FY01074F/00/EN/02.23-00
71623893
2023-07-03

01.00.zz (Device firmware)

Functional Safety Manual
Solicap M FTI55

Capacitance level measurement for bulk solids

Endress+Hauser
People for Process Automation

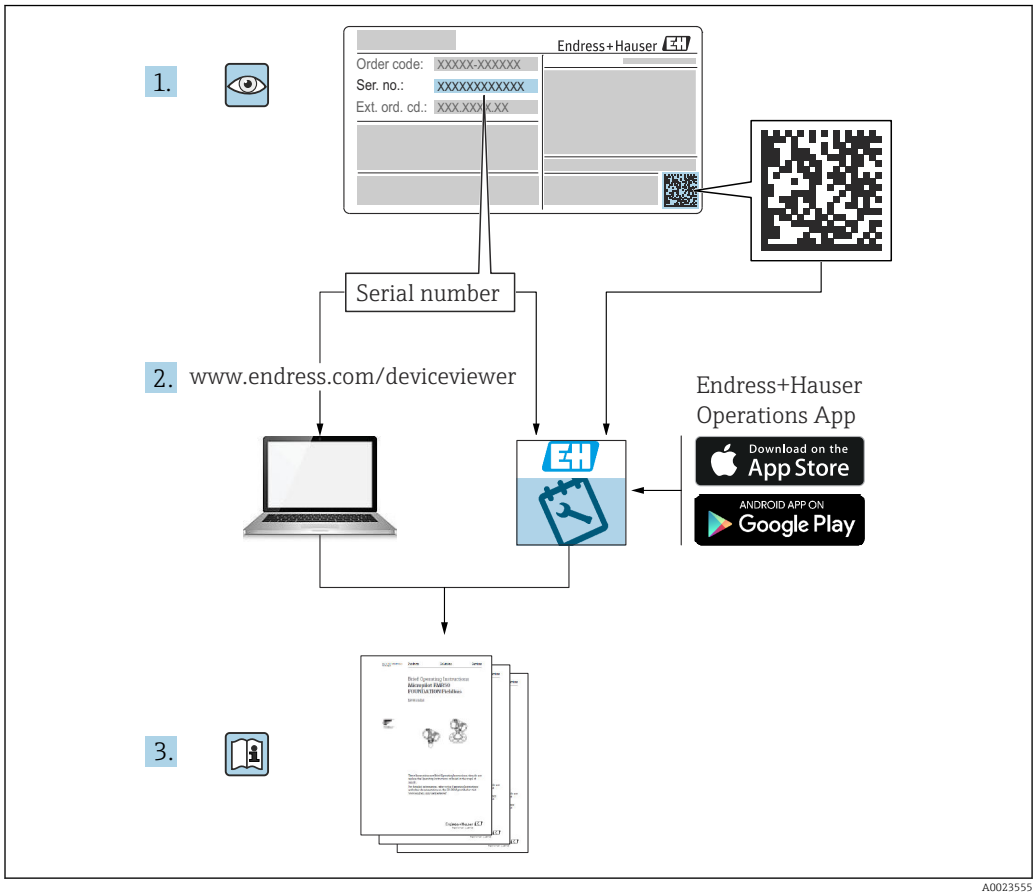

1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX XXX XX
Serial number
2. www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the App Store
ANDROID APP ON Google Play
3.
A0023555

Table of contents

1 Declaration of conformity

SIL_00498_02.23

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

Solicap M FTI5x

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, April 19, 2023
Endress+Hauser SE+Co. KG

i. V.

E-SIGNED by Thorsten Springmann
on 20 April 2023 15:14:17 GMT

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

i. V.

E-SIGNED by Manfred Hammer
on 20 April 2023 15:12:38 GMT

Manfred Hammer
Dept. Man. R&D Quality Management/FSM
Research & Development

A0050489

1.1 Safety-related characteristic values

SIL_00498_02.23

Endress+Hauser
People for Process Automation

General			
Device designation and permissible types [1]	Solicap M FTI5x * * * * *** F,5 * * 1 F		
	x = 5, 6		
Safety-related output signal	8 / 16 mA		
Fault signal	≤ 3.6 mA / ≥ 21 mA		
Process variable/function	Level switch for bulk solids		
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	02.01.ww (ww: any double number)		
Valid software version	02.00.zz (zz: any double number)		
Safety manual	FTI55: FY01074F / FTI56: FY01075F		
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 Nord 44 799 13761309		
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
λ_{DU} [2),3)]	45 FIT	36 FIT	/
λ_{DD} [2),3)]	363 FIT	221 FIT	/
λ_S [2),3)]	73 FIT	223 FIT	/
SFF	91%	93%	/
PFD_{avg} (T_1 = 1 year)[3)] (single channel architecture)	$1.97 \cdot 10^{-4}$	$1.58 \cdot 10^{-4}$	/
PFH	/	/	/
PTC [4)] A / B / C	98% / 98% / 35%	98% / 98% / 35%	/
Diagnostic test interval [5)]	≤ 2 min	≤ 2 min	/
Fault reaction time [6)]	≤ 1 s	≤ 1 s	/

Comments
Safety function "MIN" not permitted for partially insulated probe types.

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

A0050490

2 About this document

2.1 Document function

This supplementary Safety Manual applies in addition to the Operating Instructions, Technical Information and ATEX 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 used

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 dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

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

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

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:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

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

2.3.1 Further applicable documents

- TI00418F
- BA00300F

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)

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

2.3.4 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.

2.3.5 Certificate

The associated certificate is available in the Endress+Hauser W@M 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

Fully insulated devices are permitted for MAX and MIN safety. Partially insulated devices are only permitted for MAX safety.

"FTI55"

Feature: 010 "Approval"
Version: all

Feature: 020 "Inactive length L3"
Version: all

Feature: 030 "Active length L1; insulation"
Version: all

Feature: 040 "Insulation, rod"
Version:
- 1; fully insulated PE, max. 80 °C (175 °F)
- 2; 75 mm L2, partially insulated PPS max. 180 °C (Ex max. 150 °C (300 °F))
- 3; 3 in in L2, partially insulated PPS, max. 180 °C (Ex max. 150 °C (300 °F))

Feature: 050 "Process connection"
Version: all

Feature: 060 "Electronics; output"
Version:
- 5: FEI55; 8/16 mA, 11 to 36 V_{DC}
- F: FEI55; 8/16 mA, 11 to 36 V_{DC} + UK marking

Feature: 070 "Housing"
Version: all

Feature: 080 "Cable entry"
Version: all

Feature: 090 "Probe design"
Version: 1; compact

Feature: 100 "Additional options"
Version: F; SIL Declaration of Conformity

Feature: 995 "Marking"
Version: all

Applicable versions
- Firmware: from 02.00.zz (→ device nameplate)
- Hardware (electronics): from 02.00 (→ device nameplate)

3.2 Identification marking

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

3.3 Safety function

The device's safety functions are:
- Minimum point level detection (dry running protection, MIN detection)
- Maximum point level detection (overfill prevention, MAX detection)

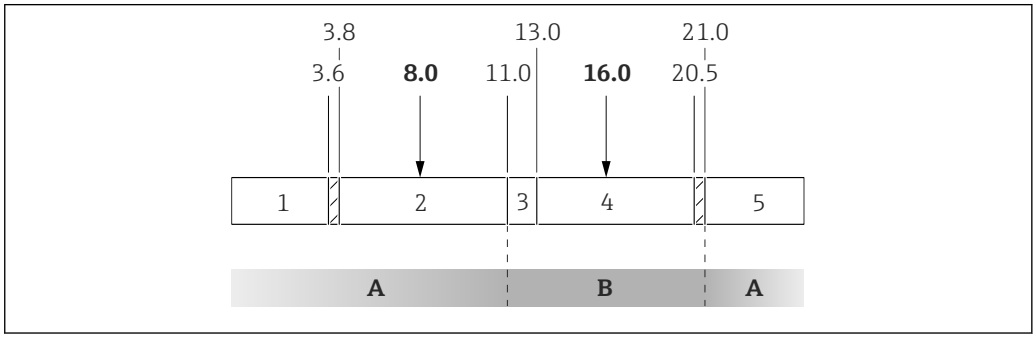
3.3.1 Activation of the safety function

For applications in bulk solids:

- ▶ Lock the device after calibration

3.3.2 Safety-related output signal

The device's safety-related signal is the switch signal: 8/16 mA. All safety measures refer to this output exclusively.



1 *Engineering unit: mA*

A Safe state
B Potentially dangerous range
1 Signal on alarm, lower current range (NE43)
2 Demand mode (nominal)
3 Switching range of the isolation amplifier to be guaranteed (12 ±1 mA)
4 Good state (nominal)
5 Signal on alarm, upper current range (NE43)

NOTICE

In an alarm condition

- ▶ Ensure that the equipment under control achieves or maintains a safe state.

3.3.3 Redundant configuration of multiple sensors

This section provides additional information regarding the use of homogeneously redundant sensors e.g. in a 1oo2 or 2oo3 architecture.

The device meets the requirements for SIL 3 in homogeneously redundant applications. The following common cause factors β and β_D can be used for the design:

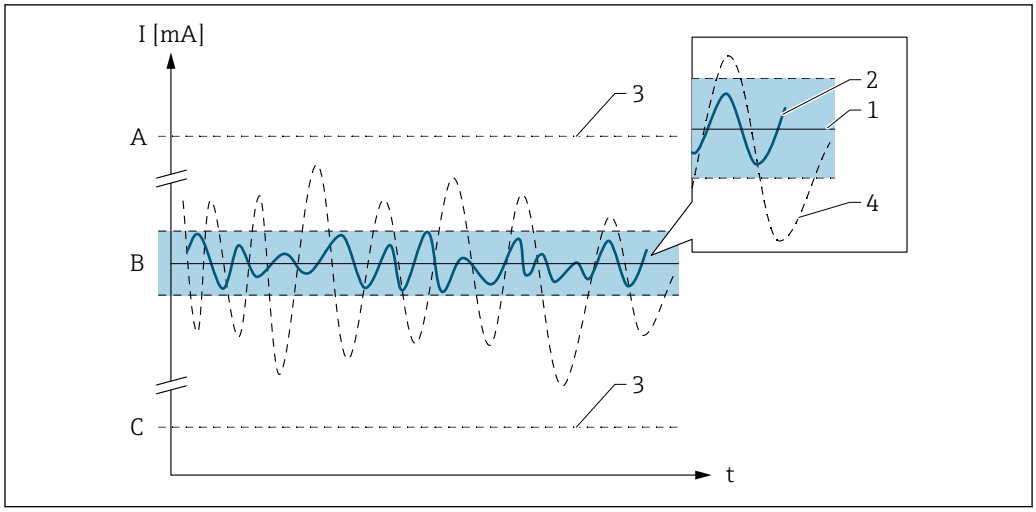
- β for homogeneously redundant use: 5 %
- β_D for homogeneously redundant use: 2 %

The system-specific analysis can produce other values depending on the specific installation and use of additional components.

3.4 Basic conditions for use in safety-related applications

The measuring system 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 Safety-related failures according to IEC / EN 61508



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

No device error
- No failure
- Implications for the safety-related output signal:
  None (1) and measuring uncertainty is within the specification (TI, BA, etc.)

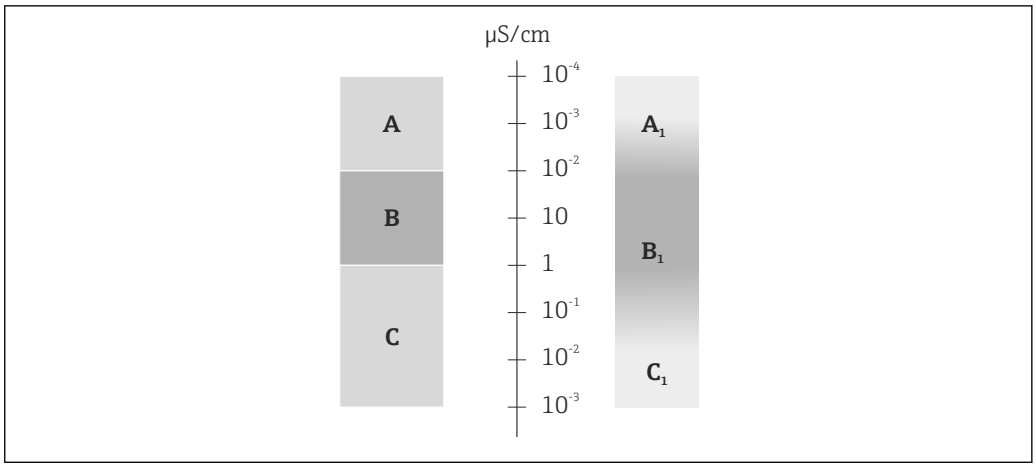
λ_S (Safe)
- Safe failure
- Implication for the safety-related output signal:
  The current measured value is output (2) or adopts the safe state (3) and measuring uncertainty is within the specified safety measured errors

λ_{DD} (dangerous detected)
- Dangerous but detectable failure
- Implication for the safety-related output signal:
  Results in a failure mode at the output signal (3) and the measuring uncertainty can exceed the specified safety measured error.

λ_{DU} (dangerous undetected)
- Dangerous and undetectable failure
- Implication for the safety-related output signal:
  The current measured value is output (4) and the measuring uncertainty can exceed the specified safety measured error.

3.4.2 Restrictions for safety-related use

The following restrictions also apply to safety-related use:
- In the event of the buildup of conductive deposits, observe the commissioning measures
- Heavy buildup (≥ 100 g/m) is not permitted in applications with vibrations/oscillations
- Check the resistance of parts in contact with the medium with regard to corrosion and diffusion
- Only compact versions are permitted
  Separate versions are not permitted due to the additional cable capacitance
- Overview of the permitted device types and device versions for the MIN or MAX safety modes
- The relative dielectric constant ε_r (relative permittivity) of the medium must be ≥ 2.5 or the changes in capacitance between empty and full calibration must be 10 pF.



2 *Conductivity [µs/cm]*

A The accuracy is independent of the conductivity and the ϵ_r
A_1 e.g.: Water-based liquids, aqueous solutions of salts, acids, alkalis, aqueous dispersions and emulsions, wastewater, electrolytes, beverages
B The accuracy depends on the ϵ_r and the conductivity of the medium. Measurement not recommended, therefore select another measuring principle
B_1 e.g.: Hydrocarbons with higher water content, demineralized water
C The measurement depends on the ϵ_r
C_1 e.g.: Hydrocarbon with a water content below 0.1 %, gasolines, oils, solvents

3.5 Dangerous undetected failures in this scenario

An incorrect output signal that deviates from the real measured value by more than 2 %, but is still at 8 mA, or at 16 mA depending on the configuration, is considered a dangerous, undetected failure.

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.

According to DIN EN 61508-2:2011 section 7.4.9.5 (national footnote N3) appropriate measures taken by the 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 performed by carrying out a test sequence as described in **Section 6 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

Calibration of the measuring point, see the Operating Instructions.

4.5.2 Configuration methods

Device configuration, see the Operating Instructions.

1. Carry out the configuration as described in the Operating Instructions
2. On completion of the configuration, set the device to the SIL mode
   ↳ The device is locked automatically
3. Perform a proof test after every new configuration

4.5.3 Unlocking a SIL device

To unlock a SIL device, see the Operating Instructions.

5 Operation

5.1 Device behavior during power-up

Device behavior during power-up, see the Operating Instructions.

5.2 Device behavior in safety function demand mode

For the device behavior in safety function demand mode, see the Operating Instructions.

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

5.3.1 Failure current

The failure current is permanently set to a value of ≤3.6 mA.

In some cases (e.g. signal cable short-circuit) in which it is not possible to set the failure current ≤3.6 mA, the signal on alarm "Upper current range (NE43)" is output.

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.

In addition, an LED flashes red cyclically to signal an error.

This signaling system provides additional diagnostic information and is not part of the safety-related output signal.

6 Proof testing

The safety-related functionality of the device in the SIL mode must be verified during commissioning, when changes are made to safety-related parameters, and also at appropriate time intervals. This enables this functionality to be verified within the entire 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.

Overview of the proof tests:

- Test sequence A: Approach the level in the original vessel
- Test sequence B: Remove the device and immerse it in a medium with comparable properties
- Test sequence C: Device self-test and level simulation. No change of level in the vessel is necessary for this sequence

Note the following for the test sequences:
- Test sequence C is not permitted for a commissioning test!
- The transmitter can be tested without a sensor using an appropriate sensor simulator (resistance decade, reference voltage source, etc.).
- The accuracy of the device used must meet the transmitter specifications.
- If both transmitter input channels are used, the test for the second sensor must be repeated accordingly.
- A three-point calibration must be performed when customized linearization (e.g. with CvD coefficients) is used. In addition, the Upper sensor limit and Lower sensor limit must be checked.

Recommendation: Check the probe rod for bending and other signs of substantial application of force!

NOTICE

Ensure correct device sealing!

▶ You must also check and ensure that all cover seals and cable entries are sealing correctly.

6.1 Test sequence A

Approach the level

6.1.1 MIN detection

Preparatory steps

1. Connect a suitable device to the current output (recommended accuracy better than ±0.1 mA).
2. Determine point level detection (see the Operating Instructions).

Proof testing procedure, Step 1

▶ Check the current at terminal 1.
  ↳ The current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 2

1. Lower the level so that the demand mode is expected.
2. Check the current at terminal 1.
   ↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 7.5 to 8.5 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 3

1. Raise the level so that the good state is expected.
2. Check the current at terminal 1.
   ↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

6.1.2 MAX detection

Preparatory steps

1. Connect a suitable device to the current output (recommended accuracy better than ±0.1 mA).
2. Determine point level detection (see the Operating Instructions).

Proof testing procedure, Step 1

▶ Check the current at terminal 1.
↳ The current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 2

1. Raise the level so that the demand mode is expected.
2. Check the current at terminal 1.
↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 7.5 to 8.5 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 3

1. Lower the level so that the good state is expected.
2. Check the current at terminal 1.
↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

6.2 Test sequence B

Remove and immerse in a medium of identical conductivity or dielectric constant

6.2.1 MIN detection

Preparatory steps

1. Prepare a test vessel with a medium (conductivity ≥100 µS/cm) and a suitable counterelectrode. For installation instructions, refer to the Operating Instructions.
2. Remove the device and mount it in the test vessel. Connect the functional ground!
3. Connect a suitable device to the current output (recommended accuracy better than ±0.1 mA).
4. Determine point level detection (see the Operating Instructions).

Proof testing procedure, Step 1

1. Where necessary, raise the level so that the good state is expected.
2. Check the current at terminal 1.
↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 2

1. Raise the level so that the demand mode is expected.
2. Check the current at terminal 1
   ↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 7.5 to 8.5 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 3

1. Lower the level so that the good state is expected.
2. Check the current at terminal 1.
   ↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

6.2.2 MAX detection

Preparatory steps

1. Prepare a test vessel with a medium (conductivity ≥100 µS/cm) and a suitable counterelectrode. For installation instructions, refer to the Operating Instructions.
2. Remove the device and mount it in the test vessel. Connect the functional ground!
3. Connect a suitable device to the current output (recommended accuracy better than ±0.1 mA).
4. Determine point level detection (see the Operating Instructions).

Proof testing procedure, Step 1

1. Where necessary, lower the level so that the good state is expected.
2. Check the current at terminal 1.
   ↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 2

1. Raise the level so that the demand mode is expected.
2. Check the current at terminal 1
   ↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 7.5 to 8.5 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 3

1. Lower the level so that the good state is expected.
2. Check the current at terminal 1.
   ↳ After a response time of approx. 0.3 to 0.5 s, the current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

6.3 Test sequence C

MIN and MAX detection

Preparatory steps

1. Connect a suitable device to the current output (recommended accuracy better than ±0.1 mA).
2. Determine point level detection (MIN or MAX detection, see the Operating Instructions).

Proof testing procedure, Step 1

- Check the current at terminal 1.
  - The current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 2

1. Turn the function switch to position 6.
2. Press the "-" and "+" keys simultaneously for 2 s.
   - When LED 5 starts flashing, this indicates that proof testing has commenced.
3. Check the current at terminal 1.
   - After 10 s (plus a response time of approx. 10 s), the current must be between 7.5 to 8.5 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

Proof testing procedure, Step 3

1. Turn the function switch back to position 1.
2. Check the current at terminal 1.
   - After a response time of approx. 0.3 to 0.5 s, the current must be between 15.2 to 16.8 mA.

If the current is outside the specified tolerance, a fault has occurred in the safety path. The proof test has not been passed and must be aborted.

This test sequence does not test the probe rod and the electrical coupling of the probe. Take a proof test coverage of 35 % into consideration.

6.4 Verification criterion

If one of the test criteria from the test sequences described above is not fulfilled, 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 (λ_{DU}).
- This test does not cover the impact of systematic faults on the safety function, which must be assessed separately.
- Systematic faults can be caused, for example, by process material properties, operating conditions, build-up or corrosion.
- As part of the visual inspection, for example, 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 for this purpose.

Document the repair with the following information:
- 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 to SIL devices by the user are not permitted as they can impair the functional safety of the device**
- Modifications to SIL devices on site at the user's plant are possible following approval by the Endress+Hauser manufacturing center
- Modifications to SIL devices must be performed by staff who have been authorized to perform this work by Endress+Hauser
- Only **original spare parts** from Endress+Hauser must be used for modifications
- All modifications must be documented in the Endress+Hauser W@M Device Viewer
- All modifications require a modification nameplate or the 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 Endress+Hauser for disposal under the applicable conditions.

7.6 Battery disposal

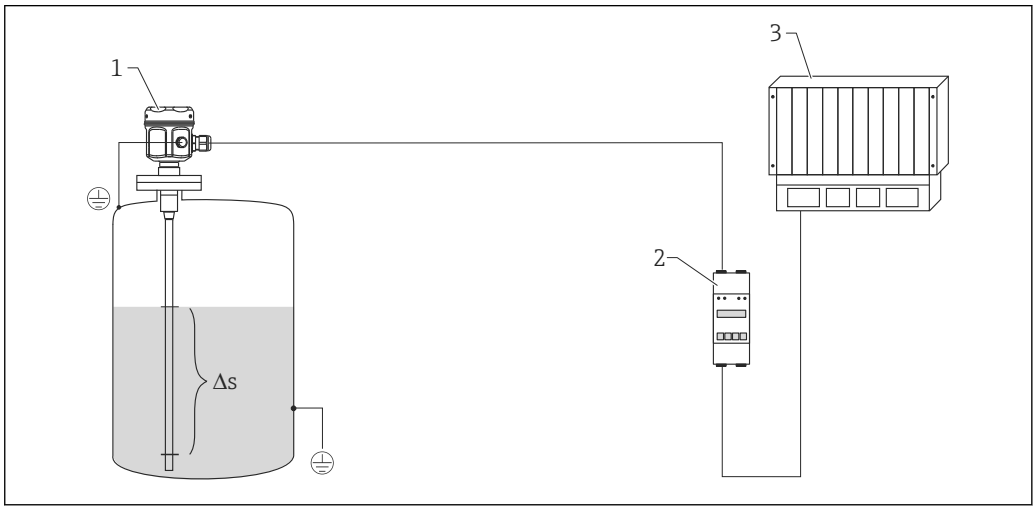
- In some countries, the end user is legally obliged to return used batteries.
- The end user can return old batteries or electronic assemblies containing these batteries free of charge to Endress+Hauser.

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



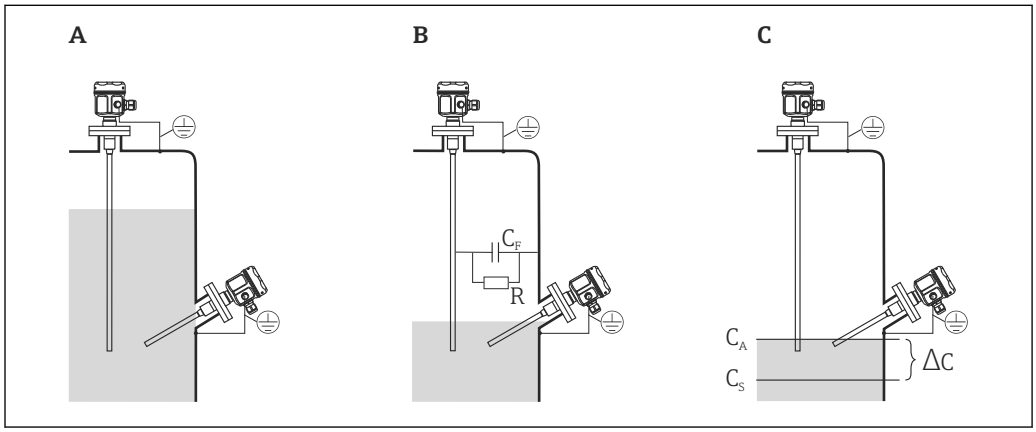
3 Example: remote operation via HART protocol

1 Device with electronic insert FEI55
2 Active barrier (optional)
3 PLC (or similar)

A switch signal (8/16 mA) that depends on the level is generated in the device. This signal is sent to a downstream logic unit (e.g. PLC, limit signal transmitter, etc.) where it is monitored to determine whether it is below or above a specified limit value.

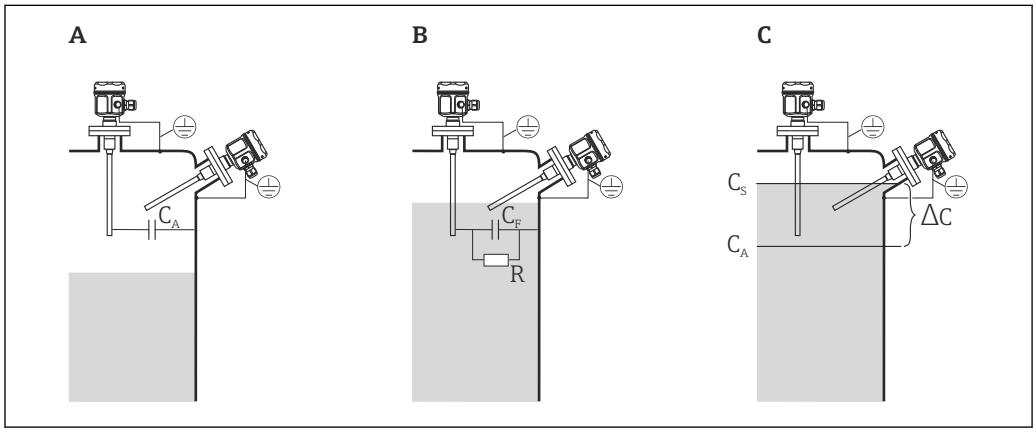
For fault monitoring, the logic unit must be able to detect both HI alarms (≥ 21.0 mA) and LO alarms (≤ 3.6 mA).

8.1.2 Description of use as a safety instrumented system



4 *Typical measuring arrangement for minimum point level detection in safety instrumented systems*

A Covered
B Covered (switch point not yet reached)
C Free (switch point reached)
R Conductivity of bulk solids
C_F Capacitance of bulk solids
C_A Initial capacitance (probe covered)
C_S Switching capacitance
ΔC Change in capacitance



5 *Typical measuring arrangement for maximum point level detection in safety instrumented systems*

A Not covered
B Covered (switch point not yet reached)
C Covered (switch point reached)
R Conductivity of bulk solids
C_F Capacitance of bulk solids
C_A Initial capacitance (probe free)
C_S Switching capacitance
ΔC Change in capacitance

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

The principle of capacitance point level detection is based on the change in capacitance of a capacitor as a result of the probe being covered by bulk solids or liquid. The probe and vessel wall (conductive material) form an electric capacitor. When the probe is in air, a certain low initial capacitance is measured. When the vessel is filled, the capacitance of the capacitor increases as more of the probe is covered.

The limit switch switches when the switching capacitance specified in the calibration:
- is undershot in the minimum point level detection mode
- is exceeded in the maximum point level detection 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
Facility
Device tag
Device name/Order code
Serial number

Test information
Company/contact person
Performed by
Date/time
Inspector

Verification result	
Overall result	
☐ Passed ☑	☐ Failed ☒

Comment

Date Signature Signature of tester

8.2.2 Test Report - Page 2 -

Device information
Facility
Device tag
Device name/Order code
Serial number

Type of safety function
☐ MIN detection
☐ MAX detection

Commissioning parameters
Test medium, conductivity and Er if necessary
Measuring range [pF]
Switching delay [s]
Empty/full calibration
Switchpoint adjustment [pF]

Proof testing
☐ Test sequence A, MIN detection
☐ Test sequence A, MAX detection
☐ Test sequence B, MIN detection
☐ Test sequence B, MIN detection
☐ Test sequence C, simulation with "Self-test" function switch

Terminal 1, check current			
Test step	**Target value**	**Actual value**	**Result**
Step 1	15.2 to 16.8 mA		☐ Passed ☐ Failed
Step 2	7.5 to 8.5 mA		☐ Passed ☐ Failed
Step 3	15.2 to 16.8 mA		☐ Passed ☐ Failed ☐ Not applicable

8.3 Version history

FY01074F; version 01.22

- Firmware version: 02.00.zz (zz: any double number)
- Hardware version: from 02.00 (→ device nameplate)
- Changes: certificate renewed
- Predecessor: SD00278F
  Liquicap M FTI51/52, Solicap M FTI 55/56, Solicap S FTI77

www.addresses.endress.com

Endress+Hauser

People for Process Automation