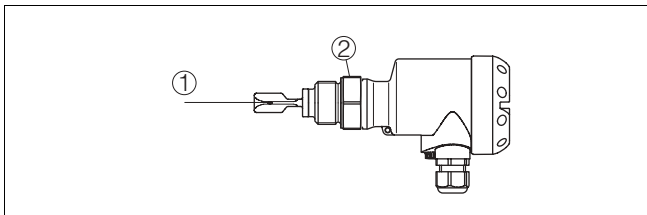


Fig. 4: Horizontal mounting (recommended installation location - particularly for adhesive products)
1 Switching point
2 Marking with screwed version on top - with flange versions directed to the flange holes

Moisture

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

You can give your OPTISWITCH 5100 C, 5150 C additional protection against moisture penetration by leading the connection cable downward in front of the cable entry. Rain and condensation water can thus drain off. This applies mainly to mounting outdoors, in areas where moisture is expected (e.g. by cleaning processes) or on cooled or heated vessels.

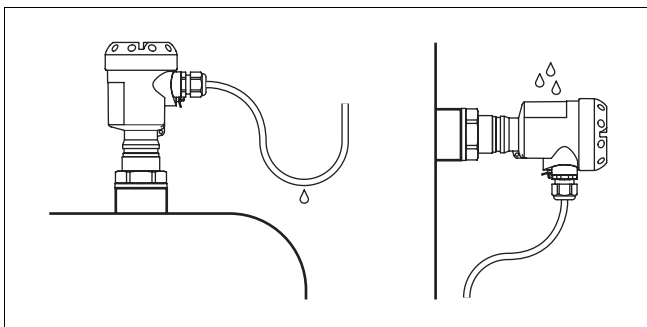


Fig. 5: Measures against moisture penetration

Transport

Do not hold OPTISWITCH 5100 C, 5150 C on the tuning fork. Particularly with flange or tube versions, the tuning fork can be damaged by the instrument weight. Transport enamelled and ECTFE coated instruments very carefully and avoid touching the tuning fork.

Remove the protective cover just before mounting.

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.

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 to the housing can damage its internal mechanical components.

To screw in, use the hexagon above the thread.

4.2 Mounting information

Welding the socket

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 (e.g. enamel).

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, aligned with the direction of flow.

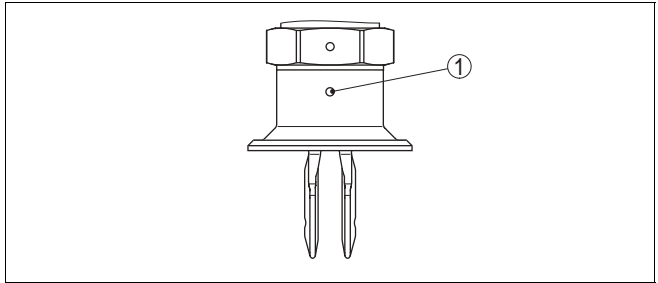


Fig. 6: Marking on the welded socket

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 be still turned by approx. half a turn. This is sufficient to reach the recommended installation position.

With flange versions, the fork is directed to the flange holes.

In case of adhesive and viscous products, the tuning fork should protrude into the vessel to avoid buildup. Therefore sockets for flanges and mounting bosses should be avoided with horizontal mounting.

Inflowing medium

If OPTISWITCH 5100 C, 5150 C is mounted in the filling stream, unwanted switching signals can be generated. Mount OPTISWITCH 5100 C, 5150 C at a location in the vessel where no disturbing influence from e.g. filling openings, agitators, etc. can occur.

Flow

If there is movement within the product, the tuning fork of OPTISWITCH 5100 C, 5150 C should be mounted in such a way that the surfaces of the fork 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.

5 Connecting to power supply

5.1 Preparing the connection

Note safety instructions

Always observe the following safety instructions:

- Connect only in the complete absence of line voltage

Take note of safety instructions for Ex applications



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

Select power supply

Connect the power supply acc. 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 stated in the Technical data in the Supplement.

Select connection cable

OPTISWITCH 5100 C, 5150 C is connected with standard cable with round wire cross section. An outer cable diameter of 5 ... 9 mm (0.2 ... 0.35 in) ensures the seal effect of the cable entry.

If cable with a different diameter or wire cross section is used, exchange the seal or use an appropriate cable connection.



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

Select connection cable for Ex applications



Take note of the corresponding installation regulations for Ex applications.

5.2 Connection procedure



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

Proceed as follows:

- 1 Unscrew the housing cover
- 2 Loosen compression nut of the cable entry

- 3 Remove approx. 10 cm (4 in) of the cable mantle, strip approx. 1 cm (0.4 in) 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, the seal ring must completely encircle the cable
 - 10 Screw the housing cover back on
- The electrical connection is finished.

5.3 Wiring plans, single chamber housing



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

Housing overview

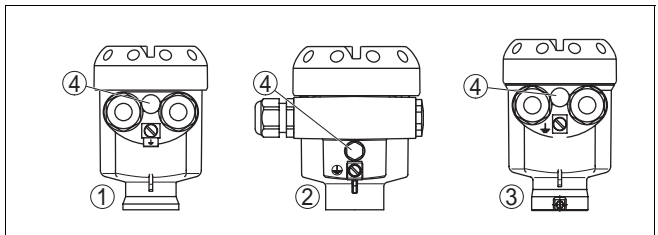


Fig. 7: Material versions, single chamber housing

- 1 Plastic (not with EEx d)
- 2 Aluminium
- 3 Stainless steel (not with EEx d)
- 4 Filter element for pressure compensation (not with EEx d)

Electronics and connection compartment

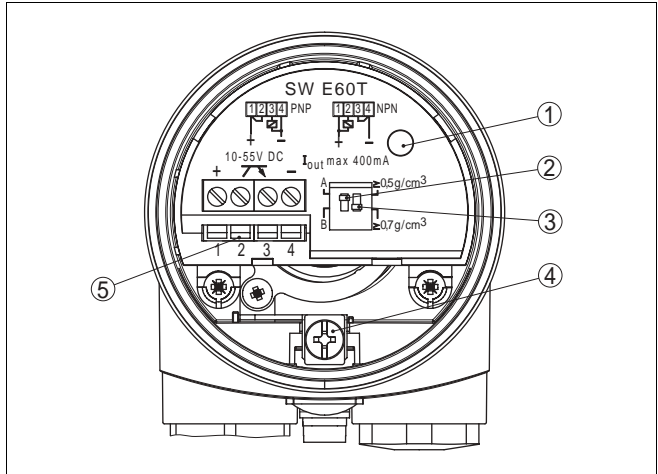


Fig. 8: Electronics and connection compartment, single chamber housing

- 1 LED display
- 2 DIL switch for mode adjustment
- 3 DIL switch for switching point adaptation
- 4 Ground terminal
- 5 Terminals

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 condition).

The instrument is used to control relays, contactors, magnet valves, warning lights, horns as well as PLC inputs.

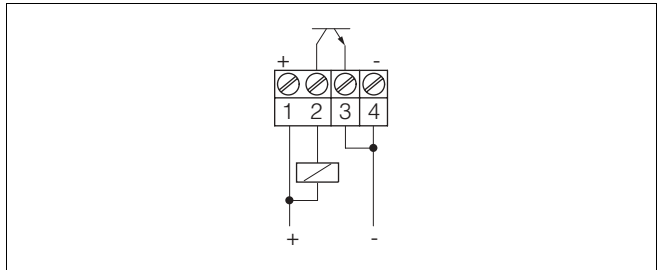


Fig. 9: NPN action

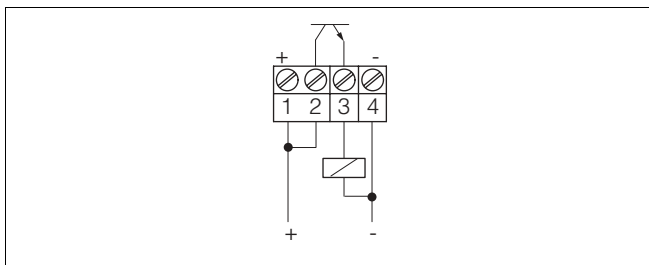


Fig. 10: PNP action

6 Set up

6.1 General

The numbers in brackets refer to the following illustrations.

Function/Configuration

The switching condition of the electronics can be checked with plastic housing and closed housing cover (LED display). In the basic adjustment, products with a density $>0.7 \text{ g/cm}^3$ ($>0.025 \text{ lbs/in}^3$) can be detected. In liquids with lower density, you must set the switch to $>0.5 \text{ g/cm}^3$ ($>0.018 \text{ lbs/in}^3$).

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

- LED display (1)
- DIL switch for mode adjustment - A/B (2)
- DIL switch for sensitivity adjustment (3)



Note:

For test purposes, immerse the tuning fork of OPTISWITCH 5100 C, 5150 C always in liquids. Do not test the function of OPTISWITCH 5100 C, 5150 C with the hand. This can damage the sensor.

6.2 Adjustment elements

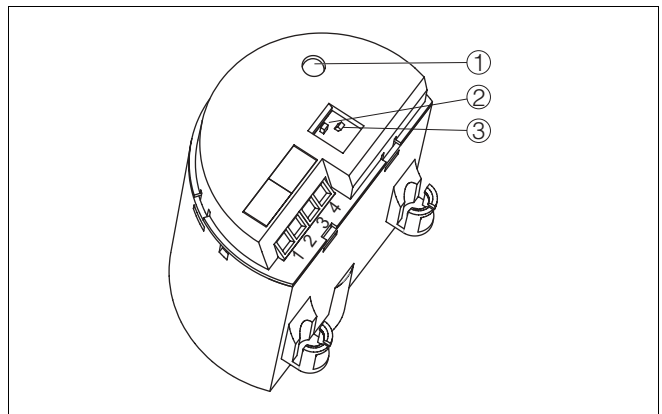


Fig. 11: Oscillator SW E60T - Transistor output

- 1 LED display
- 2 DIL switch for mode adjustment
- 3 DIL switch for switching point adaptation

LED display (1)

Diode for indication of the switching condition

- green = output conducts
- red = output blocks
- red (flashing) = failure

Mode adjustment (2)







With the mode adjustment (A/B) you can change the switching condition of the relay. You can set the required mode acc. to the "Function chart" (A - max. detection or overflow protection, B - min. detection or dry run protection).





Sensitivity adjustment (3)

With this DIL switch (3) 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). In the basic adjustment, liquids with a density of >0.7 g/cm³ (0.025 lbs/in³) can be detected. In products 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 the water - density value 1.0 g/cm³ (0.036 lbs/in³). In products with another density, the switching point shifts depending on the density and installation in direction of the housing or tuning fork end.

6.3 Function chart

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

	Level	Switching status	Control lamp
Mode A Overfill protection		transistor conducts	 green
Mode A Overfill protection		transistor blocks	 red
Mode B Dry run protection		transistor conducts	 green

	Level	Switching status	Control lamp
Mode B Dry run protection		transistor blocks	 red
Failure of the supply voltage (mode A/B)	any	transistor blocks	
Failure	any	transistor blocks	 flashes red

7 Maintenance and fault rectification

7.1 Maintenance

When used as directed in normal operation, OPTISWITCH 5100 C, 5150 C is completely maintenance-free.

7.2 Fault rectification

Checking the switching signal

- ? OPTISWITCH 5100 C, 5150 C signals "covered" when the vibrating element is not submerged (overfill protection)
- ? OPTISWITCH 5100 C, 5150 C signals "uncovered" when the vibrating element is submerged (dry run protection)
 - Supply voltage too low
 - Check the power supply
 - Electronics defective
 - Push the mode switch. If the instrument then changes the mode, the instrument may be mechanically damaged. Should the switching function in the correct mode still be faulty, return the instrument for repair.
 - Push the mode switch. If the instrument then does not change the mode, the oscillator may be defective. Exchange the oscillator.
 - Unfavourable installation location
 - Mount the instrument at a location where no dead zones or air bubbles can form in the vessel.
 - Wrong mode selected
 - Set the correct mode on the mode switch (max: overfill protection; min: dry run protection). Wiring should be carried out acc. to the quiescent current principle.
- ? LED flashes red
 - Electronics has detected a failure
 - exchange instrument or return it for repair

? LED flashes alternately red and green

- instrument defective

→ exchange instrument or return it for repair

7.3 Instrument repair

If a repair is necessary, please proceed as follows:

You can download a return form from our Internet homepage
http://www.krohne-mar.com/fileadmin/media-lounge/PDF-Download/Specimen_e.pdf.

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

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

8 Dismounting

8.1 Dismounting procedure

**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 be opened only if no explosive atmosphere is present.

8.2 Disposal

OPTISWITCH 5100 C, 5150 C consists of materials which can be recycled by specialised recycling companies. We have purposely designed the electronic modules to be easily separable. Mark the instrument as scrap and dispose of it according to government regulations (electronic scrap ordinance, ...).

Materials: see "*Technical data*"

If you cannot dispose of the instrument properly, please contact us about disposal methods or return.

9 Functional safety

9.1 General

Validity

This safety manual applies to measuring systems consisting of OPTISWITCH 5100 C, 5150 C vibrating level switches and integrated oscillator SWE60T.



Note:

For OPTISWITCH 5100 C, 5150 C with enamelled fork, oscillator SWE60TEEx.E or SWE60TEEx.E1 is used.

Area of application

The measuring system can be used for level detection of liquids which meet the specific requirements of the safety technology, e.g.:

- Mode for overfill protection
- Mode for dry run protection

The measuring system is qualified in both modes to meet the following requirement degree acc. to IEC 61508-2/IEC 61511:

- **SIL2** with architecture 1oo1D (single channel)
- **SIL3** with architecture 1oo2D (double-channel/redundant)

Safety function

The safety function of this measuring system is the detection and signalling of the condition of the vibration element. The safe condition depends on the mode:

- Overfill protection: condition "covered"
- Dry run protection: condition "uncovered"

Relevant standards

- IEC 61508-1, -2, -4
 - Functional safety of electrical/electronic/programmable electronic systems
- IEC 61511-1
 - Functional safety – safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and software requirements

Safety requirements

The failure limit values for a safety function, depending on the SIL class (of IEC 61508-1, 7.6.2)

Safety integrity level	Low demand mode	High demand or continuous mode
SIL	PFD _{avg}	PFH
4	$\geq 10^{-5}$ up to $< 10^{-4}$	$\geq 10^{-9}$ up to $< 10^{-8}$
3	$\geq 10^{-4}$ up to $< 10^{-3}$	$\geq 10^{-8}$ up to $< 10^{-7}$
2	$\geq 10^{-3}$ up to $< 10^{-2}$	$\geq 10^{-7}$ up to $< 10^{-6}$
1	$\geq 10^{-2}$ up to $< 10^{-1}$	$\geq 10^{-6}$ up to $< 10^{-5}$

Safety integrity of the hardware for safety-relating subsystems of type A (IEC 61508-2, 7.4.3)

Safe failure fraction	Hardware fault tolerance		
SFF	HFT = 0	HFT = 1	HFT = 2
< 60 %	SIL 1	SIL 2	SIL 3
60 % up to < 90 %	SIL 2	SIL 3	SIL 4
90 % up to < 99 %	SIL 3	SIL 4	SIL 4
≥ 99 %	SIL 3	SIL 4	SIL 4

9.2 Planning

General instructions and restrictions

- The measuring system must be operated acc. to the quiescent current principle:
 - Mode A - overflow protection (max)
 - Mode B - dry run protection (min)
- The measuring system must be used acc. to the application
- The application-specific limits must be maintained and the specifications must not be exceeded.
- The fault tolerance time of the complete system must be higher than the reaction time of the measuring system
- It must be used only in products to which the materials of the vibrating system are sufficiently chemically resistant.

In min. operation also avoid:

- Buildup on the vibrating system
- Solids in the measured product > 5 mm (> 0.2 in)
- Foam generation with a density > 0.5 g/cm³ (> 0.018 lbs/in³)

Assumptions

For the implementation of FMEDA (Failure Mode, Effects and Diagnostics Analysis) the following assumptions form the basis:

- Failure rates are constant, wear of the mechanical parts is not taken into account
- Failure rates of external power supplies are not included
- Multiple errors are not taken into account
- The average ambient temperature during the operating time is +40°C (104°F)
- The environmental conditions correspond to an average industrial environment
- The lifetime of the components is around 8 to 12 years (IEC 61508-2, 7.4.7.4, remark 3)
- The processing unit evaluates the output circuit of the measuring system acc. to the quiescent current principle.
- The repair time (exchange of the meas. system) after a fail-safe error is eight hours (MTTR = 8 h)
- In the mode with the lowest demand rate, the reaction time of a connected control and processing unit to dangerous detectable errors is max. 1 hour.

Low demand mode

If the demand rate is only once a year, then the measuring system can be used as safety-relevant subsystem in "low demand mode" (IEC 61508-4, 3.5.12).

If the ratio of the internal diagnostics test rate of the measuring system to the demand rate exceeds the value 100, the measuring system can be treated in the way it is executing a safety function in the mode with low demand rate (IEC 61508-2, 7.4.3.2.5).

Corresponding characteristics is the value PFD_{avg} (average Probability of dangerous Failure on Demand). It is dependent on the test interval T_{Proof} between the function tests of the protective function.

Numbers see paragraph "Safety-technical characteristics".

High demand mode

If the "low demand mode" does not apply, the measuring system must be used as safety-relevant subsystem in "high demand" (IEC 61508-4, 3.5.12).

The fault tolerance time of the complete system must be higher than the sum of the reaction times or the diagnostics test periods of all components in the safety chain.

Corresponding characteristics is the value PFH (failure rate).

Numbers see paragraph "Safety-technical characteristics".

Safe condition and fault description

The safe condition of the measuring system is the switched off status (quiescent current principle):

- SWE60T (transistor output) – Transistor blocks

A fail-safe failure (safe failure) exists if the measuring system changes to the defined safe condition without demand of the process.

A dangerous undetected failure exists if the measuring system does not go to the defined safe condition when required by the process.

Configuration of the processing unit

The processing unit must evaluate the output circuit of the measuring system by taking the quiescent current principle into account.

The processing unit must correspond to the SIL level of the measuring chain.

9.3 Setup**Mounting and installation**

The prevailing plant conditions influence the safety of the measuring system. Therefore note the mounting and installation instructions of the appropriate operating instructions manual. Mainly important is the correct setting of the mode (A/B).

The switching point of the measuring system must be adapted depending on the density limits in the operating instructions manual.

9.4 Reaction during operation and in case of failure

- The adjustment elements must not be modified during operation.
- In case of modifications during operation, you have to take note of the safety functions.
- Occurring fault signals are described in the appropriate operating instructions manual.
- In case of detected failures or fault signals, the entire measuring system must be switched out of service and the process held in a safe condition by means of other measures.
- An electronics exchange is easily possible and described in the operating instructions manual.

- If due to the detected failure, the electronics or the complete sensor is interchanged, the manufacturer must be informed (incl. a fault description).

9.5 Recurring function test

The recurring function test serves to reveal potential dangerous errors that are otherwise not discernible. The function of the measuring system must be checked at adequate intervals.

The operator is responsible for choosing the type of test and the intervals in the stated time frame. The time frame depends on the PFD_{avg} value acc. to the chart and diagram in section "Safety-related characteristics".

With high demand rate, a recurring function test is not requested in IEC 61508. The function of the measuring system is proven by the frequent use of the system. In double channel architectures it is useful to proof the redundancy by recurring function tests in appropriate intervals.

The test must be carried out in a way that verifies the flawless operation of the safety functions in conjunction with all system components.

This is ensured by a controlled reaching of the response height during filling. If filling up to the response height is not possible, then a response of the measuring system must be triggered by a suitable simulation of the level or the physical effect.

The methods and procedures used during the tests must be stated and their suitability must be specified. The tests must be documented.

If the function test proves negative, the entire measuring system must be switched out of service and the process held in a safe condition by means of other measures.

In the double channel architecture 1oo2D this applies separately to both channels.

9.6 Safety-related characteristics

The failure rates of the electronics and the vibrating systems are determined by an FMEDA acc. to IEC 61508. These calculations are based on component failure rates acc. to SN 29500. All numerical values refer to an average ambient temperature during the operating time of +40°C (104°F). The calculations are also based on the specifications stated in chapter "Planning".

Overfill protection

Mode switch is set to A

λ_{sd}	0 FIT	safe detected failure (1 FIT = failure/10 ⁹ h)
λ_{su}	243 FIT	safe undetected failure
λ_{dd}	0 FIT	dangerous detected failure
λ_{du}	27 FIT	dangerous undetected failure
SFF	> 89 %	Safe Failure Fraction

Dry run protection

Mode switch is set to B

λ_{sd}	0 FIT	safe detected failure
λ_{su}	241 FIT	safe undetected failure
λ_{dd}	0 FIT	dangerous detected failure
λ_{du}	30 FIT	dangerous undetected failure
SFF	> 89 %	Safe Failure Fraction

General data

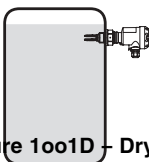
$T_{Reaction}$ Failure reaction time	1.5 sec
MTBF = MTTF + MTTR	3.7x10 ⁶ h
max. useful life of the measuring system for the safety function	approx. 10 years

Single channel architecture

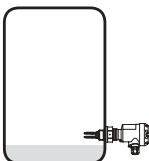
SIL2 (Safety Integrity Level)

HFT = 0 (Hardware Fault Tolerance)

Architecture 1oo1D – Overfill protection



Architecture 1oo1D – Dry run protection



Mode switch is set to A

PFD_{avg} $T_{Proof} = 1 \text{ year}$ $T_{Proof} = 5 \text{ years}$ $T_{Proof} = 10 \text{ years}$	 $< 0.012 \times 10^{-2}$ $< 0.059 \times 10^{-2}$ $< 0.120 \times 10^{-2}$
PFH [1/h]	$< 0.027 \times 10^{-6}$

Mode switch is set to B

PFD_{avg} $T_{Proof} = 1 \text{ year}$ $T_{Proof} = 5 \text{ years}$ $T_{Proof} = 10 \text{ years}$	 $< 0.013 \times 10^{-2}$ $< 0.066 \times 10^{-2}$ $< 0.130 \times 10^{-2}$
PFH [1/h]	$< 0.030 \times 10^{-6}$

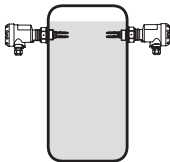
Double channel architecture
SIL3 (Safety Integrity Level)

HFT = 1 (Hardware Fault Tolerance)

Here you see an example how the measuring system in double channel architecture can be used in an application with demand rate SIL3. A Common Cause Factor of beta = 10 % (worst case) is taken into account.

If the instruments are used in another (multiple channel) architecture, the values must be calculated for the selected application by means of the above failure rates.

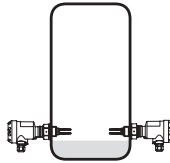
Architecture 1oo2D – Overfill protection



Mode switch is set to A

PFD _{avg}	
T _{Proof} = 1 year	< 0.012 x 10 ⁻³
T _{Proof} = 5 years	< 0.059 x 10 ⁻³
T _{Proof} = 10 years	< 0.120 x 10 ⁻³
PFH [1/h]	< 0.027 x 10 ⁻⁷

Architecture 1oo2D – Dry run protection



Mode switch is set to B

PFD _{avg}	
T _{Proof} = 1 year	< 0.013 x 10 ⁻³
T _{Proof} = 5 years	< 0.066 x 10 ⁻³
T _{Proof} = 10 years	< 0.130 x 10 ⁻³
PFH [1/h]	< 0.030 x 10 ⁻⁷

Time-dependent process of PFD_{avg}

The time-dependent process of PFD_{avg} reacts in the time period up to 10 years virtually linear to the operating time. The above values only apply to the T_{Proof} interval, after which a recurring function test must be carried out.

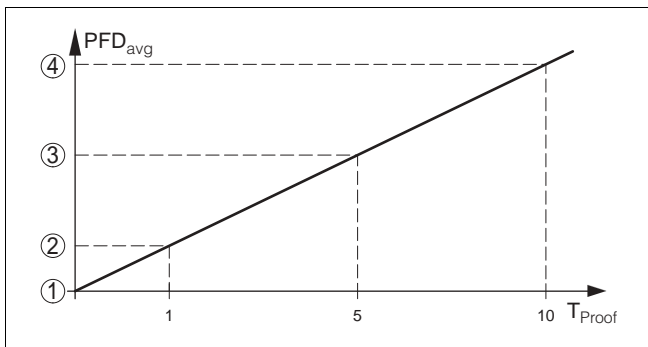


Fig. 12: Time-dependent process of PFD_{avg} ¹⁾

- 1 $PFD_{avg} = 0$
- 2 PFD_{avg} after 1 year
- 3 PFD_{avg} after 5 years
- 4 PFD_{avg} after 10 years

¹⁾ Numbers see in the above charts.

10 Supplement

10.1 Technical data

General data

Material 316L corresponds to 1.4404 or 1.4435

Materials, wetted parts

- | | |
|--|--|
| – Process fitting – thread | 316L; 2.4602 (Hastelloy C4) |
| – Process fitting – Flange | 316L; 316L with Hastelloy C4 plated; enamel-
led steel; 316L with ECTFE coating; 316L with
PFA coating |
| – Process seal | Klingsil C-4400 |
| – Tuning fork | 316L/2.4610 (Hastelloy C4) |
| – Extension tube ø 21.3 mm (ø 0.84 in) | 316L; 2.4610 (Hastelloy C4); 2.4610 (Hastelloy
C4) enamelled; 316L with ECTFE coating;
316L with PFA coating |

Sensor length

- | | |
|---------------------------------------|-----------------------------|
| – length OPTISWITCH 5100 C, 5150
C | see Supplement - Dimensions |
|---------------------------------------|-----------------------------|

Materials, non-wetted parts

- | | |
|--|---|
| – Housing | plastic PBT (Polyester), Alu-die casting pow-
der-coated, stainless steel 316L |
| – Seal ring between housing and
housing cover | NBR (stainless steel housing), silicone (Alu/
plastic housing) |
| – waveguide in the housing cover | PMMA (Makrolon) |
| – Ground terminal | 316L |
| – temperature adapter (option) | 316L |
| – gastight leadthrough (option) | 316L/glass |

Weights

- | | |
|---------------------------|----------------|
| – Plastic housing | 760 g (27 oz) |
| – Aluminium housing | 1170 g (41 oz) |
| – Stainless steel housing | 1530 g (54 oz) |

Layer thickness

- | | |
|----------|------------------|
| – enamel | 0.8 mm (0.03 in) |
| – ECTFE | 0.5 mm (0.02 in) |
| – PFA | 0.5 mm (0.02 in) |

Surface quality

- Standard R_a approx. 3 μm (approx. 1.18^{-4} in)
- Hygienic version 3A (OPTISWITCH 5150 C) $R_a < 0.8 \mu\text{m}$ ($< 3.15^{-5}$ in)

Process fittings

- Thread G $\frac{3}{4}$ A, $\frac{3}{4}$ NPT, G1A, 1 NPT
- flanges DIN from DN 25, ANSI from 1"
- hygienic fittings bolting DN 40 PN 40, Tri-Clamp 1", Tri-Clamp 1½" PN 10, cone DN 25 PN 40, Tuchenhausen Varivent DN 50 PN 10

Coatings

- ECTFE approx. 0.5 ... 0.8 mm (approx. 0.02 ... 0.03 in)
- PFA approx. 0.3 ... 0.5 mm (approx. 0.01 ... 0.02 in)
- enamel approx. 0.8 mm (approx. 0.03 in)

**High voltage test (enamel)
gastight leadthrough (option)**

- leakage rate max. 5 KV
 - pressure resistance $< 10^{-6}$ mbar l/s
 - hygienic fittings PN 64
- bolting DN 40 PN 40, Tri-Clamp 1", Tri-Clamp 1½" PN 10, cone DN 25 PN 40, Tuchenhausen Varivent DN 50 PN 10

Output variable

- Output floating transistor output, overload and permanently shortcircuit proof
- Load current max. 400 mA
- Voltage loss max. 1 V
- Turn-on voltage max. 55 V DC
- Blocking current $< 10 \mu\text{A}$
- Modes (adjustable)
- A max. detection or overflow protection
 - B min. detection or dry run protection

Accuracy

- Hysteresis approx. 2 mm (0.08 in) with vertical installation
- Integration time approx. 500 ms
- Frequency approx. 1200 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

Parameter	level of liquids
Process pressure	-1 ... 64 bar (-14.5 ... 938 psi) depending on the process fitting, e.g. flange
OPTISWITCH 5100 C, 5150 C of 316L/Hastelloy C4 (2.4610)	-50 ... +150°C (-58 ... +302°F)
Process temperature (thread or flange temperature) with temperature adapter (option)	
– OPTISWITCH 5100 C, 5150 C of 316L/Hastelloy C4	-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 ... +150°C (-58 ... +302°F)

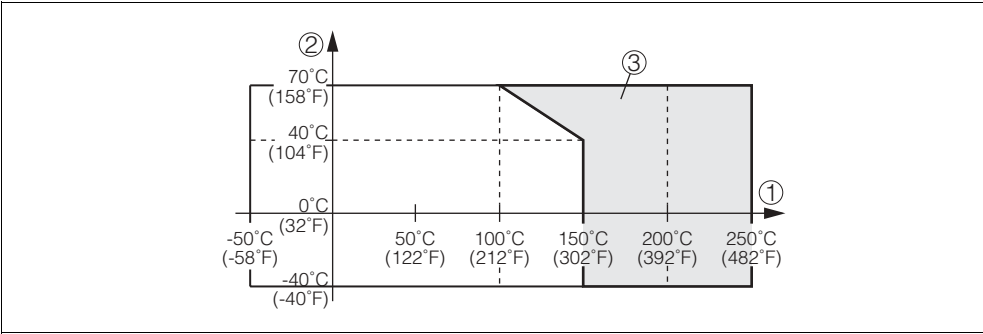


Fig. 13: Ambient temperature – Product temperature
1 Product temperature
2 Ambient temperature
3 Temperature range with temperature adapter

Viscosity - dynamic	0.1 ... 10,000 mPa s (requirement: with density 1)
Density	0.7 ... 2.5 g/cm ³ (0.025 ... 0.09 lbs/in ³); 0.5 ... 2.5 g/cm ³ (0.018 ... 0.09 lbs/in ³) by switching over

Electromechanical data

Cable entry/plug ²⁾

- Single chamber housing
 - 1x cable entry M20x1.5 (cable-ø 5 ... 9 mm), 1x blind stopper M20x1.5
 - or:
 - 1x closing cap ½ NPT, 1x blind stopper ½ NPT
 - or:
 - 1x plug depending on the version, 1x blind stopper M20x1.5

Screw terminals for wire cross section up to 1.5 mm² (0.0023 in²)

Adjustment elements

Mode switch

- A max. detection or overflow protection
- B min. detection or dry run protection

Density switch

- 0.5 0.5 ... 2.5 g/cm³ (0.018 ... 0.9 oz/in³)
- 0.7 0.7 ... 2.5 g/cm³ (0.025 ... 0.9 oz/in³)

Power supply

Power supply 10 ... 55 V DC

Power consumption max. 0.5 W

Electrical protective measures

Protection IP 66/IP 67

Overvoltage category III

Protection class II

²⁾ Depending on the version M12x1, acc. to DIN 43650, Harting, Amphenol-Tuchel, 7/8" FF

Approvals³⁾

WHG

Ship approvals

ATEX II 1/2G, 2G EEx d IIC T6⁴⁾

Overfill protection acc. to WHG

Ship approvals

³⁾ Deviating data with Ex applications: see separate safety instructions.
⁴⁾ only with Aluminium housing

10.2 Dimensions

Housing

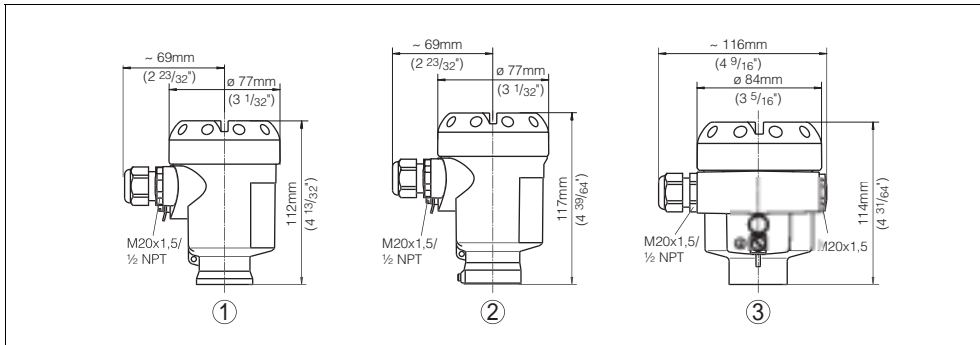


Fig. 14: Housing versions

- 1 Plastic housing
- 2 Stainless steel housing
- 3 Aluminium housing

OPTISWITCH 5100 C, 5150 C

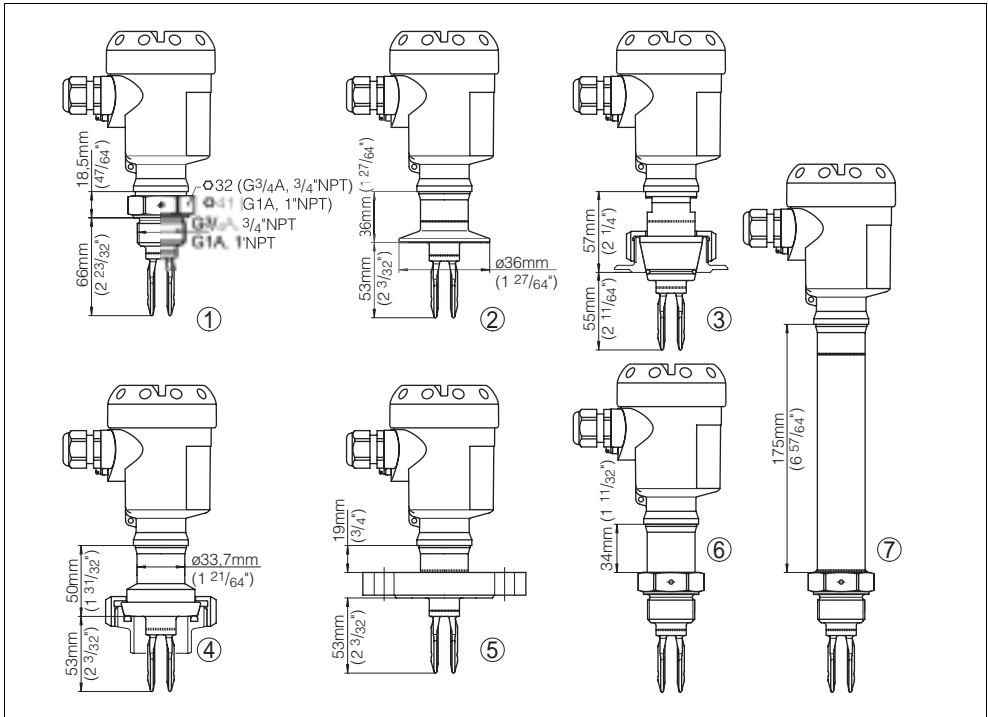


Fig. 15: OPTISWITCH 5100 C, 5150 C – Threaded version

- 1 Thread
- 2 Tri-Clamp
- 3 Cone DN 25
- 4 Bolting DN 40
- 5 Flange
- 6 Gas-tight leadthrough
- 7 Temperature adapter

10.3 Certificates

SIL declaration of conformity



Konformitätserklärung
declaration of conformity
Déclaration de conformité
IEC 61508 / IEC 61511

KROHNE S.A.S.
 Les Ors
 26103 ROMANS
 France

erklärt als Hersteller, dass die Vibrationsgrenzschalter
 declares as manufacturer, that the vibrating level switches
 déclare en tant que fabricant que les détecteurs vibrants

OPTISWITCH 5100 C, 5150 C, 5200 C, 5250 C
mit / with / avec SWE60C / ...R / ...T / ...N / ...Z (Ex)

entsprechend der IEC 61511 für den Einsatz in sicherheitsinstrumentierten Systemen
 geeignet sind. Die Sicherheitstechnische Kennzahlen sowie die Sicherheitshinweise im
 Safety Manual sind zu beachten.
 (siehe entsprechende Betriebsanleitung, Kapitel „Funktionale Sicherheit“)

according to IEC 61511 are suitable for safety instrumented systems (SIS). The safety
 related characteristics as well as the instructions of the safety manual must be considered.
 (see corresponding operating instruction, chapter "Functional Safety")

convient à une utilisation dans les systèmes de sécurité instrumentés suivant la norme
 IEC 61511. Les caractéristiques techniques relatives à la sécurité ainsi que les consignes de
 sécurité stipulées dans le Safety Manual sont à respecter.
 (voir la notice technique de mise en service au chapitre „Sécurité fonctionnelle“)

Romans, 03.05.2006
 KROHNE S.A.S.

 Dr. Florian Stengels
 Geschäftsführer
 Managing Director
 Directeur général

Fig. 16: SIL declaration of conformity

CE declaration of conformity

CE

Konformitätserklärung
Declaration of conformity
Déclaration de conformité

KROHNE

Krohne S.A.S.
Ludwig-Boff-Str.
F-33100 Remoué Cedex

erklärt in alleiniger Verantwortung, daß das Produkt / declare under
our sole responsibility that our product / déclare sous sa seule
responsabilité que le produit:

OPTISWITCH 5100 C, OPTISWITCH 5200 C
mit Relaisausgang / with relay output / avec sortie relais (VB60R)
mit Transistorausgang / with transistor output / avec sortie transistor (VB60T)
mit Zweifachausgang / with two-wire output / avec sortie bifilaire (VB60Z)
mit NAMUR-Ausgang / with NAMUR output / avec sortie NAMUR

auf das sich diese Erklärung bezieht, mit den folgenden Normen
übereinstimmt / to which this declaration relates is in conformity
with the following standards / auquel se réfère cette déclaration
est conforme aux normes:

Emission / Emission / Emission → EN 61326 : 1997 (Klasse B)
Immision / Susceptibility / Immision → EN 61326 : 1997 / A1 : 1998
EN 61010 - 1 : 2001

gemäß den Bestimmungen der Richtlinien / following the provision
of Directives / conformément aux dispositions des Directives

7303 EWG
89/338 EWG

10.02.2005

Thomas Wengler
L.V./p.p./P.D. Thomas Wengler

Fig. 17: CE declaration of conformity

Manufacturer declaration

KROHNE

Herstellereklärung 24815

Hiermit erklärt die Fa.

Krohne S.A.S.
Les Drs BP 86
F-06100 Romans Cedex

dass die

**Kompaktgrenzschalter Typen OPTISWITCH 5100 C, 5150 C, 5200 C, 5250 C
mit Transistorausgang**

in Übereinstimmung mit DIN EN 60079-14:2004 Abs. 5.3.3 Punkt c 1

bei bestimmungsgemäßem Gebrauch unter der Maßgabe, dass vom Betreiber die Angaben der nachfolgend aufgeführten Dokumente eingehalten werden:

- Einbau- und Betriebsanweisung der Bedienungsanleitung
- Daten und Hinweise dieser Herstellereklärung
- Einschlägige Einrichtungsanweisungen

geeignet für den Einsatz in Zone 2

Die maximale betriebsmäßige Oberflächentemperaturverhöhung beträgt 65K.

Bei einer Umgebungstemperatur von 70°C am Gehäuse und einer Prozesstemperatur von 70°C, beträgt die betriebsmäßig auftretende maximale Oberflächentemperatur 135°C.

Maßnahmen zur Aufrechterhaltung des Explosionsschutzes im Betrieb:

- Diese Erklärung gilt nur, wenn der OPTISWITCH im Bereich der angegebenen elektrischen Grenzwerte betrieben wird.
- Zulässige Versorgungsspannung: 10...55V DC max. 0,5 W
- Das Gerät ist so zu installieren und zu betreiben, dass Zündgefahren durch elektrostatische Aufladungen nicht zu erwarten sind (der Prozessanschluss, der kurzschlußbeschränkte/unsymmetrische Messendensteckel bzw. das Gehäuse ist je nach Ausführungsvariante aus nicht elektrisch leitenden Kunststoff).
- Auf das Vorhandensein, die einwandfreie Beschaffenheit und den richtigen Sitz der Dichtung zwischen dem Gehäuseunterteil und dem Deckel ist zu achten: der Deckel ist fest zu verschrauben.
- Wird das Gerät mit geöffnetem Deckel betrieben, istw. die Schalter betätigt, muss gewährleistet sein, dass keine explosionsfähige Atmosphäre vorhanden ist.
- Für eine dichte und zugentlastete Kabeleinführung ist zu sorgen; der Außerdurchmesser des Anschlusskabels muss der Kabelverschraubung angepasst sein; die Druckachse der Kabelverschraubung ist sorgfältig anzustreichen.
- Nicht benutzte Öffnungen für Kabel- und Leitungseinführungen müssen dicht verschlossen sein.
- Die Oberflächentemperatur darf die Zündtemperatur der betrieblenden explosionsfähigen Atmosphäre nicht überschreiten.

"Einzelbauteil im Gerät"

Dieses Betriebsmittel wurde durch eine Person beurteilt welche die Anforderung gemäß DIN EN 60079-14 erfüllt

Krohne S.A.S.
Romans Cedex, den 31.05.05

Klaus Jäger

(V. Stangele)

Fig. 18: Manufacturer declaration

Subject to change without notice