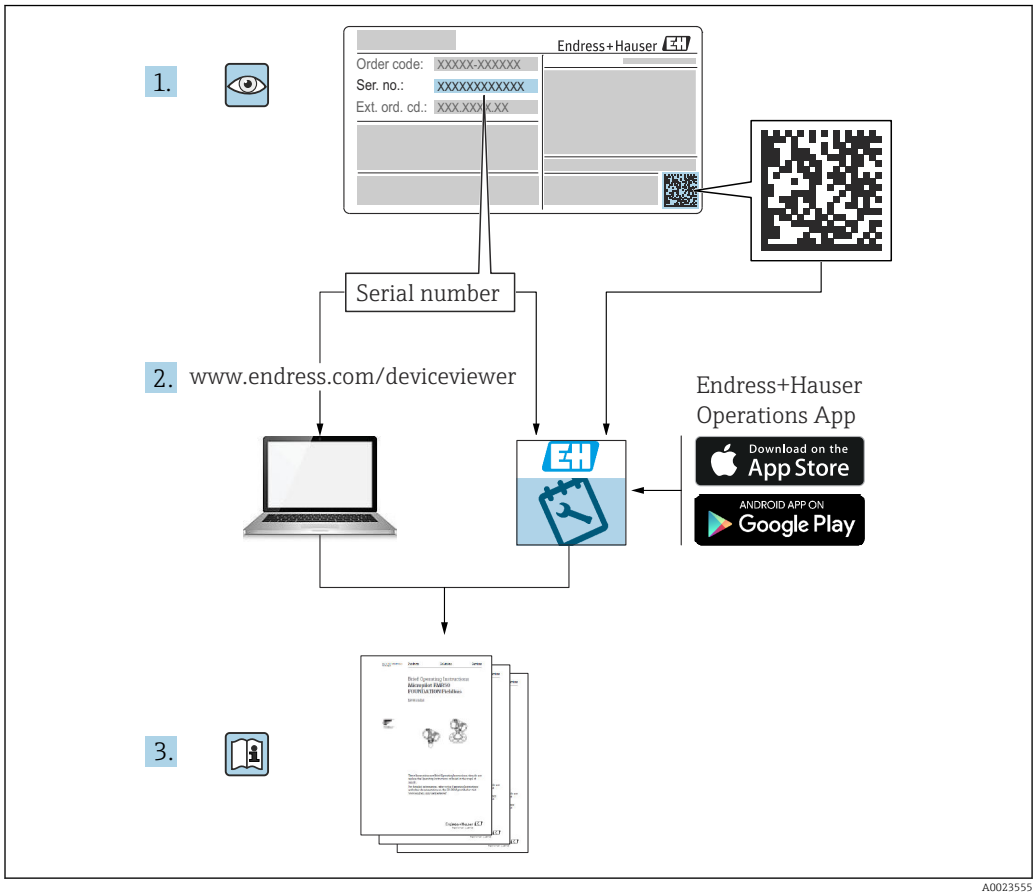
FY01091F/00/EN/02.25-00
71719096
2025-08-20
01.00.zz (Device firmware)



# Functional Safety Manual
# **Liquiphant FTL63 with electronic insert FEL60H**

Vibronic

Endress+Hauser
People for Process Automation


1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX XXX XX XX
Serial number
2. www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the App Store
ANDROID APP ON Google Play
3.
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# 1 Declaration of Conformity

SIL_00513_02.25

Endress+Hauser
People for Process Automation

## Declaration of Conformity

Functional Safety according to IEC 61508
Based on NE 130 Form B.1

Endress+Hauser SE+Co. KG, Hauptstraße 1, 79689 Maulburg

being the manufacturer, declares that the product

Liquiphant FTL51B / FTL62 / FTL63 / FTL64 (FEL60H)

is suitable for the use in safety-instrumented systems according to IEC 61508. The instructions of the corresponding functional safety manual must be followed.

This declaration of conformity is exclusively valid for the listed products and accessories in delivery status.

Maulburg, July 25, 2025
Endress+Hauser SE+Co. KG

i. V.

E-SIGNED by Thorsten Springmann
on 25 July 2025 06:54:02 GMT

Thorsten Springmann
Dept. Man. R&D Devices Level Limit
Research & Development

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E-SIGNED by Stefan Jäger
on 25 July 2025 06:53:28 GMT

Stefan Jäger
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Research & Development

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# 1.1 Safety-related characteristic values

SIL_00513_02.25

Endress+Hauser
People for Process Automation

| | | | |
|---|---|---|---|
| **General** | | | |
| Device designation and permissible types [1] | Liquiphant FTL51B / FTL62 / FTL63 / FTL64 ** BA * * * * * * ** ** *** + [LA ] (FEL60H) | | |
| Safety-related output signal | 8 / 16 mA | | |
| Fault signal | < 3.6 mA / ≥ 21 mA | | |
| Process variable/function | Level switch for liquids | | |
| Safety function(s) | MIN / MAX | | |
| Device type acc. to IEC 61508-2 | ☐ Type A | ☒ Type B | |
| Operating mode | ☒ Low Demand Mode | ☒ High Demand Mode | |
| Valid hardware version | 01.00.ww (ww: any double number) | | |
| Valid software version | 01.00.zz (zz: any double number) | | |
| Safety manual | FTL51B: FY01068F / FTL62: FY01069F / FTL63: FY01091F / FTL64: FY01070F | | |
| Type of evaluation (check only one box) | ☒ | Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3 | |
| | ☐ | Evaluation of "proven in use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3 | |
| | ☐ | Evaluation of HW/SW field data to verify „prior use" acc. to IEC 61511 | |
| | ☐ | Evaluation by FMEDA acc. to IEC 61508-2 for devices w/o software | |
| Evaluation through – report/certificate no. | TÜV Rheinland 968/FSP1388 | | |
| Test documents | Development documents | Test reports | Data sheets |
| **SIL – Integrity** | | | |
| Systematic safety integrity | | ☐ SC 2 | ☒ SC 3 |
| Hardware safety integrity | Single channel use (HFT = 0) | ☒ SIL 2 capable | ☐ SIL 3 capable |
| | Multi channel use (HFT ≥ 1) | ☐ SIL 2 capable | ☒ SIL 3 capable |

| **FMEDA** | | | |
|---|---|---|---|
| Safety function | MIN | MAX | RANGE |
| $\lambda_{DU}$ [2),3)] | 42 FIT | 26 FIT | / |
| $\lambda_{DD}$ [2),3)] | 1173 FIT | 1139 FIT | / |
| $\lambda_{S}$ [2),3)] | 542 FIT | 593 FIT | / |
| SFF | 98% | 99% | / |
| $PFD_{avg}$ ($T_1$ = 1 year)[3)] (single channel architecture) | $1.83 \cdot 10^{-4}$ | $1.15 \cdot 10^{-4}$ | / |
| PFH | $4.17 \cdot 10^{-8}$ 1/h | $2.63 \cdot 10^{-8}$ 1/h | / |
| PTC [4)] A / B / C | 94% / 35% / 35% | 93% / 56% / 56% | / |
| Diagnostic test interval [5)] | ≤ 30 min | ≤ 30 min | / |
| Fault reaction time [6)] | ≤ 5 s | ≤ 5 s | / |

| **Comments** |
|---|
| ISO 13849-1: demand rate ≤ 1/(100 · diagnostic test interval) |

| **Declaration** | |
|---|---|
| ☒ | Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future |

[1)] Valid order codes and order code exclusions are maintained in the E+H ordering system
[2)] FIT = Failure In Time, number of failures per $10^9$ h
[3)] Valid for average ambient temperature up to +40 °C (+104 °F)
For continuous operation at ambient temperature close to +60 °C (+140 °F), a factor of 2.1 should be applied
[4)] PTC = Proof Test Coverage
[5)] All diagnostic functions are performed at least once within the diagnostic test interval
[6)] Maximum time between error recognition and error response

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# 2 About this document

## 2.1 Document function

This Safety Manual applies in addition to the Operating Instructions, Technical Information and Ex-specific Safety Instructions. The supplementary device documentation must be observed during installation, commissioning and operation. The requirements specific to the protection function are described in this Safety Manual.

General information on functional safety (SIL) is available at:
www.endress.com/SIL

## 2.2 Symbols

### 2.2.1 Safety symbols

DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING
This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION
This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol alerts you to a potentially harmful situation. Failure to avoid this situation can result in damage to the product or something in its vicinity.

### 2.2.2 Symbols for certain types of information and graphics

**Tip**
Indicates additional information

Reference to documentation

Reference to graphic

▶
Notice or individual step to be observed

1., 2., 3.
Series of steps

Result of a step

**1, 2, 3, ...**
Item numbers

**A, B, C, ...**
Views

## 2.3 Supplementary device documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

The following document types are available in the download area of the Endress+Hauser website (www.endress.com/downloads):

### 2.3.1 Further applicable documents

- TI01713F
- BA02287F
- KA01642F
- SD02874F (Heartbeat Verification + Monitoring application package)

### 2.3.2 Technical Information (TI)

**Planning aid**
The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

### 2.3.3 Operating Instructions (BA)

**Reference document**
These Operating Instructions contain all the information that is required in the various life cycle phases of the device: from product identification, incoming acceptance and storage, to installation, connection, operation and commissioning, through to troubleshooting, maintenance and disposal.

### 2.3.4 Brief Operating Instructions (KA)

**Guide that takes you quickly to the 1st measured value**
The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

### 2.3.5 Heartbeat Technology Special Documentation (SD)

**Parameter description**
- Heartbeat Diagnostics
- Heartbeat Verification
- Heartbeat Monitoring

The Heartbeat Special Documentation contains a description of the additional parameters and technical data that are available with the Heartbeat Verification and Heartbeat Monitoring application packages.

### 2.3.6 Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

### 2.3.7 Certificate

The associated certificate is available in the Endress+Hauser Device Viewer (Section 2.3) or can be found in the Declaration of Conformity (Section 1) of the applicable Functional Safety Manual. This certificate must be valid at the time of delivery of the device.

# 3 Design

## 3.1 Permitted device types

The details pertaining to functional safety in this manual relate to the device versions listed below and are valid as of the specified firmware and hardware versions.

Unless otherwise specified, all subsequent versions can also be used for safety functions.

A modification process according to IEC 61508:2010 is applied for any device modifications.

Any exemptions from possible combinations of features are saved in the Endress +Hauser ordering system.

Valid device versions for safety-related use:

### 3.1.1 Order codes

**FTL63-**

**Feature: 010 "Approval"**
Version: all

**Feature: 020 "Output"**
Version: BA ; FEL60H, 2-wire 8/16mA HART + test button

**Feature: 030 "Display, operation"**
Version: all

**Feature: 040 "Housing; material"**
Version: all

**Feature: 050 "Electrical connection"**
Version: all

**Feature: 060 "Application"**
Version: all

**Feature: 080 "Surface refinement"**
Version: all

**Feature: 085 "Probe design"**
Version: all

**Feature: 090 "Sensor length, material"**
Version: all

**Feature: 105 "Process connection, sealing surface"**
Version: all

**Feature: 110 "Process connection"**
Version: all

**Feature: 590 "Additional approval"**
Version: LA
Advanced diagnostic measures are only implemented in this version. This version must be selected for use as a safety function as per IEC 61508.

## 3.2 Identification marking

SIL-certified devices are marked with the SIL logo (SIL) on the nameplate.

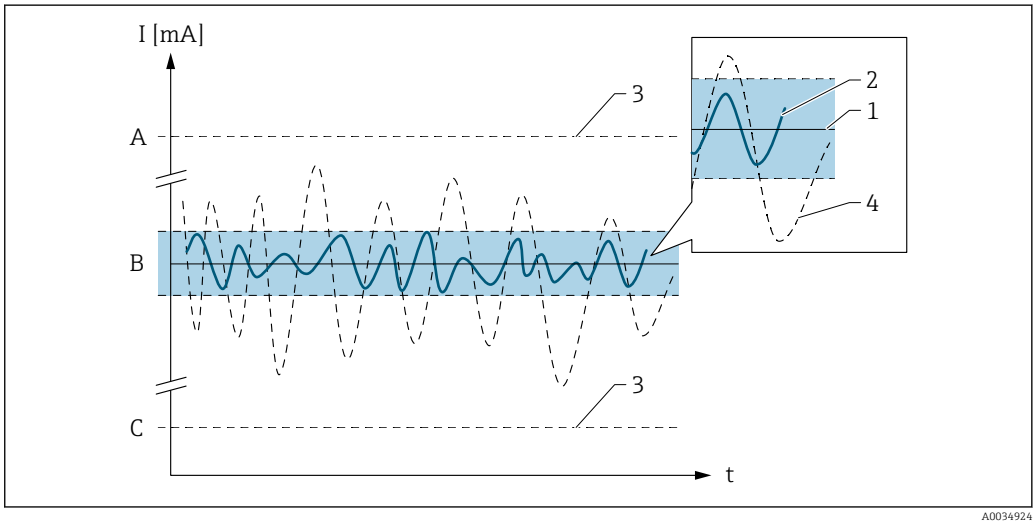
## 3.3 Safety function

The device's safety functions are:
- Maximum level monitoring (overfill protection system, maximum detection)
- Minimum level monitoring (dry-run protection, minimum detection)

## 3.4 Basic conditions for use in safety-related applications

The device must be used correctly for the specific application, taking into account the medium properties and ambient conditions. Carefully follow instructions pertaining to critical process situations and installation conditions from the Operating Instructions. The application-specific limits must be observed. The specifications in the Operating Instructions and the Technical Information must not be exceeded.

### 3.4.1 Random failures in accordance with IEC/EN 61508




*A HI alarm ≥ 21 mA*
*B SIL error range ±2%*
*C LO alarm ≤ 3.6 mA*

**No device error**
- No failure
- No impact on the safety-related output signal
- Impact on measurement uncertainty:
  1 – within the specification (TI, BA etc.)

**$\lambda_S$ (Safe)**
- Safe failure
- No impact on the safety-related output signal: output signal enters the safe state
- Impact on the measurement uncertainty:
  - 2 - Moves within the specified SIL error band B
  - 3 – Has no effect

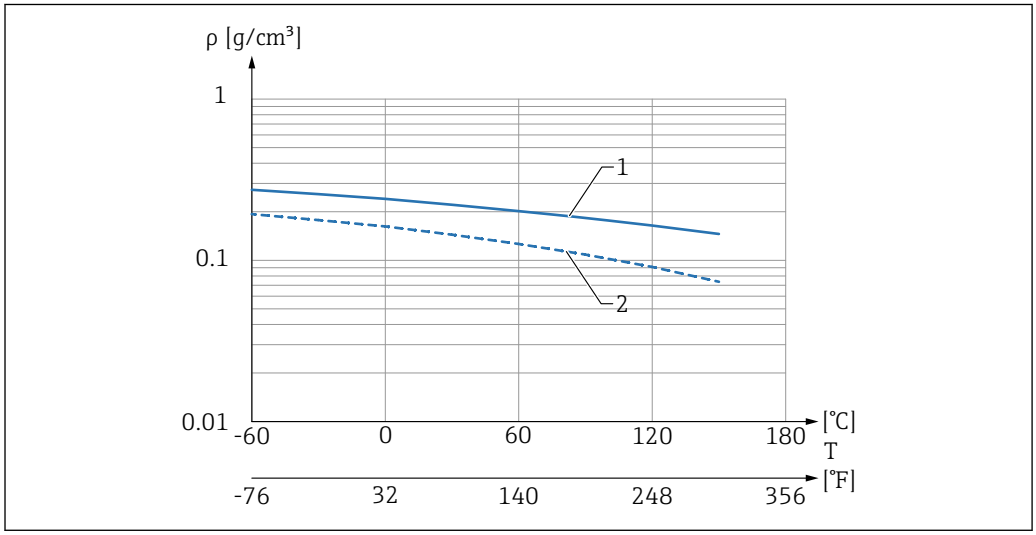
**$\lambda_{DD}$ (Dangerous detected)**
- Dangerous, detected failure
- Impact on the safety-related output signal: results in a failure mode at the output signal
- Impact on the measurement uncertainty:
  3 – Has no effect

**$\lambda_{DU}$ (Dangerous undetected)**
- Dangerous and undetected failure
- Impact on the safety-related output signal: can be outside the defined error range B
- Impact on the measurement uncertainty:
  4 – May be outside the specified error range

## 3.4.2 Restrictions for safety-related use

### Density

Operation is only permitted with liquids:
- Depending on the configuration of the density setting, the density of the liquid must be as follows:
  - over 0.7 g/cm³ if switch position is > 0.7 (common water- or oil-based liquids)
  - over 0.5 g/cm³ if switch position is > 0.5 (e.g. liquefied gas, isopentane, benzine)
- The gas phase above the liquid may not exceed a maximum permitted density value. The maximum possible gas density depends on the temperature and the device




*1 316L stainless steel, polished*

*1 Switch position for density 0.7 g/cm³*
*2 Switch position for density 0.5 g/cm³*

**⚠ CAUTION**

**Gas density is exceeded!**

The "Uncovered" state is not recognized and the "Covered" state is always reported.

► The gas density may not be exceeded.

- There is no minimum density for the gas phase.
- Operation in a vacuum is permitted.
- There is no maximum density for the liquid.

For more information on the levels of diagnostic coverage, refer to IEC 61508-2:2010 Appendix A.2, Comment 2 and Table A.1.

### Buildup: only minimum detection

The device may only be used in media that do not tend to cause buildup.

Buildup is detected with a low diagnostic coverage. An additional diagnostic message can be configured via the menu Heartbeat Monitoring → Process window. The proof test coverage is not affected by this, since this is a systematic fault.

### Solid particles - heterogeneous mixtures

The medium may not contain solid particles with a diameter greater than 5 mm (0.2 in). Solid particles lodged between the tines of the tuning fork can have the effect that the demand mode of the safety function is not detected and the device will not switch as intended.

- Only for MIN detection
- Lodged solid particles are detected with low diagnostic coverage.

### Wall distance

The distance between the tuning fork and the wall of the vessel containing medium (e.g. tank, pipe) must be at least 10 mm (0.39 in).

### Corrosion

The device may only be used in media to which the parts in contact with the process are resistant. Corrosion can have the effect that the demand mode of the safety function is not detected and the device will not switch as intended.

Corrosion is detected with low diagnostic coverage. An additional diagnostic message can be configured via the menu Heartbeat Monitoring → Process window. The proof test coverage is not affected by this, since this is a systematic fault.

### Abrasion

It is not permitted to use the device with abrasive media. Material abrasion on the vibrating fork can result in the device malfunctioning.

Abrasion is detected with low diagnostic coverage. An additional diagnostic message can be configured via the menu Heartbeat Monitoring → Process window. The proof test coverage is not affected by this, since this is a systematic fault.

### Flow velocity

In the case of flowing media, the flow velocity in the area around the tuning fork may not exceed max. 5 m/s. Higher flow velocities can have the effect that the demand mode is not detected and the sensor signals that it is free (uncovered).

### External vibration

In systems exposed to strong external vibrations, e.g. in the 400 to 1 200 Hz range (acceleration spectral density >1 $(m/s^2)^2/Hz$) or ultrasound with cavitation, the safety function must be verified by simulating a demand mode prior to operation. Accidental switchings may sporadically occur if a strong frequency from an external source is superimposed on the frequency of the vibrating fork.

An additional diagnostic message can be configured via the menu Heartbeat Monitoring → Process window. The proof test coverage is not affected by this, since this is a systematic fault.

### EMC compatibility

The device is tested according to IEC 61326-3-1 and is therefore suitable for general industrial safety-related applications. If the specified electromagnetic ambient conditions

are exceeded, the switch status might not be reliably detected. An unshielded cable can be used between the devices in these environmental conditions. Electromagnetic interference immunity can be further improved by using shielded cables.

### Mounting with sliding sleeve

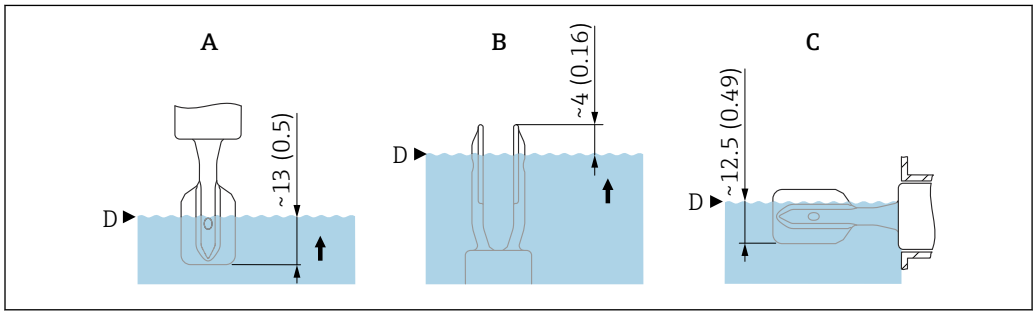
The use of a sliding sleeve is not permitted.

### Display with Bluetooth

The device may be operated with the following displays when used as a safety function:
- VU112A
- VU113A

Display and Bluetooth modules may only be used for information purposes but may not be used as part of the safety function. They do not have any effect on the safety function.

## 3.4.3 Safety measured error




2 *Switch point depending on the installation position. Unit of measurement mm (in)*

*A Installation from above*
*B Installation from below*
*C Installation from the side*

## 3.4.4 Systematic faults

Systematic faults are faults for which a cause can be clearly identified and which can only be eliminated by modifying the design or the manufacturing process, the method of operation, the operating instructions, or other influencing factors.

Failures caused by systematic faults are always reproducible and can be avoided by taking appropriate measures.

The flexible testing of field devices using Heartbeat Verification can support the detection of systematic faults as part of a proof test (see Section 6).

**Examples:**
- **Application-specific faults:**
  Formation of buildup, corrosion, abrasion
  Possible remedy: Configure and activate Heartbeat Monitoring, process window.
- **Faults during installation, commissioning or maintenance:**
  Installation in dead legs; incorrect safety-related parameter settings
  Possible remedy: Write protection via hardware DIP switch or software wizard safety mode (see Section 4.5.2) with verification of the CRC device configuration checksum.
- **Planning faults:**
  Avoid using unsuitable device configuration for the application.

## 3.5 Systematic faults

Systematic faults are faults for which a cause can be clearly identified that can only be eliminated by modifying the design or the manufacturing process, the method of operation, the operating instructions or other influencing factors.

Failures caused by systematic faults are always reproducible and can be avoided by taking appropriate measures.

The flexible testing of field devices using Heartbeat Verification can support the detection of systematic faults as part of a proof test (see Section 6).

**Examples:**

- **Application-specific faults:**
  Clogged impulse lines, corrosion, diffusion, mechanical stress
  Possible remedy: Heartbeat Monitoring statistical sensor diagnostics
- **Faults during installation, commissioning or maintenance:**
  Possible remedy: Write protection via hardware DIP switch or software wizard safety mode (see Section 4.5.2) with verification of the CRC device configuration checksum.
- **Planning faults:**
  Avoid using unsuitable device configuration for the application.
  Possible remedy: Use Endress +Hauser Applicator to calculate the total performance or diaphragm seal faults.

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## 3.6 Useful lifetime of electrical components

The established failure rates of electrical components apply within the useful lifetime as per IEC 61508-2:2010 section 7.4.9.5 note 3.

In accordance with DIN EN 61508-2:2011 section 7.4.9.5 (national footnote N3), appropriate measures taken by the manufacturer and operator can extend the useful lifetime.

# 4 Commissioning (installation and configuration)

## 4.1 Requirements for personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:

- ▶ Trained, qualified specialists must have a relevant qualification for this specific function and task.
- ▶ Personnel must be authorized by the plant owner/operator.
- ▶ Be familiar with federal/national regulations.

- Before starting work: personnel must read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Personnel must follow instructions and comply with general policies.

The operating personnel must fulfill the following requirements:
- Personnel are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- Personnel follow the instructions in this manual.

## 4.2 Installation

The mounting and wiring of the device and the permitted orientations are described in the Operating Instructions pertaining to the device.

Correct installation is a prerequisite for safe operation of the device.

## 4.3 Commissioning

The commissioning of the device is described in the Operating Instructions pertaining to the device.

Prior to operating the device in a safety instrumented system, verification must be carried out by means of a test sequence as described in **the section "Proof testing"**.

## 4.4 Operation

The operation of the device is described in the Operating Instructions pertaining to the device.

## 4.5 Device configuration for safety-related applications

### 4.5.1 Calibration of the measuring point

NOTICE

**After commissioning the measuring system, changes to the settings can impact the protective function.**
The protective function can be compromised.
- After changing the settings, perform a proof test to ensure that the safety function is working correctly.
- Device settings must not be changed in the active SIL mode.
- The configuration of the measuring point is described in the Operating Instructions.

### 4.5.2 Device protection

The devices can be protected against external influences as follows:
- Hardware write protection
- Software write protection via the "Safety mode" wizard

### 4.5.3 Configuration methods

The following operating methods are possible to configure the safety function:
- DTM-based software such as Field Care or Device Care
- MSD-based software SmartBlue (App)
- Operation via display
- EDD-based software such as PDM / FDI /AMS

The safety function can be commissioned in a number of ways:
- Configured onsite without the operating menu
- Configured using the wizard
- Expert setting

### 4.5.4 On-site setting

- Without an operating menu
- Recommended for initial commissioning

Reset the device according to the Operating Instructions. This resets all parameters to defined values (factory settings or customized settings).

1. Check the position of DIP switch 1 on the electronic insert, set to "OFF" if necessary.
2. Configure the device as specified in the Operating Instructions.
3. Lock the device using DIP switch 1 on the electronic insert.

A function test is necessary before the device is used in the SIL mode. This can be done, for example, using one of the methods described for the proof test.

### 4.5.5 Configuration and locking using the wizard

- Recommended for initial commissioning
- Use of the wizard provides increased safety against incorrect settings, since only relevant parameters can be configured.
- Optionally, locking can also be activated via DIP switch 1 on the electronic insert.

1. Reset the device according to the Operating Instructions. This resets all parameters to defined values (factory settings or customized settings).
2. Check the position of DIP switch 1 on the electronic insert; set to **OFF** if necessary.
3. Carry out the configuration as described in the Operating Instructions. Observe the restrictions (see below). **Simulation** parameter must be set to **Off** option.
4. Guidance → Safety mode → Preparation → Enter safety locking code
5. Enter **7452**.

Locking status: **Temporarily locked** option

A temporary lock is only implemented if all of the following restrictions regarding configuration options are implemented:
- **Current range output** parameter is NOT set to the Customer-specific option
- **Loop current mode** parameter is set to **Enable** option
- **Simulation** parameter is set to **Off** option
- **Assign PV** parameter is set to **Level limit detection** option

6. Perform **Safety mode** wizard step by step. Under **Locking** wizard re-enter **7452** as Enter safety locking code.
7. Once all the pages have been completed, click Finish to close the wizard.

Locking status: **Safety locked** option.

The current CRC device configuration is saved.

If a device is unlocked and then locked again, the current CRC device configuration is compared with the **Stored CRC device configuration** parameter:
- No difference in configuration: The device is immediately Safety locked.
- Difference in configuration: The safety-related parameter settings must be confirmed again.

If the wizard is aborted, the device is unlocked again. All the necessary wizard pages must be processed again.

### 4.5.6 Configuration and locking without the wizard

Offers the expert all the device configuration options.

1. Reset the device according to the Operating Instructions. This resets all parameters to defined values (factory settings or customized settings).
2. Check the position of DIP switch 1 on the electronic insert; set to **OFF** if necessary.
3. Carry out the configuration as described in the Operating Instructions. **Simulation** parameter must be set to **Off** option.

A temporary lock is only implemented if all of the following restrictions regarding configuration options are implemented:
- **Loop current mode** parameter is set to **Enable** option
- **Assign PV** parameter is set to **Level limit detection** option

4. Lock the device using DIP switch 1 on the electronic insert.
5. Check and document the device settings. Documentation option: print function in FieldCare

### 4.5.7 Unlocking

A locked device is protected against unauthorized operation by means of a locking code and optionally by a hardware write protection switch (DIP switch 1 on the electronic insert). The device must be unlocked in order to change parameters and to reset self-sustaining diagnostic messages.

1. Check the position of DIP switch 1 on the electronic insert; set to **OFF** if necessary.
2. Guidance → Safety mode → Preparation → Enter safety unlocking code
3. Enter **7452**.

Locking status: Safety unlocked

**⚠ CAUTION**

**Device is unlocked**

The protection function is not guaranteed

► Take suitable measures to guarantee the safety of the facility.

### 4.5.8 Settings for Heartbeat Verification and Monitoring (optional)

**Process window**

The actual frequency of the fork can be monitored in-situ and, as a plausibility check, compared with the fluid-specific frequency (for MIN) or the uncovered fork frequency (for MAX). Deviations may indicate systematic faults such as deposit buildup or corrosion/ abrasion.

If the threshold values are exceeded, the Heartbeat Verification result is Failed.

For MAX (Heartbeat Technology → Process window)
- Activate function
- The current frequency is displayed. Upper and lower limit values must be defined. Previous min./max. values must be used as a reference.
- Define diagnostic behavior and alarm delay.

For MIN (Heartbeat Technology → Process window)
- Activate function
- The current frequency is displayed. Upper and lower limit values must be defined. Previous min./max. values must be used as a reference. The frequencies depend on the density and temperature of the liquid.
- Define diagnostic behavior and alarm delay.

**Loop diagnostics**

To monitor the loop resistance, the current/voltage characteristic must be stored during commissioning.

If the threshold values are exceeded, the Heartbeat Verification result is Failed.

Heartbeat Technology → Loop diagnostics
- Store the characteristic and define limit values.
- Define diagnostic behavior and alarm delay.

## 4.6 Parameters and default settings for the SIL mode

The following parameters affect the safety function. However, they may be freely configured in accordance with the application. In increased safety mode, it is necessary to confirm the configured values during the remainder of the commissioning process. Confirmation is not required in expert mode.

Values must be confirmed and documented using the Safety mode wizard. It is recommended to note down the configured values!

**Application → Sensor setting**
- Mode of operation
- Safety function
- Density setting
- Switching delay

The following settings are not permitted for the SIL mode:
- Parameter "Simulation"
  - Fork state
  - Sensor frequency
  - Current output
  - Diagnostic event simulation
- Parameter "Loop current mode": deactivate

Those parameters which are not mentioned do not affect the safety function and can be configured to any meaningful values. The visibility of the parameters mentioned in the operating menu depends in part on the user role, the SW options ordered and on the settings of other parameters.

**CAUTION**

**The current output adopts a fixed value**
- ▶ Do not operate the device in HART Multidrop during the SIL mode

# 5 Operation

## 5.1 Device behavior during power-up

Once switched on, the device runs through a diagnostic phase. For the first 5 s of the diagnostic phase, this current is ≤ 3.6 mA. After that, depending on the setting of the "Failure behavior current output" parameter, the current is:
- at the MIN value: ≤3.6 mA
- at the MAX value: ≥21.0 mA

During the diagnostic phase, no communication is possible via the service interface (CDI) or via HART.

## 5.2 Device behavior in safety function demand mode

**MIN operating mode**
- Tuning fork covered: OK status is reported, 16 mA [1)]
- Tuning fork uncovered: demand mode is reported, 8 mA [1)]

**MAX operating mode**
- Tuning fork covered: demand mode is reported, 8 mA [1)]
- Tuning fork uncovered: OK status is reported, 16 mA [1)]

## 5.3 Behavior of device in the event of an alarm and warnings

**MIN and MAX operating mode**
- Fault: alarm is reported, < 3.6 mA
- Short-circuit: alarm is reported, >21.0 mA

For alarm monitoring, the downstream logic unit must be able to detect both HI alarms (≥ 21.0 mA) and LO alarms (≤ 3.6 mA).

## 5.4 Alarm and warning messages

The behavior of the device in the event of an alarm and warnings is described in the relevant Operating Instructions.

Correlation between the error code and the current that is output:

**Error code "Fxxx"**
- Current output: ≥ 21.0 mA or ≤ 3.6 mA
- Comment: xxx - three-digit number

**Error code "Mxxx" / "Cxxx" / "SXXX"**
- Current output: as per measured value
- Comment:
  - xxx - three-digit number
  - Overview of output signals depending on the diagnostic state (warning and alarm).

1) For the following safety function, it suffices to program the current threshold between the OK status and demand mode at 12 mA.

# 6 Proof testing

The safety-related functional integrity of the device in safety-related applications must be checked during commissioning, whenever safety-relevant parameters are changed, and at appropriate intervals. This ensures that the functional integrity can be verified within the complete safety instrumented system. The time intervals must be specified by the operator.

**⚠ CAUTION**

**The safety function is not guaranteed during a proof test**

Suitable measures must be taken to guarantee process safety during the test.

- The safety-related output signal 4 to 20 mA must not be used for the safety instrumented system during testing.
- A completed test must be documented; the reports provided in the Appendix can be used for this purpose (see Section 8.2).
- The operator specifies the test interval and this must be taken into account when determining the probability of failure $PFD_{avg}$ of the sensor system.

If no operator-specific proof testing requirements have been defined, the following is a possible alternative for testing the transmitter depending on the measured variable used for the safety function. The individual proof test coverages (PTC) that can be used for calculation are specified for the test sequences described below.

**Flexible testing of field devices**

NAMUR Worksheet NA106 "Flexible proof testing of field devices in safety instrumented systems" explains how to optimize testing activities on existing installations.

Device verification (Heartbeat Verification) enables documentation of the current device diagnosis or device status as proof of testing. This supports the documentation of proof tests according to IEC 61511-1:2016 Section 16.3.3, "Documentation of proof tests and inspections".

Heartbeat Verification is not a substitute for a proof test. Test sequences with Heartbeat Verification can support the detection of systematic faults as part of a proof test. In this case, Heartbeat Verification is one step in the proof test sequence.

Heartbeat Verification is based on device-specific test sequences that are performed automatically. The verification also enables the detection of systematic faults in the process, e.g.

- Deposit/buildup on the fork
- Abrasion/corrosion on the fork
- Changes in the measuring circuit resistance

Heartbeat Technology is a methodological design concept based on IEC 61508:2010 consisting of the Heartbeat Diagnostic, Verification and Monitoring modules. For more information on Heartbeat Technology, see the associated documentation (SD02953F).

**NOTICE**

**If the device is in a fault state before the start of the test, an alarm message is issued.**

- The cause of the fault must be rectified before starting the proof test.

**Overview of the proof tests:**
- Test sequence A
  Simulation of the alarm currents and by approaching the level or by removing and immersing in a medium of similar density and viscosity
- Test sequence B
  Simulation using proof test button on the device
- Test sequence C
  Simulation of the alarm currents and simulation of the demand mode by tooling (app/display etc.)
- Test sequence E
  Test sequence C and Heartbeat Verification (Heartbeat Monitoring → Process window is set up and activated)

Test sequence A and B can be performed both with and without tooling (app/display etc.). Test sequence C and E only with tooling.

**Note the following for the test sequences:**
- The individual proof test coverages (PTC) that can be used for calculation are specified in the Declaration of Conformity.
- Test sequences B, C und E are only permitted for commissioning tests if the operator ensures suitability for the application, including installation, by means of appropriate measures.
- A demand mode or a fault takes absolute precedence over the proof test and in the measuring system safety path. The demand mode must first be ended or the fault rectified before the proof test can commence.
- The proof test can only be performed if the device status is OK.
- The status of the individual output signal is indicated by a device or a downstream component of the safety path (e.g. PLC, actuator). It suffices to evaluate the response of downstream parts of the safety function. If the different states are correctly identified there, the device has passed the test steps.
- For troubleshooting, refer to the Operating Instructions.

## 6.1 Test sequence A

Simulation of the alarm currents and by approaching the level or by removing and immersing in a medium of similar density and viscosity

Proof testing procedure with tooling (app/display…)

1. Select Guidance → Proof test
2. Confirm the warning message
3. Perform a visual inspection and confirm
4. Confirm the device information
5. Confirm selection of test sequence A and device settings (MAX/MIN, density etc.)
6. Confirm settings for high alarm current, simulate high alarm current, confirm triggering of subsequent safety instrumented system, confirm read-back current
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.
7. Simulate the low alarm current and confirm the triggering of the subsequent safety instrumented system
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.
8. Confirm the OK status at the tuning fork and the read-back current 16 mA
   ↳ These currents can be determined by the read-back value in the tooling system (app/display, etc.).

9. Change the status of the tuning fork so that the demand mode is active and confirm the read-back current 8 mA
   ↳ These currents can be determined by the read-back value in the tooling system (app/display, etc.).
10. Change the status of the tuning fork so that an OK status is active and confirm the read-back current 16 mA
    ↳ These currents can be determined by the read-back value in the tooling system (app/display, etc.).
11. On the "Assessment of reviewer" page, enter "Passed" or "Failed". If "Passed" is entered, the date of the last proof test is updated.

The device has passed the proof test once all the steps have been performed successfully.

Proof test procedure without tooling (manual)

1. Perform the visual inspection
2. Ensure an OK status at the tuning fork and check current 16 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.
3. Change the status of the tuning fork so that the demand mode is active and check current 8 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.
4. Change the status of the tuning fork so that an OK status is active and check current 16 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.

The device has passed the proof test once all the steps have been performed successfully.

## 6.2 Test sequence B

- No change of level in the tank is necessary for this proof test.
- Test sequence B is only permitted for commissioning tests if the operator ensures suitability for the application, including installation, by means of appropriate measures.

Proof testing procedure with tooling (app/display…)

1. Select Guidance → **Proof test** wizard
2. Confirm the warning message
3. Perform a visual inspection and confirm
4. Confirm the device information
5. Confirm selection of test sequence B and device settings (MAX/MIN, density etc.)
6. Confirm the OK status at the tuning fork and current 16 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.
7. Press the key at the device (> 3 s): confirm demand mode and current 8 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.

8. Release the key: confirm the OK status and current 16 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.

The simulation of the demand mode takes at least 10 s even when the key is pressed for a shorter time. If the key is pressed for longer > 10 s, the simulation is active until the key is released.

9. On the "Assessment of reviewer" page, enter "Passed" or "Failed". If "Passed" is entered, the date of the last proof test is updated.

The device has passed the proof test once all the steps have been performed successfully.

Proof test procedure without tooling (manual)

1. Perform the visual inspection
2. Ensure an OK status at the tuning fork and check current 16 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.
3. Press the key at the device: check demand mode and current 8 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.
4. Release the key: check the OK status and current 16 mA
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.

The device has passed the proof test once all the steps have been performed successfully.

The simulation of the demand mode takes at least 10 s even when the key is pressed for a shorter time. If the key is pressed for longer > 10 s, the simulation is active until the key is released.

## 6.3 Test sequence C

- No change of level in the tank is necessary for this proof test.
- Test sequence C is only permitted for commissioning tests if the operator ensures suitability for the application, including installation, by means of appropriate measures.

Proof testing procedure with tooling (app/display...)

1. Select Guidance → Proof test
2. Confirm the warning message
3. Perform a visual inspection and confirm
4. Confirm the device information
5. Confirm selection of test sequence C and device settings (MAX/MIN, density etc.)
6. Confirm settings for high alarm current, simulate high alarm current, confirm triggering of subsequent safety instrumented system, confirm read-back current
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.
7. Simulate the low alarm current and confirm the triggering of the subsequent safety instrumented system
   ↳ These currents must be determined by the response of the SIS or by measuring at the terminal.

8. Confirm the OK status at the tuning fork and the read-back current 16 mA
   ↳ These currents can be determined by the read-back value in the tooling system (app/display, etc.).
9. Start simulation of the demand mode: confirm the demand mode and read-back current 8 mA
   ↳ These currents can be determined by the read-back value in the tooling system (app/display, etc.).
10. Demand mode is ended: confirm the OK status and the read-back current 16 mA
    ↳ These currents can be determined by the read-back value in the tooling system (app/display, etc.).
11. On the "Assessment of reviewer" page, enter "Passed" or "Failed". If "Passed" is entered, the date of the last proof test is updated.

The device has passed the proof test once all the steps have been performed successfully.

## 6.4 Test sequence E

Test sequence E can only be carried out with the "Heartbeat Verification + Monitoring" application package.

Proof test procedure:

1. Perform test sequence C according to → 22.
2. Start Heartbeat Verification (**Guidance** menu -> **Heartbeat Technology** submenu -> **Heartbeat Verification** submenu).
3. Perform Heartbeat Verification step by step. Details of the test steps are described in SD02525P.

## 6.5 Verification criterion

**If one of the test criteria from the test sequences described above is not satisfied, the device may no longer be used as part of a safety instrumented system.**

- The purpose of proof-testing is to detect dangerous undetected device failures ($\lambda_{DU}$).
- The impact of systematic faults on the safety function is not covered by this test and must be assessed separately.
- Systematic faults can be caused, for example, by process material properties, operating conditions, buildup or corrosion.
- A Heartbeat Verification "FAILED" can indicate systematic faults.
- As part of the visual inspection, ensure that all of the seals and cable entries provide adequate sealing and that the device is not visibly damaged.

# 7 Repair and error handling

## 7.1 Maintenance

Maintenance instructions and instructions regarding recalibration may be found in the Operating Instructions pertaining to the device.

Alternative monitoring measures must be taken to ensure process safety during configuration, proof-testing and maintenance work on the device.

## 7.2 Repair

Repair means restoring functional integrity by replacing defective components.

**Only original Endress+Hauser spare parts may be used here.**

The repair must be documented. This includes:
- Serial number of the device
- Date of the repair
- Type of repair
- Person who performed the repair

Components may be repaired/replaced by the customer's technical staff if original Endress +Hauser spare parts are used (they can be ordered by the end user), and if the relevant installation instructions are followed.

A proof test must always be performed after every repair.

Installation Instructions are supplied with the original spare part and can also be accessed in the Download Area at www.endress.com

Send in replaced components to Endress+Hauser for fault analysis.

When returning the defective component, always enclose the "Declaration of Hazardous Material and Decontamination" with the note "Used as SIL device in a safety instrumented system".

Information on returns: http://www.endress.com/support/return-material

## 7.3 Modification

Modifications are changes to SIL devices that are already delivered or installed:
- **Modifications to SIL devices by the user are not permitted as they can impair the functional safety of the device.**
- Modifications to SIL devices may be performed onsite at the user's plant following approval by the Endress+Hauser manufacturing center.
- Modifications to SIL devices must be performed by personnel authorized to do so by Endress+Hauser.
- Only **original spare parts** fromEndress+Hauser may be used for modifications.
- All modifications must be documented in the Endress+Hauser Device Viewer (www.endress.com/deviceviewer)
- All modifications require a change nameplate or replacement of the original nameplate.

## 7.4 Decommissioning

When decommissioning, the requirements according to IEC 61508-1:2010 section 7.17 must be observed.

## 7.5 Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

## 7.6 Battery disposal

- In some countries, the end user is legally obliged to return used batteries.
- The end user can return old batteries or electronic assemblies containing these batteries free of charge to Endress+Hauser.

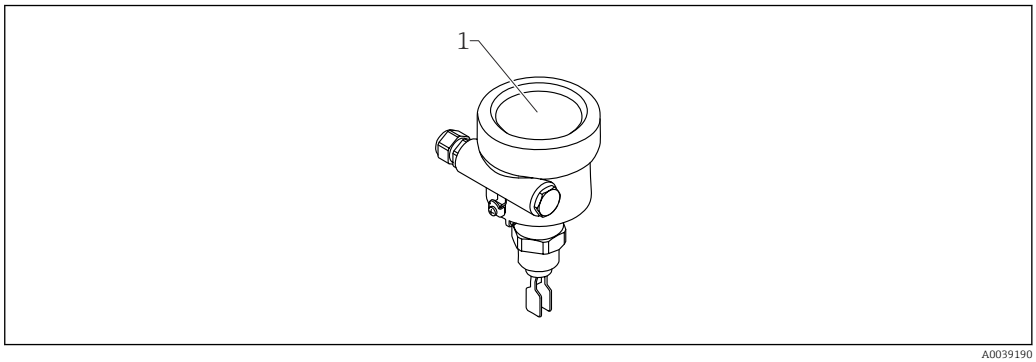
In accordance with German law regulating the use of batteries (BattG §17 Para Number 3), this symbol is used to denote electronic assemblies that must not be disposed of as municipal waste.

# 8 Appendix

## 8.1 Structure of the measuring system

### 8.1.1 System components

The measuring system's devices are shown in the following diagram (example).



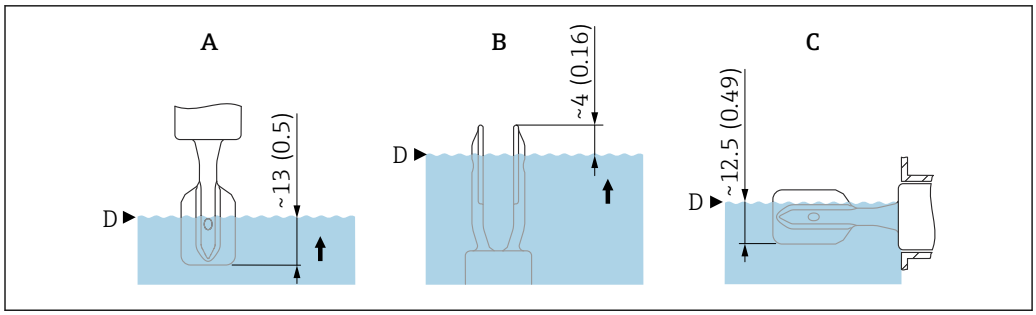

*3 System components*

*1 Measuring device/sensor*

### 8.1.2 Description of use as a protective system

The sensor's tuning fork vibrates at its intrinsic frequency. The vibration frequency decreases as the density increases. This change in the frequency causes the current signal to change.

The switch point is in the range of the tuning fork and depends on the installation position.




4 *Switch point depending on the installation position. Unit of measurement mm (in)*

*A Installation from above*
*B Installation from below*
*C Installation from the side*

- For information on the switch point under reference operating conditions, see the Technical Information.
- Correct installation is a prerequisite for safe operation of the device.

### 8.1.3 Installation conditions

The installation conditions for various measurements are described in the Technical Information for the device.

Correct installation is a prerequisite for safe operation of the device.

### 8.1.4 Measurement function

Choice of operating modes:
- MIN detection
  The measuring system is used to prevent the level becoming too low (e.g. dry running protection for pumps, empty running protection or protection against underfills). In normal operation, the tuning fork is covered by liquids and the measuring system reports the OK status. When the tuning fork is uncovered, the device adopts the safe state and reports the demand mode.
- MAX detection
  The measuring system is used to prevent the level becoming too high (e.g. overfill protection). In normal operation, the tuning fork is not covered by liquids and the measuring system reports the OK status. When the tuning fork is covered, the device adopts the safe state and reports the demand mode.

## 8.2 Commissioning or proof test report

The following device-specific test report acts as a print/master template and can be replaced or supplemented any time by the customer's own SIL reporting and testing system.

### 8.2.1 Test Report - Page 1 -

| Device information |
|---|
| System |
| Device tag |
| Device name/Order code |
| Serial number |
| Firmware version |
| Hardware revision |

| Test information |
|---|
| Company/contact person |
| Performed by |
| CRC device configuration |
| Date/time |
| Inspector |

| Result of proof test | |
|---|---|
| Overall result | |
| ☐ Pass ☑ | ☐ Fail ☒ |

| Comment |
|---|
| |

| Date | Signature | Signature of tester |
|---|---|---|

### 8.2.2 Test Report - Page 2 -

| Device information |
|---|
| System |
| Device tag/TAG No. |
| Serial number |

| Information on verification |
|---|
| Date/time |

| Safety function - Limit value monitoring | |
|---|---|
| ☐ MIN | ☐ MAX |

| Density range setting | |
|---|---|
| ☐ > 0.7 g/cm³ | ☐ > 0.5 g/cm³ |

| Proof testing |
|---|
| ☐ Test sequence A, simulation of alarm currents and wet approach |
| ☐ Test sequence B, simulation of output using proof test button |
| ☐ Test sequence C, simulation of alarm currents and output with tooling |
| ☐ Test sequence E, simulation of alarm currents, output and Heartbeat Verification with tooling |

| Protocol of test sequence A and C | | | |
|---|---|---|---|
| **Test step** | **Target output current** | **Actual value** | **Result** |
| Read out max alarm current | ≥ 21.0 mA | | ☐ Passed<br>☐ Failed |
| Max alarm current / safety instrumented system is triggered | ≥ 21.0 mA/alarm | | ☐ Passed<br>☐ Failed |
| Min alarm current / safety instrumented system is triggered | ≤ 3.6 mA/alarm | | ☐ Passed<br>☐ Failed |
| Output current | 15.2 to 16.8 mA | | ☐ Passed<br>☐ Failed |
| Output current | 7.6 to 8.4 mA | | ☐ Passed<br>☐ Failed |
| Output current | 15.2 to 16.8 mA | | ☐ Passed<br>☐ Failed |

| Report for test sequence B | | | |
|---|---|---|---|
| **Test step** | **Target output current** | **Actual value** | **Result** |
| Output current | 15.2 to 16.8 mA | | ☐ Passed<br>☐ Failed |
| Output current | 7.6 to 8.4 mA | | ☐ Passed<br>☐ Failed |
| Output current | 15.2 to 16.8 mA | | ☐ Passed<br>☐ Failed |

| Report for test sequence E: Test sequence C + Heartbeat Verification | | | |
|---|---|---|---|
| **Test step** | **Set limit value** | **Actual value** | **Result** |
| Frequency | ▪ Process frequency too low: _____ Hz<br>▪ Process frequency too high: _____ Hz | | ☐ Passed<br>☐ Failed |
| Heartbeat Verification | Verification ID: | | ☐ Passed<br>☐ Failed |

| Information on verification |
|---|
| Date/time |

### 8.2.3 Parameter settings for safety-related applications

| Device information |
|---|
| System |
| Device tag/Tag no. |
| Serial number |

| Information on verification |
|---|
| Date/time |

| Parameter name | Default setting | Set value | Tested |
|---|---|---|---|
| Enter access code | 0 | | ☐ Passed<br>☐ Failed |
| CRC device configuration | | | |
| Failure current | 22.5 mA | | ☐ Passed<br>☐ Failed |
| Fault mode | Low alarm | | ☐ Passed<br>☐ Failed |
| Mode of operation | Point level measurement | | ☐ Passed<br>☐ Failed |
| Safety mode | MAX | | ☐ Passed<br>☐ Failed |
| Density setting | > 0.7 g/cm³ | | ☐ Passed<br>☐ Failed |
| Switching delay uncovered to covered | 0.5 s | | ☐ Passed<br>☐ Failed |
| Switching delay covered to uncovered | 1 s | | ☐ Passed<br>☐ Failed |
| Corrosion warning | On | | ☐ Passed<br>☐ Failed |

## 8.3 Recommendation for preventing systematic errors

| Systematic fault<br>Installation/commissioning | Preventive measure | Comment |
|---|---|---|
| Incorrect switch point for versions with pipe extension and sliding sleeve | Mark position of the pipe extension in the sliding sleeve and secure position with suitable measures. | |
| Installation | See installation (TI, BA etc.) | Do not install in dead legs. |
| Loop integrity; power supply | ▪ Use Heartbeat Monitoring loop diagnostics to identify potential faults in advance.<br>▪ Diagnostic message NE107 (maintenance required)<br>▪ Traceable Heartbeat Verification result: Passed/Failed | Heartbeat Monitoring loop diagnostics must be activated and configured during commissioning to record the current/voltage characteristic |
| | Current loop test<br>Simulation of output current, e.g. 4-8-12-16-20-3.6 mA via simulation | Simulation. The safety function must be bypassed. |
| Incorrect parameter settings | Use the Safety mode wizard to confirm safety-relevant parameter settings, store CRC, and activate write protection. | CRC is a checksum for all safety-related parameter settings (e.g. MIN/MAX safety function, density setting, alarm current, etc.) |

| Systematic fault Installation/commissioning | Preventive measure | Comment |
|---|---|---|
| | Confirm and archive CRC. | |
| Verification of the safety function | Proof test: Test sequence A | For test sequence A, the level must be reached in order to switch to demand mode. |
| | Proof test: Test sequence B/C + confirmation of function under process conditions | Installation, switching function under process conditions |
| Define possible frequency range for the application. | Use the Heart Type Monitoring process window. | Heartbeat Monitoring process window must be activated and configured:<br>▪ For MAX: Compare with factory-set frequency or frequency recorded during commissioning<br>▪ For MIN: Compare with configured value (depending on the density of the medium) |

| Application-specific systematic faults | Diagnostic with alarm message | Preventive measures | Comment |
|---|---|---|---|
| Process connection blocked | ▪ MAX: no diagnostic<br>▪ MIN: no diagnostic | Proof test: Test sequence A | Fork not covered with medium |
| Abrasion, corrosion and/or damaged coating of the fork | ▪ MAX: at +6.5 % of oscillation frequency on delivery)<br>▪ MIN: no diagnostic | For MIN and MAX<br>▪ Heartbeat Monitoring process window must be activated and configured<br>▪ Diagnostic message NE107 (maintenance required)<br>▪ Traceable Heartbeat Verification result: Passed/ Failed | In the Heartbeat Monitoring process window, the actual frequency is compared with the configured frequency range. |
| Pitting corrosion | ▪ MAX: no diagnostic<br>▪ MIN: no diagnostic | Visual inspection | |
| Mechanical deformation of the fork | ▪ MAX: at +6.5 % of oscillation frequency on delivery)<br>▪ MIN: no diagnostic | For MIN and MAX<br>▪ Heartbeat Monitoring process window must be activated and configured<br>▪ Diagnostic message NE107 (maintenance required)<br>▪ Traceable Heartbeat Verification result: Passed/ Failed | In the Heartbeat Monitoring process window, the actual frequency is compared with the configured frequency range. |
| Oscillating element blocked, material build-up between fork arms | ▪ MAX: no diagnostic<br>▪ MIN: no diagnostic | For MIN and MAX<br>▪ Heartbeat Monitoring process window must be activated and configured<br>▪ Diagnostic message NE107 (maintenance required)<br>▪ Traceable Heartbeat Verification result: Passed/ Failed | In the Heartbeat Monitoring process window, the actual frequency is compared with the configured frequency range. |
| Malfunction due to external resonances (e.g. high flow velocities) | ▪ MAX: at +6.5 % of oscillation frequency on delivery)<br>▪ MIN: no diagnostic | For MIN and MAX<br>▪ Heartbeat Monitoring process window must be activated and configured<br>▪ Diagnostic message NE107 (maintenance required)<br>▪ Traceable Heartbeat Verification result: Passed/ Failed | If a strong frequency from an external source overlaps with the frequency of the vibrating fork, unintentional switching may occur sporadically. |
| Crack formation due to vibrations in the extension pipe | ▪ MAX: no diagnostic<br>▪ MIN: no diagnostic | Visual inspection | |

| Application-specific systematic faults | Diagnostic with alarm message | Preventive measures | Comment |
|---|---|---|---|
| Deposit buildup, encrustations, or residues on the sensor element | ▪ MAX: no diagnostic<br>▪ MIN: no diagnostic | For MIN and MAX<br>▪ Heartbeat Monitoring process window must be activated and configured<br>▪ Diagnostic message NE107 (maintenance required)<br>▪ Traceable Heartbeat Verification result: Passed/ Failed | In the Heartbeat Monitoring process window, the actual frequency is compared with the configured frequency range. |
| Foam formation at high density | ▪ MAX: no diagnostic<br>▪ MIN: no diagnostic | For MIN and MAX<br>▪ Heartbeat Monitoring process window must be activated and configured<br>▪ Diagnostic message NE107 (maintenance required)<br>▪ Traceable Heartbeat Verification result: Passed/ Failed | In the Heartbeat Monitoring process window, the actual frequency is compared with the configured frequency range. |
| ▪ Moisture in the electronics compartment<br>▪ Moisture in the housing due to a defective cable gland<br>▪ Corrosive atmosphere | ▪ MAX: no diagnostic<br>▪ MIN: no diagnostic | Visual inspection | Check the cable gland, housing cover and terminal block. |
| Circuit<br>▪ Increased contact resistances<br>▪ Changes in the power circuit due to leak currents and/or faulty power supply | Undervoltage: NE107 fault diagnosis if terminal voltage falls below the threshold value | ▪ Heartbeat Monitoring loop diagnostics must be activated and configured.<br>▪ Diagnostic message NE107 (maintenance required)<br>▪ Traceable Heartbeat Verification result: Passed/ Failed | |
| | | Current loop test<br>Simulation of output current, e.g. 4-8-12-16-20 mA via simulation | Process interruption required; safety function must be bypassed. |

## 8.4 Version history

**FY01091F; Version 02.25**
- Firmware version: from 01.00.zz (zz: any double number)
- Hardware version: from 01.00.ww (ww: any double number)
- Changes:
  - Adjustment of diagnostic test interval
  - Addition of systematic faults/Heartbeat Technology

**FY01091F; Version 01.23**
- Firmware version: from 01.01.zz (zz: any double number)
- Hardware version: from 01.00.ww (ww: any double number)
- Changes:
  First version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