FY01043F/00/EN/01.21
71538893
2021-08-02

01.00.01 (Device firmware)

Functional Safety Manual
Deltapilot M FMB50

Hydrostatic

Endress+Hauser
People for Process Automation

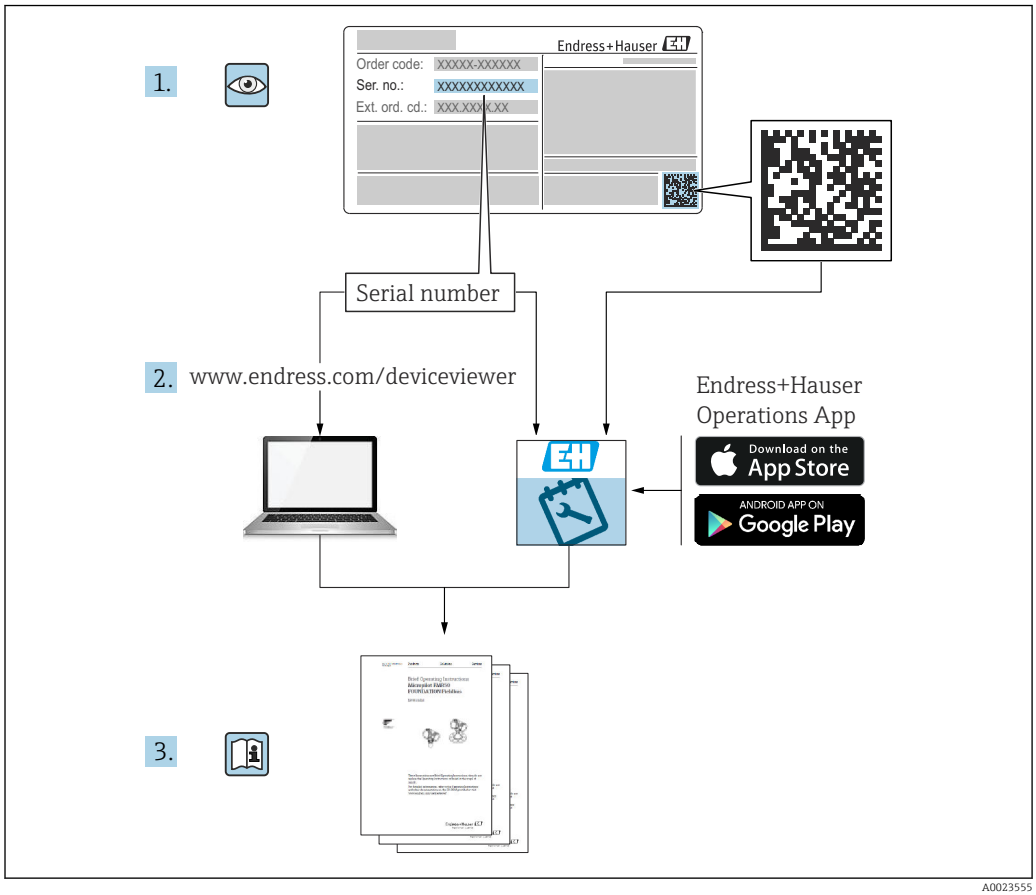
1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX XXX XX XX
Serial number
2. www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the App Store
ANDROID APP ON Google Play
3.
A0023555

Table of contents

1 Declaration of conformity

SIL_00447_01.21

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

Deltapilot M FMB50 (4-20 mA HART)

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 compliance is exclusively valid for the listed products and accessories in delivery status.

Maulburg, 05/19/2021
Endress+Hauser SE+Co. KG

i. V.

Marc Schlachter
Dept. Man. R&D Devices Pressure
Research & Development

i. V.

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

Template: D050-3_Declaration of Conformity (SIL).docx, E+H LP Version 2.0 (DWP), Valid from 23.03.2021

1/2

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1.1 Safety-related characteristic values

SIL_00447_01.21

Endress+Hauser
People for Process Automation

General			
Device designation and permissible types [1]	FMB50-## 2 # # # ## # # ### # # # + LA		
Safety-related output signal	4...20 mA		
Fault signal	≤ 3,6 mA ; ≥ 21 mA		
Process variable/function	Level, volume or mass measurements in liquids		
Safety function(s)	MIN , MAX , Range		
Device type acc. to IEC 61508-2	☐ Type A	☒ Type B	
Operating mode	☒ Low Demand Mode	☒ High Demand Mode	☐ Continuous Mode
Valid hardware version	as of 02.00.00		
Valid software version	as of 01.00.01		
Safety manual	FY01043P		
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 CERT GmbH Essen 44 799 13761310		
Test documents	Development documents	Test reports	Data sheets

SIL - Integrity			
Systematic safety integrity		☒ SIL 2 capable	☐ SIL 3 capable
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)]	100 FIT	100 FIT	100 FIT
λ_{DD} [2),3)]	118 FIT	118 FIT	118 FIT
λ_{SU} [2),3)]	337 FIT	337 FIT	337 FIT
λ_{SD} [2),3)]	194 FIT	194 FIT	194 FIT
SFF	86.6 %	86.6 %	86.6 %
PFD_{avg} (T_1 = 1 year) [3)] (single channel architecture)	4.4×10^{-4}	4.4×10^{-4}	4.4×10^{-4}
PFH	1.0×10^{-7} 1/h	1.0×10^{-7} 1/h	1.0×10^{-7} 1/h
PTC [4)]	A: 50 % / B: 99 %	A: 50 % / B: 99 %	A: 50 % / B: 99 %
λ_{total} [2,3)]	749 FIT	749 FIT	749 FIT
Diagnostic test interval [5)]	5 min (RAM,ROM...), 1 s (Measurement)	5 min (RAM,ROM...), 1 s (Measurement)	5 min (RAM,ROM...), 1 s (Measurement)
Fault reaction time [6)]	5 min (RAM,ROM...), 10 s (Measurement)	5 min (RAM,ROM...), 10 s (Measurement)	5 min (RAM,ROM...), 10 s (Measurement)

Comments
–

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

Template: D050-3_Declaration of Conformity (SIL).docx, E+H LP Version 2.0 (DWP), Valid from 23.03.2021

2/2

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2 Document information

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

- TI00437P
- BA00382P
- KA001033P

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 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 Certificate

The associated certificate is available in the Endress+Hauser W@M Device Viewer or can be found in the declaration of conformity 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 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

Deltapilot M FMB50

Feature: 010 "Approval"
Version: all

Feature: 020 "Output"
Version: 2; 4-20 mA HART

Feature: 030 "Display; operation"
Version: all

Feature: 040 "Housing"
Version: all

Feature: 050 "Electrical connection"
Version: all

Feature: 070 "Sensor range"
Version: all

Feature: 080 "Reference accuracy"
Version: all

Feature: 090 "Calibration; unit"
Version: all

Feature: 110 "Process connection"
Version: all

Feature: 170 "Membrane material"
Version: all except L

Feature: 180 "Fill fluid"
Version: all

Feature: 190 "Seal"
Version: all

Feature: 570 "Service"
Version: all except IB

Feature: 590 "Additional approval"
Version: LA; SIL
Version **"LA"** must be selected for use as a safety function in accordance with IEC 61508.

Feature: 600 "Separate housing"
Version: none permitted

Feature: 610 "Accessory mounted"
Version: none permitted

Valid firmware version: 01.00.01

Valid hardware version (electronics): 02.00.ww (ww: any double digit)

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:
- Hydrostatic pressure measurement in liquids and paste-like media in all areas of process engineering, process measuring technology, pharmaceuticals and the food industry
- Level, volume or mass measurements in liquids

3.3.1 Safety-related output signal

The device's safety-related signal is the analog output signal 4 to 20 mA as per NAMUR NE43. All safety measures refer to this signal exclusively. In addition, the device also communicates via HART® for information purposes and comprises all the HART® features with additional device information. HART® communication is not part of the safety function. The safety-related output signal is fed to a downstream logic unit, e.g. a programmable logic controller or a limit signal transmitter, where it is monitored to determine whether:
- it exceeds and/or drops below a predefined limit value
- a fault has occurred, e.g. failure current (≤ 3.6 mA, ≥ 21.0 mA, signal cable disconnection or short-circuit).

NOTICE

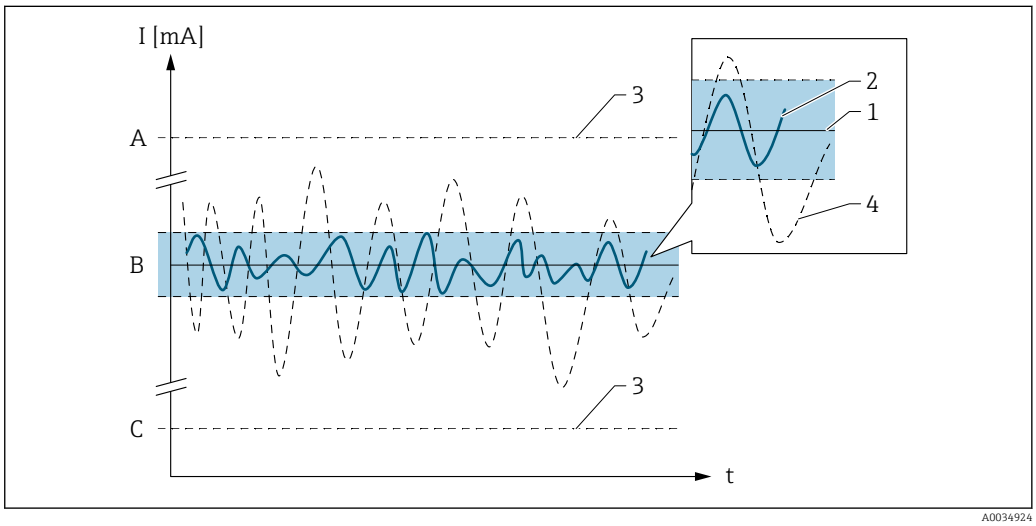
In an alarm condition

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

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 present
- No impact on the safety-related output signal
- Impact on the measuring uncertainty:
  1 - Is within the specification (TI, BA, ...)

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

λ_{DD} (dangerous detected)
- Dangerous but detectable failure
- Impact on the safety-related output signal: results in a failure mode at the output signal
- Impact on the measuring uncertainty:
  3 – Has no effect

λ_{DU} (dangerous undetected)
- Dangerous and undetectable failure
- Impact on the safety-related output signal: may be outside the defined error range **B**
- Impact on the measuring uncertainty:
  4 – May be outside the defined error range **B**

3.4.2 Safety measured error

The total deviations with regard to the safety-related current output are composed of:
- Measured errors under reference operating conditions: as per Technical Information.
- Measured errors due to process/installation/ambient conditions: as per Technical Information
- Measured errors due to ambient conditions (EMC): ±0.5 % based on the span of the safety-related current output
  Strong, pulse-like EMC interference on the power supply line can result in transient (< 1 s) deviations in the output signal (≥ ±1 % based on the span of the safety related current output). Therefore, filtering with a time constant ≥ 1 s should be performed in the downstream logic unit.
- Measured errors due to random component failures (SIL error range): ±2 % based on the span of the safety-related current output

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 in the range of 4 to 20 mA.

3.6 Service life 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 Adjustment of the measuring point

For further information, see the Operating Instructions.

4.5.2 Configuration methods

Parameter configuration via local operation

1. Reset parameters to factory setting: reset code "7864" (associated Operating Instructions, "Resetting to factory setting (reset)" section). Check default values, number formats and parameter descriptions with the "Device parameter configuration form".

After this reset, the following operating steps may no longer be performed:
- Position adjustment or onsite configuration of measuring range without local display
- Download
- Reset, except for reset code "7864"
- Current trim
- Sensor trim
- Setting of "Measuring mode" parameter to "Level" and "Level selection" parameter to "In height".

2. Configure the device parameters and keep a manual log of the settings. For parameter configuration, see the associated Operating Instructions. Switch the device off and on again. This ensures that the parameter settings have been saved.

Observe the prescribed parameters in accordance with the "Device parameter configuration form". The permitted parameter settings must also be taken into account (→ 14).

3. If necessary, check the safety functions ("Proof test" section).
4. Read out the prescribed parameters and compare them to the "Device parameter configuration form".
5. Lock the device for the safe measuring mode via the software and/or hardware (see associated Operating Instructions).
6. Read out and document the "Config. counter" parameter (menu path: Expert → Diagnosis → Config. counter).

Parameter configuration via Field Communicator 375/475 handheld terminal

1. Go to "Main Menu" → "HART Communication" → "HART-Application" → "Online". The device is then found automatically and opened online. Ensure that the device bus address = 0.
2. Ensure that the connection has been made with the correct device. This can be done using the "Measuring point" parameter, the extended order number or the serial number.
3. Reset parameters to factory setting: reset code "7864" (associated Operating Instructions, "Resetting to factory setting (reset)" section). Check default values, number formats and parameter descriptions with the "Device parameter configuration report".

After this reset, the following operating steps may no longer be performed:
- Position adjustment or onsite configuration of measuring range without local display
- Download
- Reset, except for reset code "7864"
- Current trim
- Sensor trim
- Setting of "Measuring mode" parameter to "Level" and "Level selection" parameter to "In height".

4. Configure the device parameters and keep a manual log of the settings. For parameter configuration, see the associated Operating Instructions. Switch the device off and on again. This ensures that the parameter settings have been saved. Close the application on the handheld terminal. After switching on and off again, re-establish the connection between the device and the handheld terminal (see step 1).

Observe the prescribed parameters in accordance with the "Device parameter configuration form". The permitted parameter settings must also be taken into account (→ 14).

5. If necessary, check the safety functions.
6. Read out the prescribed parameters and compare them to the "Device parameter configuration form".
7. Lock the device for the safe measuring mode via the software and/or hardware (see associated Operating Instructions).
8. Read out and document the "Config. counter" parameter (menu path: Expert → Diagnosis → Config. counter).

The "Offline" operating function is not permitted for the configuration of an application with functional safety. Please note that messages such as "Device disconnected" do not appear during parameter configuration.

Parameter configuration via FieldCare operating program

1. The connection can be established in the following two ways: 1) Select the "HART Communication" connection wizard. The device will then be found automatically and opened online. Ensure that the device bus address = 0. 2) In the tree structure, select "Create projects" → "Add device" → "HART communication" and then select "Create network". The device is opened online. Ensure that the device bus address = 0.
2. Ensure that the connection has been made with the correct device. This can be done using the "Measuring point" parameter, the extended order number or the serial number.
3. Reset parameters to factory setting: reset code "7864" (associated Operating Instructions, "Resetting to factory setting (reset)" section). Check default values, number formats and parameter descriptions with the "Device parameter configuration form".

After this reset, the following operating steps may no longer be performed:
- Position adjustment or onsite configuration of measuring range without local display
- Download
- Reset, except for reset code "7864"
- Current trim
- Sensor trim
- Setting of "Measuring mode" parameter to "Level" and "Level selection" parameter to "In height".

4. Configure the device parameters and keep a manual log of the settings. For parameter configuration, see the associated Operating Instructions. Switch the device off and on again. This ensures that the parameter settings have been saved. Close FieldCare. After switching the device off and on again and closing FieldCare, re-establish the connection between the device and FieldCare.

Observe the prescribed parameters in accordance with the "Device parameter configuration form". The permitted parameter settings must also be taken into account (→ 14).

5. If necessary, check the safety functions.

6. Read out the prescribed parameters and compare them to the "Device parameter configuration form".
7. Lock the device for the safe measuring mode via the software and/or hardware (see associated Operating Instructions).
8. Read out and document the "Config. counter" parameter (menu path: Expert → Diagnosis → Config. counter).

- The "Offline" operating function and FDT-Up-Download are not permitted for the configuration of an application with functional safety.
- Note the status during entry and display of the parameters. This is clarified by icons/symobols and refers to possible errors during parameter entry, when updating parameters and when connecting to the device. More information can be found in the FieldCare help.

4.5.3 Locking/unlocking a SIL device

WARNING

A change in the measuring system or in the parameters may compromise the safety function.

▶ After entering all of the parameters and checking the safety function, lock the device operation (see the "Locking/unlocking operation" section in the associated Operating Instructions).

- The damping setting via DIP switch 2 (damping: on/off) is independent of software and/or hardware locking. The switch position must therefore comply with the factory setting: on (damping on). The damping value can be set to 0 s if necessary.
- The setting of the current behavior in case of alarm via DIP switch 3 (alarm current: SW/Alarm min) is independent of software and/or hardware locking. The switch position must therefore comply with the "SW" factory setting.

4.6 Parameter and default settings for the SIL mode

Only certain settings are permitted for some parameters. If the setting of one of these parameters is not a permitted setting, safe operation of the device is no longer guaranteed.

Expert → Output → Current output
- Output fail mode = Max. alarm or Min. alarm [1)]
- Alarm behav. P = Alarm
- High alarm curr. = 22 mA
- Set min. current = < 3.8 mA
- Startcurrent = 12 mA

Expert → Communication → HART Config.
- Current mode = signaling
- Bus address = 0

Expert → Diagnosis → Simulation
Simulation mode = none

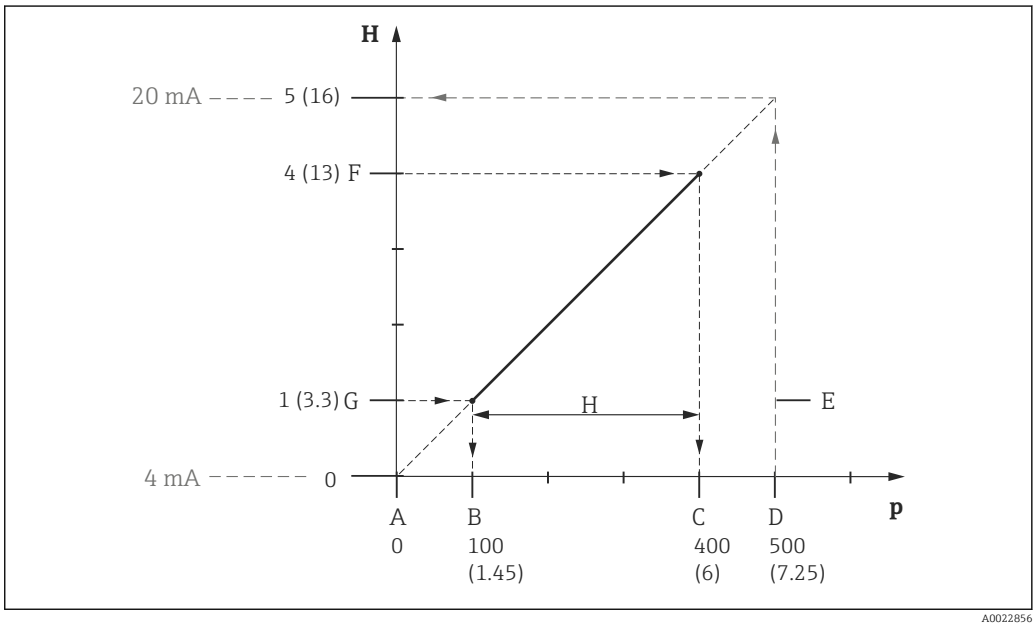
1) "Min. Alarm" can also be selected via DIP switch. It is then no longer possible to select "SW".

Expert → Measurement → Level
"Level" measuring mode, "In pressure" level selection: The "Empty pressure", "Full pressure", "Empty calib." and "Full calib." parameters must satisfy the following conditions:
- The pressure values for "Empty pressure" and "Full pressure" must be within the measuring range of the sensor. → following graphic, F + G.
- The turndown, determined by the difference between the pressure values for "Empty pressure" and "Full pressure", must not exceed the maximum recommended turndown of 10:1. This corresponds to 10 % of the nominal range of the sensor. → following graphic, B + C.

Expert → Measurement → Level
"Level" measuring mode, "In pressure" level selection: "Adjust density" (034):
Same value as "Process density" (035)

Example 500 mbar (7.25 psi) - measuring cell

The adjustment was performed correctly.



A Pressure value for 4 mA = "LRL sensor"
B "Empty pressure"
C "Full pressure"
D Pressure value 20 mA = "URL sensor"
E Measuring range of sensor
F "Full calib."
G "Empty calib."
H Set span
Y Height in m (ft)
X Pressure in mbar (psi)

- If the device is in a fault state, i.e. an alarm is output and the current output assumes the set value, the cause of the fault must first be eliminated.
- A sensor trim should only be performed by Endress+Hauser Service. All parameters, except for the parameters for a sensor trim, are reset by reset code "7864". The parameters must therefore be checked prior to locking.

4.6.1 Inspection

⚠ CAUTION

A change in the measuring system or in the parameters may compromise the safety function.

- ▶ Once all of the parameters have been entered, the safety function must be checked before performing the locking sequence! This can be done, for example, via the "Simulation" parameter or by approaching the limit pressure (see the parameter description for "Simulation" in the associated Operating Instructions).
- ▶ When the device is part of a safety function, the entire safety function must be checked following any change to the device, e.g. a change in the orientation of the device or the parameter configuration.

5 Operation

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

Internal device errors result in a failure current at the analog output.

Depending on the setting/order specifications, the failure current can be set to HI alarm (21 to 23 mA) or LO alarm (≤ 3.6 mA).

In the event of a fault, there is also the "Hold" option for the analog output, which ensures that the actual current value is maintained in the event of a fault. In addition, the current output can be permanently set to 4 mA via "Current mode" = "fixed".

⚠ CAUTION

The following settings do not guarantee a failsafe alarm.
These settings are not permitted for safety-related use!

- ▶ "Output fail mode" = "Hold" (menu path: Expert > Output > Current output > Output fail mode)
- ▶ "Current mode" = "fixed" (menu path: Expert > Communication > HART Config. > Current mode)

The current output in the event of an alarm is configured via the "Output fail mode" (factory setting as per order specifications) and "High alarm curr." (factory setting: 22 mA) parameters. The following values are permitted:

Output fail mode [1]	Current value in the event of a fault
Min. alarm (LO alarm)	≤ 3.6 mA
Max. alarm (HI alarm) [2]	Can be configured via "High alarm curr." = 22 mA

1) Can alternatively be adjusted via DIP switch 3 "SW/Alarm min"
2) DIP switch 3 "SW/Alarm min" must be set to "SW"

- The selected alarm current cannot be guaranteed for all possible fault situations (e.g. cable open circuit). However, a fault response in accordance with NE 43 (≤ 3.6 mA or ≥ 21 mA) is guaranteed at all times.
- In cases such as a power supply failure or cable open circuit, output currents < 3.6 mA may be present (regardless of the current value selected in the event of faults).
- In cases such as short-circuit, output currents ≥ 23 mA may be present (regardless of the current value selected).
- Once the fault or failure has been eliminated, the 4 to 20 mA output signal can be regarded as safe after 10 s.

6 Proof test

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 protective system during the test.
- The operator specifies the testing interval and this must be taken into account when determining the probability of failure PFDavg 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), which can be used for calculation purposes, are specified for each of the test sequences described below.

If the device is in a fault state before the test commences, i.e. an alarm is output and the current output adopts the set value, the cause of the fault must first be eliminated.

6.1 Test sequence A

Proof-test procedure

1. Bypass safety PLC or take other suitable measures to prevent alarms from being triggered in error.
2. Disable lock (see the relevant Operating Instructions)
3. Set the current output of the transmitter to HI alarm via a HART command or the local display, and check if the analog current signal reaches this value (e.g. simulate an alarm via the "Simulation" and "Sim. error no." parameter). This test detects problems due to non-standard voltages (e.g. due to a loop current supply voltage that is too low or due to increased line resistance) and checks for possible failures in the transmitter electronics.
4. Set the current output of the transmitter to LO alarm via a HART command or the local display, and check if the analog current signal reaches this value (e.g. set "Output fail mode" parameter to "Min. alarm" or simulate an alarm via the "Simulation" or "Sim. error no." parameter). This test detects any faults associated with quiescent currents.
5. Restore the full functionality of the current loops.
6. Remove the bypass for the safety PLC or restore normal operation by some other means.
7. After the proof test has been carried out, the results must be documented and retained in a suitable manner.

This test reveals 50 % of dangerous undetected failures.

6.2 Test sequence B

Proof-test procedure

1. Carry out steps 1 to 4 of test sequence A.

2. Compare displayed pressure measured value with applied pressure and check current output. Appropriate procedures, measuring equipment and references must be used for this test. For the lower range value (4 mA value) and upper range value (20 mA value), compare the applied pressure with the measured pressure. If the measured pressure differs from the pressure applied to the device, the respective applied reference pressure must be reassigned to the 4 mAvalue and the 20 mA value. For the 4 mA value, see the parameter description for "Set LRV" and "Get LRV" in the relevant Operating Instructions. For the 20 mA value, see the parameter description for "Set URV" and "Get URV" in the relevant Operating Instructions. Compare displayed pressure measured value with applied pressure again and check current output. If they do not match, contact Endress+Hauser Service.
3. Carry out steps 5 to 7 of test sequence A.

This test reveals 99 % of dangerous undetected failures.

NOTICE

The current value is output correctly following this procedure. The displayed value, e.g. on the onsite display, and the digital value via HART may differ from the actual pressure applied.

▶ If the display value and the digital value need to be corrected too, contact Endress +Hauser Service.

6.3 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 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 specialist staff if original Endress +Hauser spare parts (which can be ordered by the end customer) are used, 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.
- Modifications to SIL devices may compromise the functional safety of the device and must be performed by personnel who have been authorized by Endress+Hauser to perform this work.
- Only original spare parts from Endress+Hauser may be used for alterations.
- All alterations must be documented in the W@M Device Viewer.
- All alterations 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

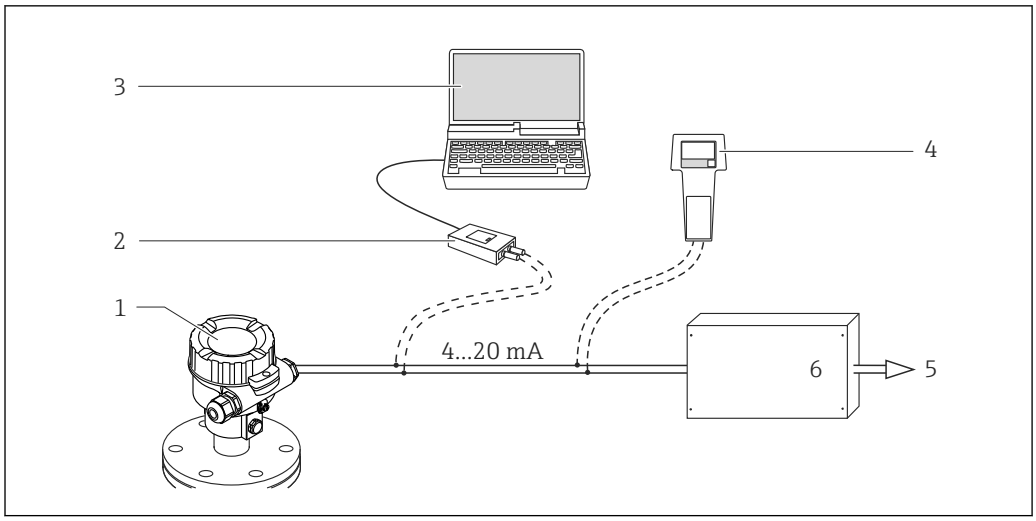
If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return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

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).



1 Pressure transmitter
2 Commubox FXA195
3 Computer with operating program, e.g. FieldCare
4 HART handheld terminal, e.g. Field Communicator 375, 475
5 Actuator
6 Logic unit, e.g. PLC, limit signal transmitter

The device generates an analog signal that is proportional to the pressure (≥ 3.8 to ≤ 20.5 mA). This signal is sent to a logic unit located downstream, e.g. a programmable logic controller or a limit signal transmitter, and monitored to determine whether:
- it exceeds or drops below a predefined value
- it is outside a range to be monitored
- a fault has occurred (e.g. sensor error, sensor line disconnection or short-circuit, supply voltage failure)

For fault monitoring, the logic unit must recognize both HI alarms (≥ 21 mA) and LO alarms (≤ 3.6 mA).

8.1.2 Description of application as a safety instrumented system

The hydrostatic pressure sensor is used for the following measuring tasks:
- Hydrostatic pressure measurement in liquids and paste-like media in all areas of process engineering, process measuring technology, pharmaceuticals and the food industry
- Level, volume or mass measurements in liquids

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 measuring principle and the measurement functions are described in the Technical Information for the device

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 Pressure device parameter configuration report

Operation via: ❑ Handheld terminal ❑ FieldCare ❑ On site

Extended order no.: _____ Serial number: _____

Measuring point: _____ Upper range limit (URL sensor): _____

Parameter name	Direct access	Menu path: Expert	Factory setting	Permitted settings	Set point	Actual value	Tested
Measuring mode	005	→ Measurement	as per order		Pressure		
Calib. offset	008	→ Measurement → Basic setup	0.0	[1]			
Damping [2]	017		2.0 s or as per order	0 to 999			
Press. eng. unit	125		mbar/bar or as per order				
Set LRV	013	→ Measurement → Pressure	0 mbar/bar or as per order	[1]			
Set URV	014		Upper range limit or as per order	[1]			
Alarm behav. P	050	→ Output → Current output	Warning	Alarm	Alarm		
Output fail mode [2]	190		Max. alarm	Max. alarm Min. alarm			
High alarm current	052		22 mA	22 mA			
Set min. current	053		< 3.8 mA	< 3.8 mA			
Startcurrent	134		12 mA	12 mA			
Current mode	144	→ Communication → HART Config.	Signaling	Signaling			
Bus address	145		0	0			
after locking: Config. counter	100	→ Diagnosis					
Simulation mode	112	→ Diagnosis → Simulation	None	None			

1) Within the lower and upper range limit.
2) Note DIP switch position.

Date _____ Signature _____ Signature of tester _____

8.2.2 Level device parameter configuration report

Operation via: ❑ Handheld terminal ❑ FieldCare ❑ On site

Extended order no.: _____ Serial number: _____

Measuring point: _____ Upper range limit (URL sensor): _____

Parameter name	Direct access	Menu path: Expert	Factory setting	Permitted settings	Set point	Actual value	Tested
Measuring mode	005	→ Measurement	as per order		Level		
Calib. offset	008	→ Measurement → Basic setup	0.0	1)			
Damping 2)	017		2.0 s or as per order	0 to 999 s			
Press. eng. unit	125		mbar/bar or as per order				
Level selection	013	→ Measurement → Level	In pressure	In pressure			
Empty calib.	028/011		0.0% or as per order				
Empty pressure	029		0.0 or as per order	1)			
Full calib.	031/012		100.0% or as per order				
Full pressure	032		Upper range limit or as per order	1)			
Adjust density	034		1.0 g/cm³	= Process density (035)			
Process density	035		1.0 g/cm³	= Adjust density (034)			
Output unit	025		% or as per order				
Lin. mode	037	→ Measurement → Linearization	Linear	Linear			
Alarm behav. P	050	→ Output → Current output	Warning	Alarm	Alarm		
Output fail mode 2)	190		Max. alarm	Max. alarm Min. alarm			
High alarm current	052		22 mA	22 mA			
Set min. current	053		< 3.8 mA	< 3.8 mA			
Set LRV	166		0.0% or as per order				
Set URV	167		100.0% or as per order				
Startcurrent	134		12 mA	12 mA			
Current mode	144	→ Communication → HART Config.	Signaling	Signaling			
Bus address	145		0	0			
after locking: Config. counter	100	→ Diagnosis					
Simulation mode	112	→ Diagnosis → Simulation	None	None			

1) Within the lower and upper range limit.
2) Note DIP switch position.

Date _____ Signature _____ Signature of tester _____

8.3 Version history

FY01043P

- Firmware version: 01.00.01
- Hardware version: 02.00.ww (ww: any double digit)
- Changes:
  Certificate renewed
- Predecessor: SD00347P
  Functional Safety Manual
  Cerabar M PMC51, PMP51, PMP55
  Deltabar M PMD55
  Deltapilot M FMB50, FMB51, FMB52, FMB53

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