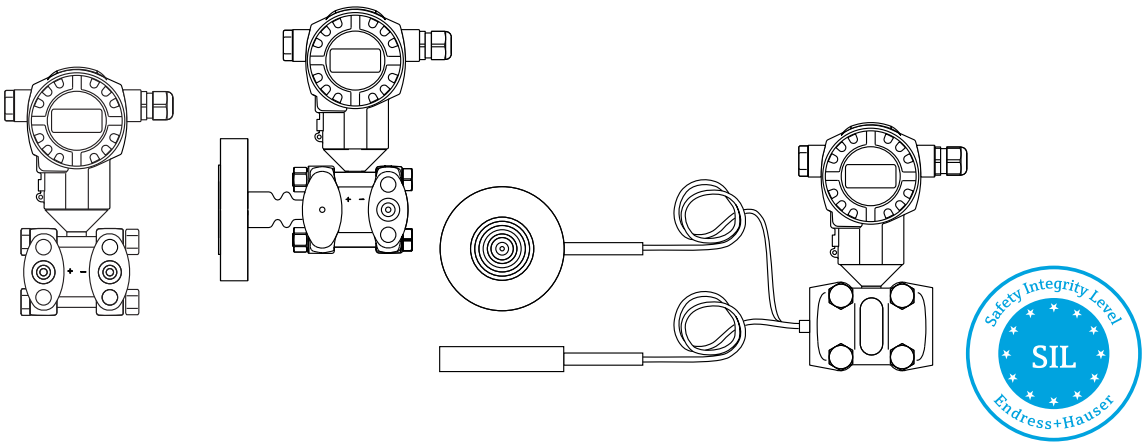
Functional Safety Manual
Deltabar S
PMD75, FMD77, FMD78



Differential Pressure, Level and Flow Measurement with Output Signal 4...20 mA

Application
Used for flow measurement (e.g. backflow monitoring on orifice plates) or differential pressure measurement (e.g. filter or pump monitoring) in aggressive and non-aggressive gases, vapours and liquids level measurement in systems that have to meet the particular requirements for safety-related systems in accordance with IEC 61508.

The measuring device fulfills the requirements concerning:
- Functional safety in accordance with IEC 61508
- Explosion protection (depending on version)
- Electromagnetic compatibility in accordance with EN 61326 and NAMUR recommendation NE 21
- Electrical safety in accordance with IEC/EN 61010-1

Your benefits
- Use for
  - flow monitoring
  - level monitoring
  - differential pressure monitoring

  up to SIL 3, independently assessed (Functional Safety Assessment) by TÜV Süd in accordance with IEC 61508
- Continuous measurement
- Easy commissioning
- Permanent self-monitoring
- Safe parameterization concept

Endress+Hauser
People for Process Automation

Table of contents

SIL declaration of conformity

The binding document forms part of the scope of delivery when the Deltabar S is ordered with the "SIL 2/SIL 3 IEC 61508 Declaration of Conformity" option.

SIL-Konformitätserklärung

SIL-04005c/00/a2

Funktionale Sicherheit nach IEC 61508

SIL Declaration of Conformity

Functional safety according to IEC 61508

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


Level


Pressure


Flow


Temperature


Liquid Analysis


Registration


Systems Components


Services


Solutions

erklärt als Hersteller, dass der Differenzdrucktransmitter (Seriennummer XXXXXXXXXX)
declares as manufacturer, that the differential pressure transmitter (Serial number XXXXXXXXXX)

Deltabar S PMD70, PMD75, FMD76, FMD77, FMD78

für den Einsatz in Schutzeinrichtungen entsprechend der IEC 61508 geeignet ist, wenn das Handbuch zur Funktionalen Sicherheit SD189P/00 und nachfolgende Kenngrößen beachtet werden:

is suitable for the use in safety-instrumented systems according to IEC 61508, if the functional safety manual SD189P/00 and following characteristics are observed:

Gerät/Product	Deltabar S PMD75, FMD77, FMD78			Deltabar S PMD70, FMD76		
Schutzfunktion/Safety function	MIN, MAX, Bereich/Range					
SIL	2, 3 [3]					
HFT	0					
Gerätetyp/Device type	B					
Betriebsart/Mode of operation	Low demand mode					
SFF	92,8 %			95,0 %		
MTTR	8 h					
PFD_{avg} [1] (T_1 = 1 Jahr/year, einkanalig/single channel)	$3{,}02 \times 10^{-4}$			$2{,}51 \times 10^{-4}$		
PFD_{avg} [1] (T_1 = 5 Jahre/years, einkanalig/single channel)	$1{,}51 \times 10^{-3}$			$1{,}26 \times 10^{-3}$		
Prüfintervall/Proof test interval	empfohlen/recommended T_1 = 5 Jahre/years					
	MIN	MAX	Bereich/ Range	MIN	MAX	Bereich/ Range
λ_{sd} [2]	52 FIT	396 FIT	448 FIT	52 FIT	876 FIT	928 FIT
λ_{su} [2]	440 FIT	440 FIT	440 FIT	175 FIT	175 FIT	175 FIT
λ_{dd} [2]	396 FIT	52 FIT	0 FIT	876 FIT	52 FIT	0 FIT
λ_{du} [2]	69 FIT	69 FIT	69 FIT	57 FIT	57 FIT	57 FIT
$MTBF_{tot}$ [4]	96 Jahre/years			82 Jahre/years		

[1] Die Werte entsprechen SIL 2 nach ISA S84.01. PFD_{avg}-Werte für andere T_1-Werte siehe Handbuch zur Funktionalen Sicherheit. / The values comply with SIL 2 according to ISA S 84.01. PFD_{avg}-values for other T_1-values see Functional Safety Manual.
[2] Gemäß Siemens SN29500 / according to Siemens SN29500
[3] SIL 3 bei homogen redundantem Einsatz / SIL 3 for homogeneous redundant application
Die Gerätesoftware entspricht SIL 3. / The device software meets SIL 3 requirements.
[4] Gemäß Siemens SN29500, einschließlich Fehlern, die außerhalb der Sicherheitsfunktion liegen / according to Siemens SN29500, including faults outside the safety function

Das Gerät wurde in einem vollständigen Functional Safety Assessment unabhängig bewertet.
The device was assessed independently in a complete Functional Safety Assessment.

Maulburg, 16.04.2008
Endress+Hauser GmbH+Co. KG

i. V.
Leitung Produktsicherheit
Management Product Safety

i. A.
Leitung Entwicklungsprojekt
Management R&D Project

Endress+Hauser
People for Process Automation

SIL-04005c

General information

General information on functional safety (SIL) is available at: www.de.endress.com/SIL (German) or www.endress.com/SIL (English) and in the Competence Brochure CP01008Z/11/DE "Functional Safety in the Process Industry - Risk Reduction with Safety Instrumented Systems".

Safety symbols

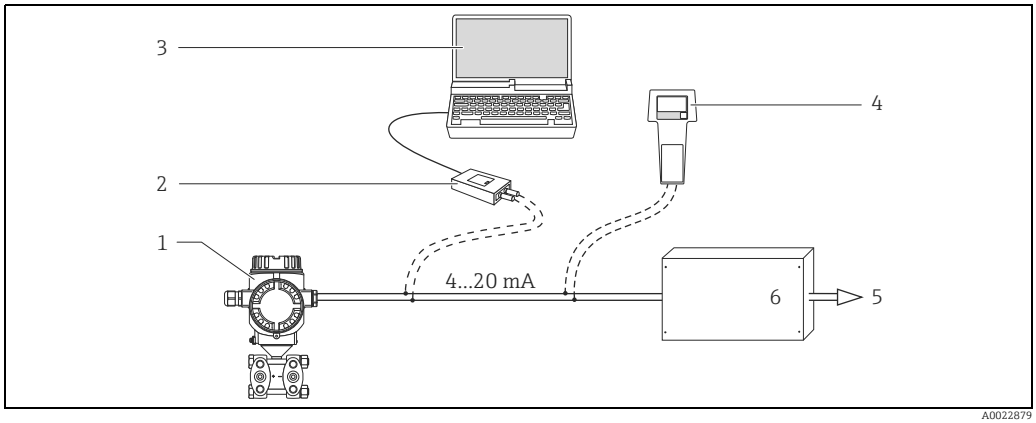
Symbol	Meaning
DANGER A0011189-DE	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
WARNING A0011190-DE	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
CAUTION A0011191-DE	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE A0011192-DE	**NOTICE!** This symbol contains information on procedures and other facts which do not result in personal injury.

Symbols for certain types of information

Symbol	Meaning
A0011193	**Tip** Indicates additional information.

Measuring system design

System components



A0022879

1 *Deltabar S*
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 generator, ...*

The Deltabar S generates an analogue signal (≥ 3.8 to ≤ 20.5 mA) that is proportional to the differential pressure. This signal is sent to a logic unit located downstream, e.g. a programmable logic controller or a limit signal transmitter, and monitored there to establish if:

- A specified value for the "Pressure", "Level" or or "Flow" operating modes has been overshot or undershot ("Level Easy Pressure")
- A range to be monitored for the "Pressure", "Level" or "Flow" operating modes has been violated ("Level Easy Pressure")
- A fault has occurred (e.g. sensor error, sensor cable disconnection or short-circuit, supply voltage failure).

Permitted device types without diaphragm seals

The functional safety assessment described in this manual applies to the device versions listed below and is valid from the stated software and hardware versions.
Unless otherwise indicated, all subsequent versions can also be used for safety functions. Device versions valid for use in safety-related applications:

PMD75 -

Feature	Designation	Option model
010	Approval	all
020	Output; Operating	A 4-20 mA HART; extern + LCD B 4-20 mA HART; inside + LCD C 4-20 mA HART; inside D 4-20 mA HART; Li = 0; extern + LCD E 4-20 mA HART; Li = 0; inside + LCD F 4-20 mA HART; Li = 0; inside
030	Housing; Cover Sealing; Cable Entry	all
040	Nominal Range; Cell Material; PN	all
050	Calibration; Unit	all
060	Membrane Material	all
070	Process Connection	all
080	Seal	all
100	Additional Option 1	E SIL declaration of conformity

or

110	Additional Option 2	E SIL declaration of conformity

Valid software version: from 02.0x; recommended 02.1x
Valid hardware version (electronics): 02.00 and higher
In the event of device modifications, a modification process compliant with IEC 61508 is applied.

The following controls are permitted and recommended for devices without an on-site display that are to be used in PCT protection equipment:
- Via the FieldCare operating program and DTM for Deltabar S with software version ≥ 02.1x, or
- Via Handheld terminal Field Communicator 375, 475 and Device Description for Deltabar S with device revision ≥ 21.

Devices with a lower software version (02.0x) which are already in use can still be operated if the suitable DTM or DD is used.

An operating program is included in the scope of delivery for devices with the "HistoROM/M-DAT" option (option model N "HistoROM/M-DAT Setup-/diagnostic software included" in feature 100 "Additional option 1" or option model N "HistoROM/M-DAT Setup-/diagnostic software included" in feature 110 "Additional option 2" in the order code).

⚠ WARNING

The functional safety assessment of the devices includes the basic unit with the main electronics, sensor electronics and sensor up to the sensor membrane and the process connection mounted directly. Process adapter and diaphragm seal are not taken into account in the rating.
Assessing the suitability of the overall system, for safety-related operation is the responsibility of the operator.
The additional use of diaphragm seal system, primary devices (orifice plates, probes, etc.) and accessories (e.g. impulse piping) has an impact on the overall accuracy of the measuring transmission and the settling time.
- ▸ The planning instructions in the conventional standards has to be observed (e.g. ISO 5167, AGA 3) for flow measurements with primary devices
- ▸ The Technical Information ("Supplementary device documentation", → 🖹 7)

Permitted device types with diaphragm seals

The functional safety assessment described in this manual applies to the device versions listed below and is valid from the stated software and hardware versions.
Unless otherwise indicated, all subsequent versions can also be used for safety functions. Device versions valid for use in safety-related applications:

FMD77 -

Feature	Designation	Option model
010	Approval	all
020	Output; Operating	A 4-20 mA HART; extern + LCD B 4-20 mA HART; inside + LCD C 4-20 mA HART; inside D 4-20 mA HART; Li = 0; extern + LCD E 4-20 mA HART; Li = 0; inside + LCD F 4-20 mA HART; Li = 0; inside
030	Housing; Cover Sealing; Cable Entry	all
040	Nominal Range; Cell Material; PN	all
050	Calibration; Unit	all
060	Membran Material (High Pressure Side)	all
070	Process connection; LP Side; Seal	all
080	Process Connection; High Pressure Side	all
090	Fill Fluid	all (see "Warning" on the following page)
100	Additional Option 1	E SIL declaration of conformity

or

110	Additional Option 2	E SIL declaration of conformity

FMD78 -

Options	Designation	Version
010	Approval	all
020	Output; Operating	A 4-20 mA HART; extern + LCD B 4-20 mA HART; inside + LCD C 4-20 mA HART; inside D 4-20 mA HART; Li = 0; extern + LCD E 4-20 mA HART; Li = 0; inside + LCD F 4-20 mA HART; Li = 0; inside
030	Housing; Cover Sealing; Cable Entry	all
040	Nominal Range; Cell Material; PN	all
050	Calibration; Unit	all
060	Membrane Material	all
080	Process Connection	all
090	Transmitter Mounting; Fill Fluid	all (see "Warning" on the following page)
100	Additional Option 1	E SIL declaration of conformity

or

110	Additional Option 2	E SIL declaration of conformity

Valid software version: from 02.0x; recommended 02.1x
Valid hardware version (electronics): 02.00 and higher
In the event of device modifications, a modification process compliant with IEC 61508 is applied.

The following controls are permitted and recommended for devices without an on-site display that are to be used in PCT protection equipment:
- Via the FieldCare operating program and DTM for Deltabar S with software version ≥ 02.1x, or
- Via Handheld terminal Field Communicator 375, 475 and Device Description for Deltabar S with device revision ≥ 21.

Devices with a lower software version (02.0x) which are already in use can still be operated if the suitable DTM or DD is used.

An operating program is included in the scope of delivery for devices with the "HistoROM/M-DAT" option (option model N "HistoROM/M-DAT Setup-/diagnostic software included" in feature 100 "Additional option 1" or option model N "HistoROM/M-DAT Setup-/diagnostic software included" in feature 110 "Additional option 2" in the order code).

⚠ WARNING

The functional safety assessment of the devices includes the basic unit with the main electronics, sensor electronics and sensor up to the sensor membrane and the process connection mounted directly. Process adapter and diaphragm seal are not taken into account in the rating.
The following applies for diaphragm seals:
The additional use of diaphragm seal systems has an impact on the overall accuracy of the measuring transmission and the settling time.
Assessing the suitability of the overall system, consisting of the basic device and the diaphragm seal, for safety-related operation is the responsibility of the operator.
- ▸ The Technical Information ("Supplementary device documentation", → 7) has to be observed

Supplementary device documentation

Documentation	Contents	Note
Brief Operating Instructions: KA01018P/00	▪ Installation ▪ Wiring ▪ Operation ▪ Commissioning	▪ The documentation is provided with the device. ▪ The documentation is available on the Internet. → www.endress.com.
Technical Information: TI00382P/00	Technical data	The documentation is available via the Internet. → www.endress.com.
Operating Instructions: BA00270P/00	▪ Identification ▪ Installation ▪ Wiring ▪ Operation ▪ Commissioning, description of the Quick Setup menu ▪ Maintenance ▪ Trouble-shooting incl. spare parts ▪ Appendix: illustration of menus	The documentation is available via the Internet. → www.endress.com.
Operating Instructions: BA00274P/00 (Description of Device Functions)	▪ Configuration examples for pressure, level and flow measurement ▪ Parameter description ▪ Trouble-shooting ▪ Appendix: diagram of menus	The documentation is available via the Internet. → www.endress.com.
Compact Instructions: KA00218P/00	▪ Wiring ▪ Operation without display ▪ Description of the Quick Setup menu ▪ HistoROM/M-DAT operation	The documentation is provided with the device. → Connection compartment cover.
Safety Instructions, Control Drawings or Certificates	Safety, mounting and operating instructions for devices suitable for use in hazardous areas or as overfill protection (German Water Resources Act).	Select the desired explosion protection or approval by means of feature 10 "Approval" in the order code. The corresponding documentation is provided with the device.

Description of safety requirements and boundary conditions

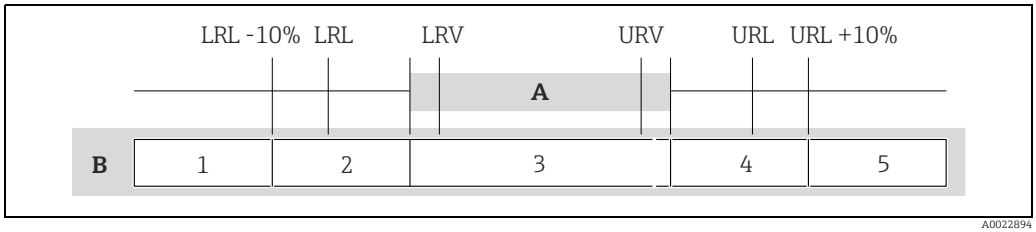
Safety function

Safety-related signal

The safety-related signal of the Deltabar S is the analogue output signal 4 to 20 mA. All safety functions solely refer to this output. In addition, the Deltabar S communicates via HART and contains all HART features with additional diagnostics information.

Safety function

The safety function of the devices and the resulting behavior of the output current is dependent on the device configuration (→ 14) and on the setting of message 620.



A *Range of the current signal for the measured value transmission (NE43)*
B *Range of output current*
LRL Lower range limit
LRV Lower range value
URV Upper range value
URL Upper range limit

Setting	Safety function	Parametrization method applied
Message E620: **Alarm**	Within the measuring range (**A**), the input value (pressure) is correctly transformed into an output value between 3.8 mA and 20.5 mA. Beyond the measuring range (**A**), the device outputs an error current. Internal errors detected by the device result in an error current.	▪ Standard device configuration, → 14 ▪ Increased security during parameter entry, → 15

Range of output current (B)				
1	2	3	4	5
3.6 mA or 22 mA	3.6 mA or 22 mA	3.8 to 20.5 mA	3.6 mA or 22 mA	3.6 mA or 22 mA

<table>
<tr><th>Setting</th><th>Safety function</th><th>Parametrization method applied</th></tr>
<tr><td>Message E620:
Warning</td><td>Within the measuring range (A), the input value (pressure) is correctly transformed into an output value between 3.8 mA and 20.5 mA.
Below the measuring range (A) and LRL -10%:
▪ The device outputs an output current of 3.8 mA.
Above the measuring range (A) and URL +10%:
▪ The device outputs an output current of 20.5 mA.
Beyond these ranges, the device outputs an error current. Internal errors detected by the device result in an error current.</td><td>▪ Standard device configuration, → 14</td></tr>
<tr><td></td><td colspan="2"><table>
<tr><th colspan="5">Range of output current (B)</th></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>3.6 mA or
22 mA</td><td>3.8 mA</td><td>3.8 to 20.5 mA</td><td>20.5 mA</td><td>3.6 mA or
22 mA</td></tr>
</table></td></tr>
</table>

The following dangerous undetected failures can occur in the devices:
- An incorrect output signal which deviates from the real measured value by more than 1%, with the output signal remaining within the 4 to 20 mA resp. 3.8 to 20.5 mA range.
- A settling time that is delayed by more than the specified settling time plus tolerance.
- Other deviations from specified safety-related properties.

For fault monitoring, the logic unit must be able to detect HI alarms (≥ 21 mA) and LO alarms (≤ 3.6 mA).

The transmitter output is not safety-oriented during the following activities:
- Changes to the configuration
- Multidrop
  - with software version < 02.20, if the parameter "bus address" (345) is set to different from "0".
  - with software version ≥ 02.20, if the parameter "current mode" (052) is set to "fixed" (on-site display and FieldCare) or "disabled" (HART handheld terminal).
- Simulation
- Proof-test

While configuring the transmitter and performing maintenance work on Deltabar S, alternative measures must be taken to ensure the process safety.

Restrictions for use in safety-related applications

- Device warmup time: after device warmup, the safety functions are available after a 30-second initialization period.
- During the calculation of SFF a tolerance range of ±1 % for the deviation of output current in case of a failure of a safety relevant component had been taken into account. The ±1 % deviation refers to the actual measured, real value of the output current. If pressure transmitters shall be operated in safety relevant applications, it is recommended to increase the total performance failure shown in the Technical Information (TI) by this value.
- In the case of local operation of the Deltabar S without a display and without an operating tool or without a HART communicator, the device cannot be safely configured because the user cannot perform a visual check. In both these situations, communication via HART alone is not sufficient.
- The device must be locked following configuration.
- When using the device as a subsystem of a safety function, the "Hold meas. value" setting in the parameter "output fail mode" (388) and also the multidrop modus (→ 🖹 9) may not be selected as this option does not provide failsafe alarming.
- During commissioning, a complete function test of the safety-related functions must be performed.
- The maximum interval for recurrent testing (Proof Test Interval) is 5 years.
- Faulty devices must be replaced as soon as possible to minimize the possibility of multiple errors occurring.
  The failure probabilities indicated in this Safety Manual are based on a medium time to repair (MTTR) of 8 hours.

Functional safety parameters

The tables shows the specific functional safety parameters.

FMD77, FMD78, PMD75

Parameters according to IEC 61508	Value		
Safety functions	MIN, MAX, Range		
SIL (hardware)	▪ 2 (single-channel), ▪ 3 (with use of a SIL 3 capable coincidence logic)		
SIL (software)	3		
Device type	B		
Mode of protection	Low demand mode		
Safety functions	MIN	MAX	Range
λ_{sd}	52 FIT	396 FIT	448 FIT
λ_{su}	440 FIT	440 FIT	440 FIT
λ_{dd}	396 FIT	52 FIT	0 FIT
λ_{du}	69 FIT	69 FIT	69 FIT
λ_{tot} [1)]	1194 FIT		
$MTBF_{tot}$ [1)]	96 years		
SFF	92.8%		
PFD_{avg} for T_1 = 1 year (single-channel)[2)]	3.02×10^{-4}		
T_1 (Proof-test interval)	→ graphic		
Diagnostic test interval [3)]	5 min (RAM, ROM, ...), 1 s (Measurement)		
Fault reaction time [4)]	5 min (RAM, ROM, ...), 10 s (Measurement)		
Settling time [5)]	→ Technical Information TI00382P/00/EN, "Dead time, time constant (T63)" section		

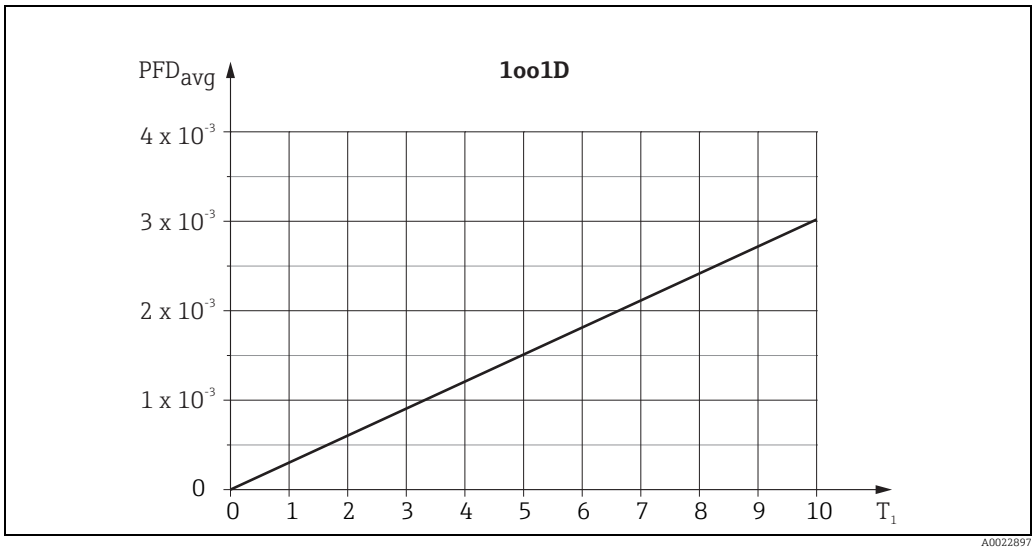
1) According to Siemens SN29500. This value takes into account all failure types (→ "Management summary", → 🖹 50).

2) Where the average temperature when in continuous use is in the region of +50 °C (+122 °F), a factor of 1.3 should be taken into account. For further information, → "Management summary", → 🖹 50.

3) During this time, all diagnostic functions are executed at least once.

4) Time between fault detection and fault reaction.

5) Step response time as per DIN EN 61298-2.



T1 Time interval for proof testing (years)

Operating life of electrical components

The underlying failure rates of electrical components apply within the usable operating life in accordance with IEC 61508-2 section 7.4.9.5 note 3.

Correct installation is essential to the safe operation of the Deltabar S.

Behavior of device when in operation and in case of failure

The behavior during operation and in case of failure is described in Operating Instructions BA00270P/00/EN.

Alarm response and current output

Increased security during parameter entry

When using this configuration method, the Deltabar S outputs a permanently configured error current ≥ 22 mA when the safety function is triggered or in the event of device errors.

NOTICE

If you selected the "On" option for the ACK. ALARM MODE parameter and an alarm occurs, proceed as follows:

- Rectify the cause of the alarm.
- Unlock the Deltabar S via the SAFETY LOCK and SAFETY PASSWORD parameters.
- Acknowledge the alarm via the ACK. ALARM parameter.
- Select the "Lock" option for the SAFETY LOCK parameter.
- Enter the password for the SAFETY PASSWORD parameter.
- Confirm the values and option selected for the parameters queried.
- Lock the Deltabar S via the password.

Standard device configuration

Configure the current output for an alarm condition via the parameters OUTPUT FAIL MODE (default value: max. alarm) and SET MAX. ALARM (default value: 22 mA). These parameters can be set to the following values:

OUPUT FAIL MODE [1]	Current value in the event of a fault
Min. alarm (LO alarm)	3.6 mA
Max. alarm (HI alarm)	Can be set via SET MAX. ALARM [1] = 22 mA

1) Menu path: (GROUP SELECTION →) OPERATING MENU → OUTPUT

⚠ WARNING

When using the Deltabar S as a subsystem of a safety function, the "Hold meas. value" setting is not failsafe.

This option does not provide failsafe alarming.

- The "Hold meas. value" setting may not be selected.
- In addition, the device may not be in the multidrop mode (→ 9).

→ 39, section "Standard device configuration".

The following applies to both configuration methods "Increased security during parameter entry" and "Standard device configuration":

- During device configuration, the selected current value in the event of a fault cannot be guaranteed for all possible fault situations (e.g. cable open circuit). However, failure reaction in accordance with NE 43 (≤ 3.6 mA or ≥ 21 mA) is always ensured.
- The current value can be (independent of the selected current value) between 22 to 25 mA when the integrated diagnostics and monitoring measures are triggered.
- In cases such as power failure or circuit break, output currents can be (independent of the selected current value) ≤ 3.6 mA.
- After an error or a fault has been removed, the 4 to 20 mA output signal can be considered to be safe after 20 seconds.
- For the maximum reaction time of alarms and warnings → 12.

Settling time

The settling time is calculated according to the following formula:
$t_{settling\ time} = t_1 + (t_2 + \text{configured damping time}) \times 5$

For t_1 (dead time) and t_2 (T63):
→Technical Information TI00382P/00/EN, "Dead time, time constant (T63)" section.
The factory setting for the damping time is 2 seconds, but can be configured between 0 and 999 seconds.

In accordance with IEC 61298-2, the settling time is the time the output signal needs to reach its steady-state value at 1% of the output span and to remain within this range.

Maximum reaction time of alarms and warnings

The reaction times of alarms and warnings are listed in the following table. In the event of an alarm (device faults), the device outputs an error current ("Alarm response and current output", → 11).

Code[1]	Message type[2] (current output)	Maximum reaction time	Diagnostic test interval
113, 704, 705, 728, 729, 736 und 737	Alarm	5 min	5 min
703 und 739	Alarm	10 s	1 s
738, 131, 132, 133, 110, 121, 747	Alarm	Only during initialization	
101, 115[3], 120[3], 122, 130, 703, 704, 707, 711, 713, 715[3], 716, 717[3], 718[3], 719, 720[3], 721, 722, 723, 725, 726[3], 727[3], 741, 742, 743, 744, 748	Alarm	Immediately	
102, 106, 116, 602, 604, 613, 700, 701, 702, 706, 710, 730[4], 731[4], 732[4], 733[4], 740[4], 745, 746, 620[3]	Warning (device continues to measure)	Immediately	

1) → Operating Instructions BA00270P/00/EN, section "Messages".

2) → Operating Instructions BA00270P/00/EN, section "Response of outputs to errors".

3) These messages are "Error"-type messages and are automatically set to "Alarm" when using the "Increased security during parameter entry" method. These messages, except code 620, have to be set to "Alarm" manually when using the "Standard device configuration" method. → 39, "Standard device configuration via on-site-display" section.

4) These messages are "Error"-type messages and are set to "Warning" at the factory. These messages are not set to "Alarm" when using the "Increased security during parameter entry" method.

Installation

Mounting, wiring and commissioning

The mounting, wiring and commissioning of the Deltabar S is described in Operating Instructions BA00270P/00/EN.

Device configuration

Methods for device configuration

When using the devices in process control protection equipment, the device configuration must meet two requirements:

1. Confirmation concept:
   proven independent checking of safety-relevant parameters input
2. Locking concept:
   device locked after configuration (required in accordance with IEC 61511-1 §11.6.4 and NE 79 §3)

The following methods for device configuration are available:

1. Standard device configuration
2. Increased security during parameter entry

Due to the increased configuration safety, the use of the "Increased security during parameter entry" method is recommended when using the device in process control protection functions.

Simultaneous operation via on-site display and handheld terminal or the FieldCare operating program is not allowed.

Procedure for "Standard device configuration" via on-site display (manual parameter confirmation and locking)

1. Perform a reset (code "7864").
2. The correct display of the characters and digits is checked via the "DIGITS SET" parameter.
3. Configure the device[1)] (see Operating Instructions BA00270P/00/EN and BA00274P/00/EN) and make a protocol of the settings manually[2)]. Switch device off and on.
4. Check safety functions if necessary ("Checks", → 🖹 45)
5. Read out the prescribed parameters and compare them to the protocol.[2)]
   Is the configuration identical to the protocol?
   – No: Repeat steps 1 to 5 until the configuration matches with the "Form for standard device configuration (→ 🖹 54ff)
   – Yes: go to step 6
6. Lock the device for safe measuring mode via software and/or hardware.
7. Read out the "CONFIG RECORDER" parameter and document it.

1) Standard device configuration" section, → 🖹 39, and for the "Level" operating mode, "Level Easy Pressure" level selection, also observe the permitted parameter settings, → 🖹 16 ff.
2) Observe the prescribed parameters in accordance with the form, → 🖹 54 ("Pressure" operating mode) and → 🖹 56 ("Level" operating mode, "Level Easy Pressure" level selection and → 🖹 58 ("Flow" operating mode).

Procedure for the "Increased security during parameter entry" via on-site display (software-guided configuration and locking)

1. Perform a reset (code "7864").
2. Configure the device[3] (see Operating Instructions BA00270P/00/EN and BA00274P/00/EN and make a protocol of the settings manually [4]. Switch device off and on.
3. Check safety functions if necessary ("Checks", → 45)
4. Initial the locking sequence via the "SAFETY LOCK" parameter.
   Device software checks whether all conditions (→ 16) have been fulfilled.
   Conditions ok?
   – No: the locking is not possible. Repeat steps 1 to 3, until locking is possible.
   – Yes: go to step 5
5. Enter the Password "7452" via the "SAFETY PASSWORD" parameter.
6. The correct display of the characters and digits is checked via the "DIGITS SET" parameter. Display ok?
   – No: Replace on-site display, perform reset (code "7864").[3]
   Repeat steps 1 to 6, until display is ok.
   – Yes: go to step 7
7. Safety-relevant parameters are queried for validity. Values ok?
   – No: Configure paramter correctly or perform reset (code "7864").[3]
   Repeat steps 1 to 7, until the values are correct.
   – Yes: The request is continued until it is complete.
8. Enter the password "7452" again.
   The device is locked for safe measuring mode.
9. Switch device off and on. Read the parameter out again and compare it to the "Form for standard device configuration" (→ 54ff).

For a description of the "Increased security during parameter entry", → 21 ff and for "Standard device configuration", → 39 ff.

3) Observe "Conditions for safe measuring mode" section, → 16.
4) Observe the prescribed parameters in accordance with the form, → 54 ("Pressure" operating mode) and → 56 ("Level" operating mode, "Level Easy Pressure" level selection) and → 58 ("Flow" operating mode).

Conditions for safe measuring mode

With the "Increased security during parameter entry" method, the device checks whether a number of operating steps have been performed beforehand and whether certain parameters have been configured with reliable settings. This method of configuration is no longer possible if one of these operating steps has been performed or if the configuration is not permitted. A corresponding message is displayed.

The "Increased security during parameter entry" method is no longer possible after the following operating steps.
- Position adjustment performed or measuring range set on site without using the on-site display.
- Following a download
- After a configuration backup using HistoROM®/M-DAT
- After a reset apart from after the reset code "7864"
- After performing sensor recalibration (observe Note, → 20.)
- Following current trimming
- For the "LEVEL SELECTION" parameter, the "Level Easy Height" or "Level Standard" option was selected (permitted setting for LEVEL SELECTION is "Level Easy Pressure").

The reset code "7864" resets all the parameters to their delivery status.
After this, the "Increased security during parameter entry" method is possible once more. With the "standard device configuration" method, the execution of the reset with the reset code "7864" is a pre-condition.

Permitted parameter settings:

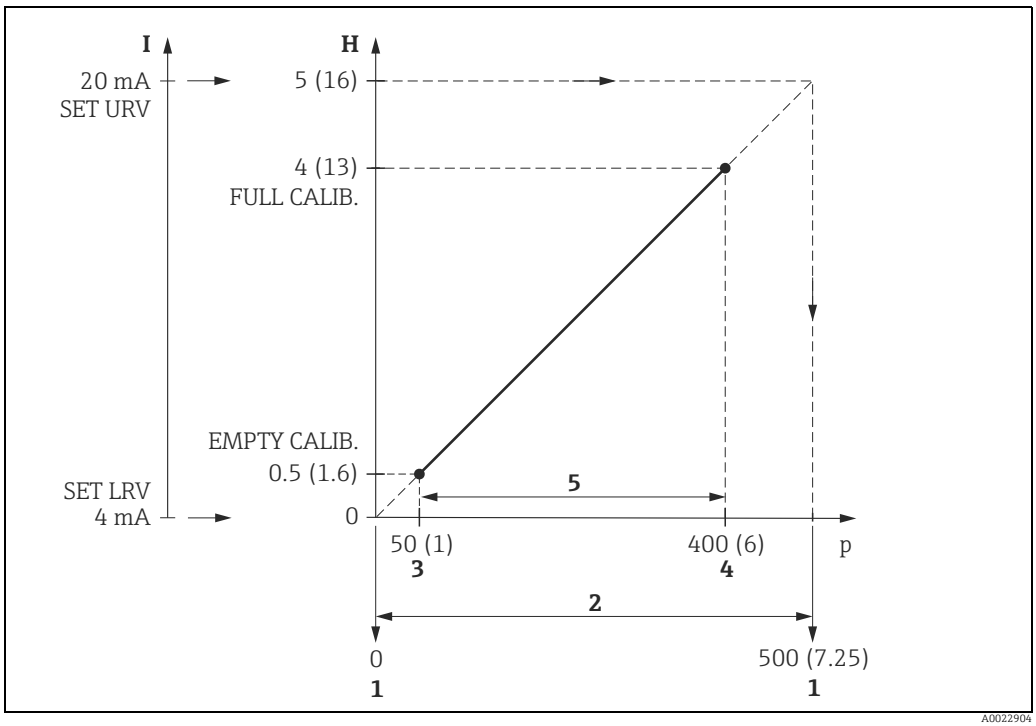
Only certain settings are possible for some parameters. If a setting that is not permitted has been selected for one of these parameters, the "Increased security during parameter entry" method is not possible. This method is possible once more as soon as the permitted setting is selected for the parameter.

Parameter and menu path	Permitted settings
▪ BUS ADDRESS (345) ▪ CURRENT MODE (052)[1)] Menu path: (GROUP SELECTION →) OPERATING MENU → TRANSMITTER INFO → HART PARAMETER	▪ 0 ▪ Signaling (on-site display and FieldCare) or enabled (HART handheld terminal)
"Pressure" MEASURING MODE: PRESS. ENG. UNIT (060) Menu path: (GROUP SELECTION →) OPERATING MENU → SETTINGS → BASIC SETUP	All units, apart from "User unit"
"Flow" MEASURING MODE: ▪ UNIT FLOW (391) ▪ NORM FLOW UNIT (661) ▪ STD. FLOW UNIT (660) or ▪ MASS FLOW UNIT (571) Menu path: (GROUP SELECTION →) OPERATING MENU → SETTINGS → BASIC SETUP	All units, apart from "User unit"
"Level" MEASURING MODE, "Level Easy Pressure" LEVEL SELECTION: The PRESSURE EMPTY, PRESSURE FULL, EMPTY CALIB., FULL CALIB., SET LRV and SET URV parameters must meet the following conditions: Menu path: (GROUP SELECTION →) OPERATING MENU → SETTINGS → BASIC SETUP	▪ The pressure values for SET LRV and SET URV must be within the sensor measuring range. → Following graphics, Point 1. ▪ The turndown, which is determined by the difference between the pressure values for SET LRV and SET URV, must not be larger than the maximum turndown (100:1 at factory). → Following graphics, Point 2. ▪ The value for PRESSURE FULL – PRESSURE EMPTY must not fall below the minimum span (1% of sensor measuring range). → Following graphics, Point 3.
"Level" MEASURING MODE, "Level Easy Pressure" LEVEL SELECTION: ADJUST DENSITY (007) Menu path: (GROUP SELECTION →) OPERATING MENU → SETTINGS → EXTENDED SETUP	Same value as PROCESS DENSITY (025)

1) Only for software version ≥ 02.20

Example of 500 mbar measuring cell.

The "Level Easy Pressure" calibration was performed **correctly**.

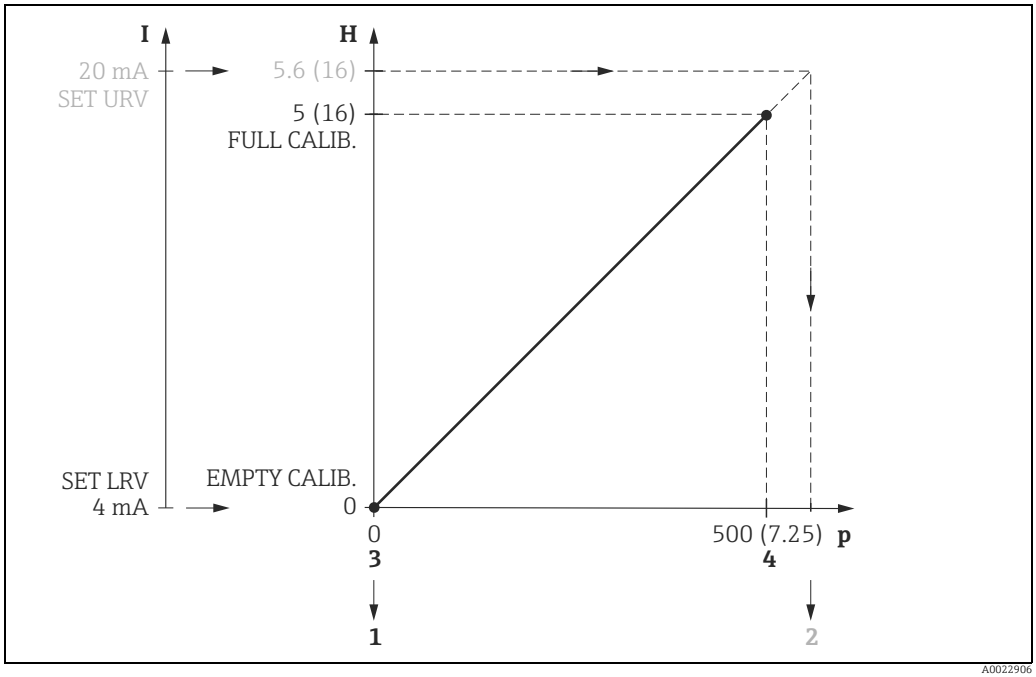


H Dimensions: m (ft)
p Pressure unit: mbar (psi)

The conditions 1, 2 and 5 are met. The "Increased security during parameter entry" method can be performed for the device.

1 The pressure values for SET LRV and SET URV must be within the sensor measuring range.
- 0 mbar (0 psi): Pressure value for 4 mA LRL SENSOR
- 500 mbar (7.25 psi): Pressure value for 20 mA URL SENSOR
2 The turndown, which is determined by the difference between the pressure values for SET LRV and SET URV, must not be larger than the maximum turndown (100:1 at factory).
3 PRESSURE EMPTY; 50 mbar (1 psi)
4 PRESSURE FULL; 400 mbar (6 psi)
5 The value for PRESSURE FULL − PRESSURE EMPTY must not fall below the minimum span (1% of sensor measuring range).

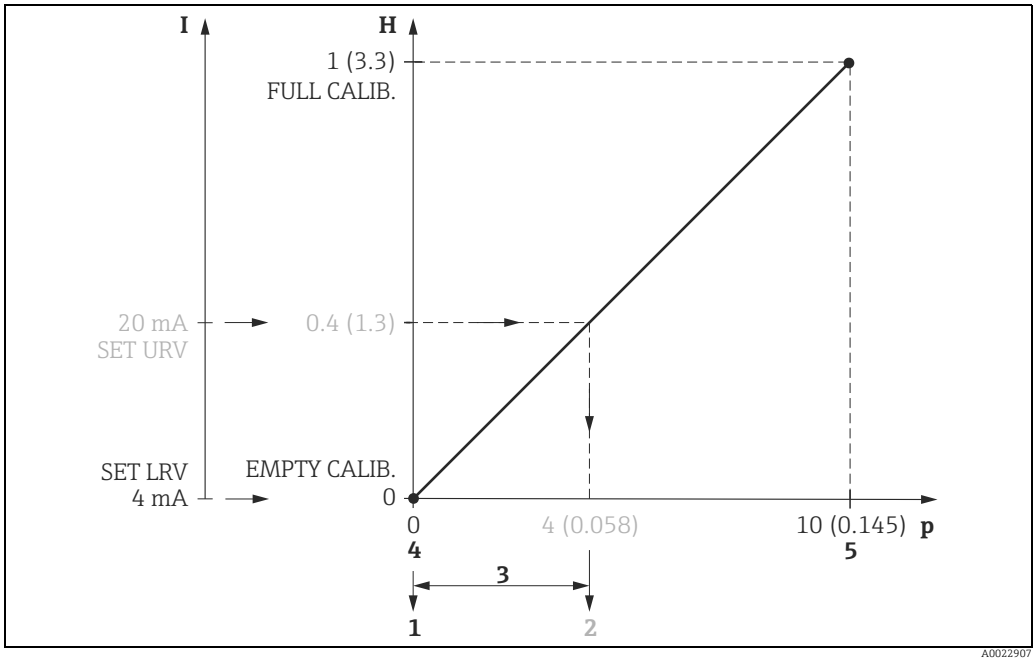
The "Level Easy Pressure" calibration was **not** performed **correctly**.



H Dimensions: m (ft)
p Pressure unit: mbar (psi)

The condition that the pressure values for SET LRV and SET URV have to be within the sensor measuring range is not met (Point 2). The "Increased security during parameter entry" method cannot be performed for the device without a correction.

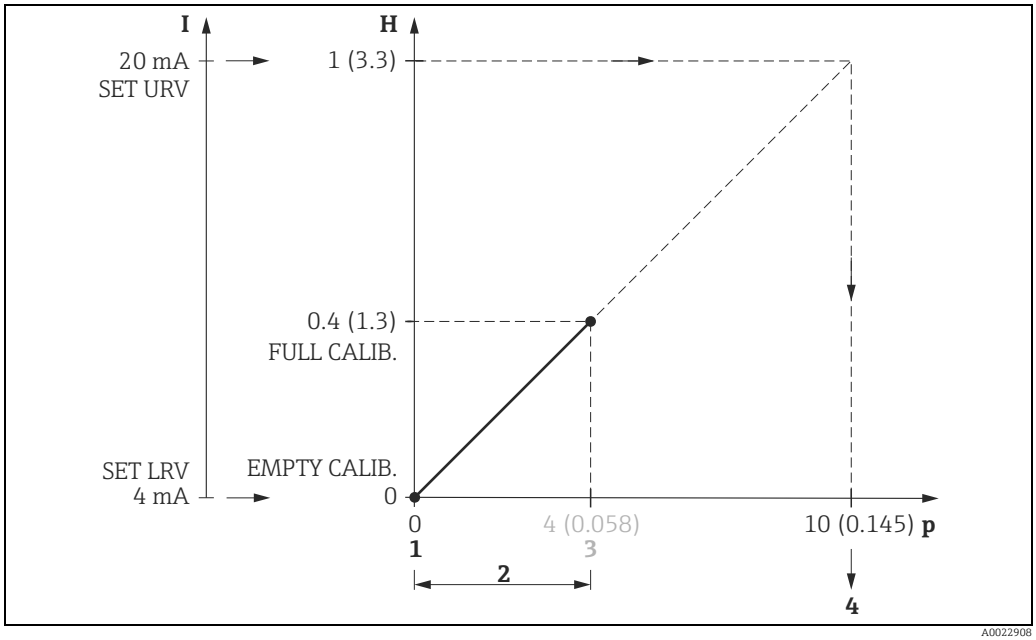
1 Pressure value for 4 mA = 0 mbar (0 psi) LRL SENSOR
2 Pressure value for 20 mA = 560 mbar (8.12 psi) > URL SENSOR
The pressure values for SET LRV and SET URV must be within the sensor measuring range.
3 EMPTY PRESS.; 0 mbar (0 psi)
4 FULL PRESS. URL SENSOR; 500 mbar (7.25 psi)



H Dimensions: m (ft)
p Pressure unit: mbar (psi)

The condition that the turndown, which is determined by the difference between the pressure values for SET LRV and SET URV, must not be larger than the maximum turndown is not met (Point n). The "Increased security during parameter entry" method cannot be performed for the device without a correction.

1 Pressure value for 4 mA = 0 mbar (0 psi)
2 Pressure value for 20 mA = 4 mbar (0.058 psi)
3 The turndown (in this case the turndown amounts 125), which is determined by the difference between the pressure values for SET LRV and SET URV, must not be larger than the maximum turndown (100:1 at factory).
4 EMPTY PRESS.; 0 mbar (0 psi)
5 FULL PRESS.; 10 mbar (0.145 psi)



H Dimensions: m (ft)
p Pressure unit: mbar (psi)

The condition that the value for PRESSURE FULL – PRESSURE EMPTY must not drop below the minimum span (1% of sensor measuring range) is not met (Point o). The "Increased security during parameter entry" method cannot be performed for the device without a correction.

1 EMPTY PRESS.; 0 mbar (0 psi)
2 The value for PRESSURE FULL – PRESSURE EMPTY must not fall below the minimum span (1% of sensor measuring range).
3 FULL PRESS; 4 mbar (0.058 psi)
4 Pressure value for 20 mA = 10 mbar (0.145 psi)

- If the device has assumed a fault condition, i.e. an alarm is output and the current output assumes the set value, the cause of the fault must first be eliminated.
- When operating via the DTM, locking via the SAFETY CONFIRM. menu is only possible in the online mode.
- The sensor can only be recalibrated by Endress+Hauser Service.
  All parameters, except the parameters for a sensor recalibration, are reset with the "7864" reset code. Therefore, the parameters have to be checked prior to locking via the SAFETY CONFIRM. menu.

Increased security during parameter entry via on-site display

For a description of the safety-relevant parameters, → 30 ff "Parameter description of the SAFETY CONFIRM. group" section.

This configuration method is a software function implemented in the device and comprising automated parameter confirmation and device locking.

1. Reset the parameters to their factory setting: with the "7864" reset code (→ Operating Instructions BA00270P/00/EN, section "Factory setting (reset)").
   Check default values, number formats and parameter designations using the "Form for device configuration" (column "Factory settings", → 54ff).
2. Configure device. → Operating Instructions BA00270P/00/EN and BA00274P/00/EN.
   Observe "Conditions for safe measuring mode" section, → 16.
3. Note the settings of the following parameters according to form (column "Specified value", → 54ff) since these settings are queried for safe device configuration:

Parameters	Available in the operating mode			Group
	Pressure	Level, "Level Easy Pressure" level selection	Flow	
ACK. ALARM MODE	X	X	X	MESSAGES
CALIB. OFFSET	X	X	X	POSITION ADJUSTMENT
MEASURING MODE	X	X	X	MEASURING MODE
PRESSURE EMPTY		X		BASIC SETUP
EMPTY CALIB.		X		BASIC SETUP
PRESSURE FULL		X		BASIC SETUP
FULL CALIB.		X		BASIC SETUP
MAX. FLOW			X	BASIC SETUP
MAX. PRESS. FLOW			X	BASIC SETUP
LOW FLOW CUT-OFF			X	EXTENDED SETUP
SET. L. FL. CUT-OFF			X	EXTENDED SETUP
LINEAR/SQROOT			X	EXTENDED SETUP
SET LRV	X	X	X	BASIC SETUP
SET URV	X	X	X	BASIC SETUP
DAMPING VALUE	X	X	X	BASIC SETUP

Switch the device off and on to make sure that the parameter settings are stored.

The PRESSURE EMPTY and PRESSURE FULL parameters are only displayed for the "Dry" CALIBRATION MODE. If you have performed a wet calibration, you subsequently have to select the "Dry" option by means of the CALIBRATION MODE parameter. You can read out the corresponding values for the PRESSURE EMPTY and PRESSURE FULL parameters here.

4. Check safety functions if necessary ("Checks", → 45).
5. Select "SAFETY CONFIRM." group.
   (Menu path: (GROUP SELECTION →) OPERATING MENU → SAFETY CONFIRM.).
6. Select the "Lock" option.
   Select the "Lock" option via the SAFETY LOCK parameter. The status "Locked" or "Unlocked" is indicated on the fourth line on the display.

7. Enter the password via the SAFETY PASSWORD parameter (password: 7452).
   - If the correct password is entered, the following parameters are reset to the factory values: CURR. CHARACT., OUTPUT FAIL MODE, ALT. CURR. OUTPUT., SET MAX. ALARM, SET MIN. CURRENT, SIMULATION MODE, ALARM DELAY, ALARM DISPL. TIME and SELECT ALARMTYPE (→ Point 9 for factory values).
   - Any simulation running is terminated.
   - The configurable messages ("Error"-type messages) 115, 120, 620, 715, 716, 717, 718, 720, 726 and 727 are set to "Alarm".
     → Operating Instructions BA00270P/00/EN, section "Messages".

   Record the following confirmed settings according to the "Form for device configuration" (column "Read-out actual value", → 54ff).
8. By means of the DIGIT SETS parameter, the user checks whether the characters and digits are displayed correctly on the user interface. "0123456789.-" is displayed if everything is displayed correctly. Options:
   - Valid: Select this option if the string of characters and digits is displayed correctly.
   - Not valid: Select this option if the string of characters and digits is not displayed correctly. In this case, operation in the safe measuring mode is not possible. The confirmation sequence is aborted.
9. By means of the OUTPUT CURRENT parameter, the user can check whether the following parameters are correctly reset to the factory values. If reset correctly, the OUTPUT CURRENT parameter displays "LinMaxNorm/22/3.8/0s".Factory values:
   - CURR. CHARACT.: linear
   - OUTPUT FAIL MODE: max. alarm
   - ALT. CURR. OUTPUT: normal
   - SET MAX. ALARM: 22 mA
   - SET MIN. CURRENT: 3.8 mA
   - ALARM DELAY: 0.0 s
   - ALARM DISPLAY TIME: 0.0 s

   Options:
   - Valid: Select this option if the factory values displayed correspond to the desired values. The system continues to interrogate the safety-related parameters.
   - Not valid: Select this option if the factory values displayed do not correspond to the desired values. In this case, operation in the safe measuring mode is not possible. The SAFETY LOCK parameter displays the status "Unlocked". The confirmation sequence is aborted.
10. The following parameters have to be confirmed depending on the operating mode selected:
    - ACK. ALARM MODE
    - CALIB. OFFSET
    - MEASURING MODE
    - PRESSURE EMPTY (only Level operating mode)
    - EMPTY CALIB. (only Level operating mode)
    - PRESSURE FULL (only Level operating mode)
    - FULL CALIB. (only for level operating mode)
    - MAX. FLOW (only for flow operating mode)
    - MAX. PRESS. FLOW (only for flow operating mode)
    - LOW FLOW CUT-OFF (only for flow operating mode)
    - SET. L. FL. CUT-OFF (only for flow operating mode)
    - LINEAR/SQROOT (only flow operating mode)
    - SET LRV
    - SET URV
    - DAMPING VALUE

    The value saved is indicated on the fourth line of the on-site display.

    Options:
    - Valid: Select this option if the value entered or the desired value is displayed. The system continues to interrogate the safety-related parameters.
    - Not valid: Select this option if an incorrect value or a value that was not entered is displayed. In this case, operation in the safe measuring mode is not possible. The SAFETY LOCK parameter displays the status "Unlocked". The confirmation sequence is aborted.
11. Once the safety-related parameters have been successfully interrogated, the password "7452" must be entered again via the CONF. PASSWORD parameter. Afterwards, the device is locked for the safe measuring mode. The SAFETY LOCK parameter displays the status "Locked".
    This locking has the highest priority and can only be disabled via the SAFETY LOCK and SAFETY PASSWORD parameters. → 45, "Locking/Unlocking" section.

12. Switch the device off and on. This makes sure that parameter settings for the current ouput, the alarm behavior and locking have been stored. Read the parameter out again and compare it to the "Form for device configuration" (→ 54ff).

Increased security during parameter entry via handheld terminal Field Communicator 374, 475

For a description of the safety-relevant parameters, → 30ff "Parameter description of the SAFETY CONFIRM. group" section.

This configuration method is a software function implemented in the device and comprising automated parameter confirmation and device locking.

After connecting the handheld terminal proceed according to the following steps:

1. Select "Main Menu" > "Hart Communication", in "Hart application" > "Online". The device will automatically be found and opened online. Make sure that the bus address of the device is = 0.
2. Make sure the connection has been established to the correct device. This can be checked using the: measuring point, extended order code or serial number parameters.
3. Reset the parameters to their factory setting: with the "7864" reset code (→ Operating Instructions BA00270P/00/EN, section "Factory setting (reset)").
   Check default values, number formats and parameter designations using the "Form for device configuration" (column "factory settings", → 54ff).
4. Configure device. → Operating Instructions BA00270P/00/EN and BA00274P/00/EN.
   Observe "Conditions for safe measuring mode" section, → 16.
5. Note the settings of the following parameters according to form (column "Specified value", → 54ff) since these settings are queried for safe device configuration:

Parameters	Available in the operating mode			Group
	Pressure	Level, "Level Easy Pressure" level selection	Flow	
ACK. ALARM MODE	X	X	X	MESSAGES
CALIB. OFFSET	X	X	X	POSITION ADJUSTMENT
MEASURING MODE	X	X	X	BASIC SETUP
PRESSURE EMPTY		X		BASIC SETUP
EMPTY CALIB.		X		BASIC SETUP
PRESSURE FULL		X		BASIC SETUP
FULL CALIB.		X		BASIC SETUP
MAX. FLOW			X	BASIC SETUP
MAX. PRESS. FLOW			X	BASIC SETUP
LOW FLOW CUT-OFF			X	EXTENDED SETUP
SET. L. FL. CUT-OFF			X	EXTENDED SETUP
LINEAR/SQROOT			X	EXTENDED SETUP
SET LRV	X	X	X	BASIC SETUP
SET URV	X	X	X	BASIC SETUP
DAMPING VALUE	X	X	X	BASIC SETUP

   Switch the device off and on to make sure that the parameter settings are stored.

6. Check safety functions if necessary ("Checks", → 45).
7. Close the application on the handheld terminal. After switching off and on reestablished the connection between the device and the handheld terminal (see step 1).
8. Select "SAFETY CONFIRM." group.
   (Menu path: (GROUP SELECTION →) OPERATING MENU → SAFETY CONFIRM.).

9. Select the "Lock" option.
   The Field Communicator offers the two SAFETY LOCKSTATE and SAFETY LOCK methods.
   - Via SAFETY LOCK, select the "Lock" option and confirm.
   - Via SAFETY LOCKSTATE, you can display the "Locked" or "Unlocked" status.
10. Enter the password via the SAFETY PASSWORD parameter (password: 7452).
    - If the correct password is entered, the following parameters are reset to the factory values: CURR. CHARACT., OUTPUT FAIL MODE, ALT. CURR. OUTPUT., SET MAX. ALARM, SET MIN. CURRENT, SIMULATION MODE, ALARM DELAY, ALARM DISPL. TIME and SELECT ALARMTYPE (→ Point 12 for factory values).
    - Any simulation running is terminated.
    - The configurable messages ("Error"-type messages) 115, 120, 620, 715, 716, 717, 718, 720, 726 and 727 are set to "Alarm". → Operating Instructions BA00270P/00, section "Messages".

    Record the following confirmed settings according to the form (column "Read-out acutal value", → 54).
11. By means of the DIGIT SETS parameter, the user checks whether the characters and digits are displayed correctly on the user interface. "0123456789.-" is displayed if everything is displayed correctly. Options:
    - Valid: Select this option if the string of characters and digits is displayed correctly.
    - Not valid: Select this option if the string of characters and digits is not displayed correctly. In this case, operation in the safe measuring mode is not possible. The confirmation sequence is aborted.
12. By means of the OUTPUT CURRENT parameter, the user can check whether the following parameters are correctly reset to the factory values. If reset correctly, the OUTPUT CURRENT parameter displays "LinMaxNorm/22/3.8/0s". Factory values:
    - CURR. CHARACT.: linear
    - OUTPUT FAIL MODE: max. alarm
    - ALT. CURR. OUTPUT: normal
    - SET MAX. ALARM: 22 mA
    - SET MIN. CURRENT: 3.8 mA
    - ALARM DELAY: 0.0 s
    - ALARM DISPLAY TIME: 0.0 s

    Options:
    - Valid: Select this option if the factory values displayed correspond to the desired values. The system continues to interrogate the safety-related parameters.
    - Not valid: Select this option if the factory values displayed do not correspond to the desired values. In this case, operation in the safe measuring mode is not possible. The SAFETY LOCK parameter displays the status "Unlocked". The confirmation sequence is aborted.
13. The following parameters have to be confirmed depending on the operating mode selected:
    - ACK. ALARM MODE
    - CALIB. OFFSET
    - MEASURING MODE
    - PRESSURE EMPTY (only Level operating mode)
    - EMPTY CALIB. (only Level operating mode)
    - PRESSURE FULL (only Level operating mode)
    - FULL CALIB. (only for level operating mode)
    - MAX. FLOW (only for flow operating mode)
    - MAX. PRESS. FLOW (only for flow operating mode)
    - LOW FLOW CUT-OFF (only for flow operating mode)
    - SET. L. FL. CUT-OFF (only for flow operating mode)
    - LINEAR/SQROOT (only flow operating mode)
    - SET LRV
    - SET URV
    - DAMPING VALUE

    The value saved is indicated on the fourth line of the on-site display.

    Options:
    - Valid: Select this option if the value entered or the desired value is displayed. The system continues to interrogate the safety-related parameters.
    - Not valid: Select this option if an incorrect value or a value that was not entered is displayed. In this case, operation in the safe measuring mode is not possible. The SAFETY LOCK parameter displays the status "Unlocked". The confirmation sequence is aborted.

14. Once the safety-related parameters have been successfully interrogated, the password "7452" must be entered again via the CONF. PASSWORD parameter. Afterwards, the device is locked for the safe measuring mode. The SAFETY LOCK parameter displays the status "Locked".
This locking has the highest priority and can only be disabled via the SAFETY LOCK and SAFETY PASSWORD parameters. → 45, "Locking/Unlocking" section.
15. Switch the device off and on. This makes sure that parameter settings for the current ouput, the alarm behavior and locking have been stored. Close application on handheld terminal. After switching off and on, reestablished the connection between the device and the handheld terminal (step 1). Read the parameter out again and compare it to the "Form for device configuration (→ 54).

The "Offline" operating option is not allowed for functional safety applications. Make sure that no messages as such "Device disconnected" occur during the configuration.

Increased security during parameter entry via the FieldCare operating program

For a description of the safety-relevant parameters, → 30, "Parameter description of the SAFETY CONFIRM. group" section.

This configuration method is a software function implemented in the device and comprising automated parameter confirmation and device locking.

After connecting FieldCare, proceed as follows:

1. There are the following two ways to established the communication:
   - Select the "HART Communication" connection wizard. The device will automatically been found and opened online. Make sure that the bus address of the device is = 0.
   - Go to the tree structure and select "Create projects" > "Add device" > "HART Communication" before selecting "Create network". The device is opened online. Make sure that the bus address of the device is = 0.
2. Make sure that the connection has been established to the correct device. This can be checked using the: measuring point, extended order code or serial number parameters.
3. Reset the parameters to their factory setting: with the "7864" reset code (→ Operating Instruction BA00270P/00/EN, section "Factory setting (reset)").
   Check default values, number formats and parameter designations using the device configuration form (column "factory settings").
4. Configure device. → Operating Instructions BA00270P/00/EN and BA00274P/00/EN.
   Observe "Conditions for safe measuring mode" section, → 16.
5. Note the settings of the following parameters according to form (column "Specified value", → 54) since these settings are queried for safe device configuration:

Parameters	Available in the operating mode			Group
	Pressure	Level, "Level Easy Pressure" level selection	Flow	
ACK. ALARM MODE	X	X	X	MESSAGES
CALIB. OFFSET	X	X	X	POSITION ADJUSTMENT
MEASURING MODE	X	X	X	BASIC SETUP
PRESSURE EMPTY		X		BASIC SETUP
EMPTY CALIB.		X		BASIC SETUP
PRESSURE FULL		X		BASIC SETUP
FULL CALIB.		X		BASIC SETUP
MAX. FLOW			X	BASIC SETUP
MAX. PRESS. FLOW			X	BASIC SETUP
LOW FLOW CUT-OFF			X	EXTENDED SETUP
SET. L. FL. CUT-OFF			X	EXTENDED SETUP
LINEAR/SQROOT			X	EXTENDED SETUP
SET LRV	X	X	X	BASIC SETUP
SET URV	X	X	X	BASIC SETUP
DAMPING VALUE	X	X	X	BASIC SETUP

   Switch the device off and on to make sure that the parameter settings are stored.

6. Check safety functions if necessary ("Checks", → 45).
7. Close FieldCare. After switching the device off and on after closing FieldCare, reestablished the connection between the device and FieldCare (see step 1).
8. Select the "SAFETY CONFIRM." group.
   (Menu path: OPERATING MENU → SAFETY CONFIRM.).

9. Select the "Lock" option via the SAFETY LOCK parameter. The SAFETY LOCKSTATE parameter displays the status "Unlocked" or "Locked".
10. Enter the password via the SAFETY PASSWORD parameter (password: 7452).
    - If the password entered is correct, the following parameters are reset to the factory settings: CURR. CHARACT., OUTPUT FAIL MODE, ALT. CURR. OUTPUT, SET MAX. ALARM, SET MIN. CURRENT, SIMULATION, ALARM DELAY and ALARM DISPLAY TIME (→ Point 12 for factory values).
    - Any simulation running is terminated.
    - The configurable messages ("Error"-type messages) 115, 120, 620, 715, 716, 717, 718, 720, 726 and 727 are set to "Alarm".
      → Operating Instructions BA00270P/00/EN, section "Messages".

    Record the following confirmed settings according to the "Form for device configuration" (column "Read-out actual value", "→ 54ff).
11. By means of the DIGIT SETS parameter, the user checks whether the characters and digits are displayed correctly on the user interface. "0123456789.-" is displayed if everything is displayed correctly. Options:
    - Valid: Select this option if the string of characters and digits is displayed correctly.
    - Not valid: Select this option if the string of characters and digits is not displayed correctly. In this case, operation in the safe measuring mode is not possible. The confirmation sequence is aborted.
12. By means of the OUTPUT CURRENT parameter, the user can check whether the following parameters are correctly reset to the factory values. If reset correctly, the OUTPUT CURRENT parameter displays "LinMaxNorm/22/3.8/0s". Factory values:
    - CURR. CHARACT.: linear
    - OUTPUT FAIL MODE: max. alarm
    - ALT. CURR. OUTPUT: normal
    - SET MAX. ALARM: 22 mA
    - SET MIN. CURRENT: 3.8 mA
    - ALARM DELAY: 0.0 s
    - ALARM DISPLAY TIME: 0.0 s

    Options:
    - Valid: Select this option if the factory values displayed correspond to the desired values.
    - Not valid: Select this option if the factory values displayed do not correspond to the desired values. In this case, operation in the safe measuring mode is not possible. The confirmation sequence is aborted.
13. The following parameters have to be confirmed depending on the operating mode selected:
    - ACK. ALARM MODE
    - CALIB. OFFSET
    - MEASURING MODE
    - PRESSURE EMPTY (only Level operating mode)
    - EMPTY CALIB. (only Level operating mode)
    - PRESSURE FULL (only Level operating mode)
    - FULL CALIB. (only Level operating mode)
    - MAX. FLOW (only Flow operating mode)
    - MAX. PRESS. FLOW (only Flow operating mode)
    - LOW FLOW CUT-OFF (only Flow operating mode)
    - SET. L. FL. CUT-OFF (only Flow operating mode)
    - LINEAR/SQROOT (only Flow operating mode)
    - SET LRV
    - SET URV
    - DAMPING VALUE

    Options:
    - Valid: Select this option if the value entered or the desired value is displayed.
    - Not valid: Select this option if an incorrect value or a value that was not entered is displayed. In this case, operation in the safe measuring mode is not possible. The confirmation sequence is aborted.

14. Once the safety-related parameters have been successfully interrogated, the password "7452" must be entered again via the CONF. PASSWORD parameter. Afterwards, the device is locked for the safe measuring mode. The SAFETY LOCKSTATE parameter displays the status "Locked". This locking has the highest priority and can only be disabled via the SAFETY LOCK and SAFETY PASSWORD parameters.
→ 45, "Locking/Unlocking" section.
15. Switch the device off and on to make sure that parameter settings for the current ouput, the alarm behavior and locking have been stored. Close FieldCare. After switching the device off and on and after closing FieldCare, reestablished the connection between the device and FieldCare (step 1). Read the parameter out again and compare it to the "Form for device configuration (→ 54ff).

The "Offline" and "FDT-Up-Download" operating options are not allowed for functional safety options.

Observe the status when entering or reading parameters. The status is represented by icons or symbols and may indicate possible errors concerning the data input, the updating of parameters or the connection to the device.
For further information, refer to the FieldCare help.

Parameter description of the SAFETY CONFIRM. group – "Pressure" operating mode

The numbers in brackets indicate the ID numbers of the parameters on the on-site display.

MEASURING MODE = Pressure	
Parameter name	**Description**
SAFETY LOCKSTATE	Displays the device status with regard to the safe measuring mode. **Possibilities:** ▪ Unlocked ▪ Locked **Prerequisites:** ▪ Operating tool or handheld terminal Field Communicator 375, 475
SAFETY LOCK (836)	This parameter offers the following functions: ▪ Check and lock the device for the safe measuring mode. → 21ff for operation via the on-site display or handheld terminal Field Communicator 375, 475 and → 27ff for operation via operating tool. ▪ Disable the lock on the safe measuring mode. → 45, "Locking/Unlocking" section. ▪ On-site display: Displays the device status with regard to the safe measuring mode.
SAFETY PASSWORD (838)	The password has to be entered in the following instances: ▪ Prior to querying safety-related parameters → 21ff for operation via the on-site display or handheld terminal Field Communicator 375, 475 and → 27ff for operation via operating tool. ▪ When unlocking the safe measuring mode → 45, "Locking/Unlocking" section.
DIGIT SETS (841)	This parameter is used to check whether the characters and digits are displayed correctly on the user interface. If the characters and digits are displayed correctly, this parameter displays the character string "0123456789.-". **Options:** ▪ Valid: Select this option if the string of characters and digits is displayed correctly. ▪ Not valid: Select this option if the string of characters and digits is not displayed correctly. In this case, operation in the safe measuring mode is not possible.
OUTPUT CURRENT (875)	For displaying and querying the settings for the CURR. CHARACT., OUTPUT FAIL MODE, ALT. CURR. OUTPUT, SET MAX. ALARM, SET MIN. CURRENT, ALARM DELAY, ALARM DISPLAY TIME parameters. Once you have entered the password correctly for the SAFETY PASSWORD parameter, the following parameters - among others - are reset to the factory setting: ▪ CURR. CHARACT. = linear ▪ OUTPUT FAIL MODE = max. alarm ▪ ALT. CURR. OUTPUT = normal ▪ SET MAX. ALARM = 22 mA ▪ SET MIN. CURRENT = 3.8 mA ▪ ALARM DELAY = 0 s ▪ ALARM DISPLAY TIME = 0 s The OUTPUT CURRENT parameter displays these factory values as "LinMaxNorm22/3.8/0s". **Options:** ▪ Valid: Select this option if the factory values displayed correspond to the desired values. ▪ Not valid: Select this option if the factory values displayed do not correspond to the desired values. In this case, operation of the device in the safe measuring mode is not possible.

MEASURING MODE = Pressure	
Parameter name	**Description**
ACK. ALARM MODE (844)	For displaying and querying the option selected for the ACK. ALARM MODE parameter (MESSAGES group). **Possibilities:** ▪ On ▪ Off **Options:** ▪ Valid: Select this option if the selected and desired value is displayed. ▪ Not valid: Select this option if an incorrect value or a value that was not selected is displayed. In this case, operation of the device in the safe measuring mode is not possible. **NOTICE** **If you selected the "On" option for the ACK. ALARM MODE parameter and an alarm occurs, proceed as follows:** ▸ Rectify the cause of the alarm. ▸ Unlock the device via the SAFETY LOCK and SAFETY PASSWORD parameters. ▸ Acknowledge the alarm via the ACK. ALARM parameter. ▸ Select the "Lock" option for the SAFETY LOCK parameter. ▸ Enter the password for the SAFETY PASSWORD parameter. ▸ Confirm the values and option selected for the parameters queried. ▸ Lock the device via the password.
CALIB. OFFSET (847)	For displaying and querying the value entered or calculated for the CALIB. OFFSET parameter (POSITION ADJUSTMENT group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible. You can also perform position adjustment by means of the POS. ZERO ADJUST or POS. INPUT VALUE parameters. The CALIB. OFFSET parameter then displays the calculated value.
MEASURING MODE (845)	For displaying and querying the set measuring mode. **Possibilities:** ▪ Pressure ▪ Level ▪ Flow **Options:** ▪ Valid (for "Pressure" operating mode): Select this option if the selected and desired value is displayed. ▪ Not valid (for "Level" operating mode and "Flow" operating mode): Select this option if an incorrect value or a value that was not selected is displayed. In this case, operation of the device in the safe measuring mode is not possible.
SET LRV (852)	For displaying and querying the value entered or calculated for the SET LRV (BASIC SETUP or QUICK SETUP group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible. You can also configure the lower-range value via the GET LRV parameter and a pressure present at the device. The SET LRV parameter displays the pressure value that was assigned to the lower-range value.

MEASURING MODE = Pressure	
Parameter name	**Description**
SET URV (853)	For displaying and querying the value entered or calculated for the SET URV parameter (BASIC SETUP or QUICK SETUP group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible. You can also configure the upper-range value via the GET URV parameter and a pressure present at the device. The SET URV parameter displays the pressure value that was assigned to the upper-range value.
DAMPING VALUE (855)	For displaying and querying the value entered for the DAMPING VALUE parameter (BASIC SETUP or QUICK SETUP group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible. Changing the "Damping" DIP switch on the electronic insert does not have any effect on the damping time when operation for the safe measuring mode is locked via SAFETY LOCK (836), SAFETY PASSWORD (838) and CONF. PASSWORD (856). A change only takes effect once operation has been unlocked.
CONF. PASSWORD (856)	Once the safety-related parameters have been successfully interrogated, the password " 7452" must be entered again via the CONF. PASSWORD parameter. Afterwards, the device is locked for the safe measuring mode. The SAFETY LOCKSTATE parameter displays the status "Locked".

Parameter description of the SAFETY CONFIRM. group – "Level" operating mode

The numbers in brackets indicate the ID numbers of the parameters on the on-site display.

MEASURING MODE = Level, LEVEL SELECTION = Level Easy Pressure	
Parameter name	**Description**
SAFETY LOCKSTATE	Displays the device status with regard to the safe measuring mode. **Possibilities:** ▪ Unlocked ▪ Locked **Prerequisites:** ▪ Operating tool or handheld terminal Field Communicator 375, 475
SAFETY LOCK (836)	This parameter offers the following functions: ▪ Check and lock the device for the safe measuring mode. → 📄 21ff for operation via the on-site display or handheld terminal Field Communicator 375, 475 and → 📄 27ff for operation via operating tool. ▪ Disable the lock on the safe measuring mode. → 📄 45, "Locking/Unlocking" section. ▪ On-site display: Displays the device status with regard to the safe measuring mode.
SAFETY PASSWORD (838)	The password has to be entered in the following instances: ▪ Prior to querying safety related parameters → 📄 21ff for operation via the on-site display or handheld terminal Field Communicator 375, 475 and → 📄 27ff for operation via operating tool. ▪ When unlocking the safe measuring mode. → 📄 45, "Locking/Unlocking" section.
DIGIT SETS (841)	This parameter is used to check whether the characters and digits are displayed correctly on the user interface. If the characters and digits are displayed correctly, this parameter displays the character string "0123456789.-". **Options:** ▪ Valid: Select this option if the string of characters and digits is displayed correctly. ▪ Not valid: Select this option if the string of characters and digits is not displayed correctly. In this case, operation in the safe measuring mode is not possible.
OUTPUT CURRENT (875)	For displaying and querying the settings for the CURR. CHARACT., OUTPUT FAIL MODE, ALT. CURR. OUTPUT, SET MAX. ALARM, SET MIN. CURRENT, ALARM DELAY, ALARM DISPLAY TIME parameters. Once you have entered the password correctly for the SAFETY PASSWORD parameter, the following parameters - among others - are reset to the factory setting: ▪ CURR. CHARACT. = linear ▪ OUTPUT FAIL MODE = max. alarm ▪ ALT. CURR. OUTPUT = normal ▪ SET MAX. ALARM = 22 mA ▪ SET MIN. CURRENT = 3.8 mA ▪ ALARM DELAY = 0 s ▪ ALARM DISPLAY TIME = 0 s The OUTPUT CURRENT parameter displays these factory values as "LinMaxNorm22/3.8/0s". **Options:** ▪ Valid: Select this option if the factory values displayed correspond to the desired values. ▪ Not valid: Select this option if the factory values displayed do not correspond to the desired values. In this case, operation of the device in the safe measuring mode is not possible.

MEASURING MODE = Level, LEVEL SELECTION = Level Easy Pressure	
Parameter name	**Description**
ACK. ALARM MODE (844)	For displaying and querying the option selected for the ACK. ALARM MODE parameter (MESSAGES group). **Possibilities:** ▪ On ▪ Off **Options:** ▪ Valid: Select this option if the selected and desired value is displayed. ▪ Not valid: Select this option if an incorrect value or a value that was not selected is displayed. In this case, operation of the device in the safe measuring mode is not possible. **NOTICE** **If you selected the "On" option for the ACK. ALARM MODE parameter and an alarm occurs, proceed as follows:** ▸ Rectify the cause of the alarm. ▸ Unlock the device via the SAFETY LOCK and SAFETY PASSWORD parameters. ▸ Acknowledge the alarm via the ACK. ALARM parameter. ▸ Select the "Lock" option for the SAFETY LOCK parameter. ▸ Enter the password for the SAFETY PASSWORD parameter. ▸ Confirm the values and option selected for the parameters queried. ▸ Lock the device via the password.
CALIB. OFFSET (847)	For displaying and querying the value entered or calculated for the CALIB. OFFSET parameter (POSITION ADJUSTMENT group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible. You can also perform position adjustment by means of the POS. ZERO ADJUST or POS. INPUT VALUE parameters. The CALIB. OFFSET parameter then displays the calculated value.
MEASURING MODE (845)	For displaying and querying the set operating mode. **Possibilities:** ▪ Pressure ▪ Level ▪ Flow **Options:** ▪ Valid (for the "Level" operating mode): Select this option if the selected and desired value is displayed. ▪ Not valid (for the "Pressure" operating mode and "Flow" operating mode): Select this option if an incorrect value or a value that was not selected is displayed. In this case, operation of the device in the safe measuring mode is not possible.
PRESSURE EMPTY (016)	For displaying and querying the value entered for the PRESSURE EMPTY parameter (BASIC SETUP group). **Options:** ▪ Valid: Select this option if the selected and desired value is displayed. ▪ Not valid: Select this option if an incorrect value or a value that was not selected is displayed. In this case, operation of the device in the safe measuring mode is not possible.
EMPTY CALIB. (018)	For displaying and querying the value entered for the EMPTY CALIBRATION parameter (BASIC SETUP group). **Options:** ▪ Valid: Select this option if the selected and desired value is displayed. ▪ Not valid: Select this option if an incorrect value or a value that was not selected is displayed. In this case, operation of the device in the safe measuring mode is not possible.

MEASURING MODE = Level, LEVEL SELECTION = Level Easy Pressure	
Parameter name	**Description**
PRESSURE FULL (015)	For displaying and querying the value entered for the PRESSURE FULL parameter (BASIC SETUP group). **Options:** ▪ Valid: Select this option if the selected and desired value is displayed. ▪ Not valid: Select this option if an incorrect value or a value that was not selected is displayed. In this case, operation of the device in the safe measuring mode is not possible.
FULL CALIB. (017)	For displaying and querying the value entered for the FULL CALIBRATION parameter (BASIC SETUP group). **Options:** ▪ Valid: Select this option if the selected and desired value is displayed. ▪ Not valid: Select this option if an incorrect value or a value that was not selected is displayed. In this case, operation of the device in the safe measuring mode is not possible.
SET LRV (021)	For displaying and querying the value entered for the SET LRV parameter (BASIC SETUP group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible.
SET URV (022)	For displaying and querying the value entered for the SET URV parameter (BASIC SETUP group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible.
DAMPING VALUE (855)	For displaying and querying the value entered for the DAMPING VALUE parameter (BASIC SETUP group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible. Changing the "Damping" DIP switch on the electronic insert does not have any effect on the damping time when operation for the safe measuring mode is locked via SAFETY LOCK (836), SAFETY PASSWORD (838) and CONF. PASSWORD (856). A change only takes effect once operation has been unlocked.
CONF. PASSWORD (856)	Once the safety-related parameters have been successfully interrogated, the password " 7452" must be entered again via the CONF. PASSWORD parameter. Afterwards, the device is locked for the safe measuring mode. The SAFETY LOCKSTATE parameter displays the status "Locked".

Parameter description of the SAFETY CONFIRM. group – "Flow" operating mode

The numbers in brackets indicate the ID numbers of the parameters on the on-site display.

MEASURING MODE = Flow	
Parameter name	**Description**
SAFETY LOCKSTATE	Display of the device status with regard to safe measuring mode **Possibilities:** ▪ Unlocked ▪ Locked **Prerequisite:** ▪ Operating tool or Handheld terminal Field Communicator 375, 475
SAFETY LOCK (836)	This parameter offers the following functions: ▪ Lock device for the safe measuring mode. → 21ff for operation via the on-site display or handheld terminal Field Communicator 375, 475 and → 27ff for operation via operating tool. ▪ Remove lock for the safe measuring mode. → 45, "Locking/Unlocking". ▪ On-site display: Displays the device status with regard to the safe measuring mode.
SAFETY PASSWORD (838)	The password must be entered in the following situations: ▪ Before the safety-relevant parameters are queried → 21ff for operation via the on-site display or handheld terminal Field Communicator 375, 475 and → 27ff for operation via operating tool. ▪ When unlocking the safe measuring mode → 45, "Locking/Unlocking" section.
DIGIT SETS (841)	This parameter is used to check the correct display of characters and digits on the user interface. If the characters and digits are displayed correctly, this parameter displays the string "0123456789.-". **Options:** ▪ Valid: select this option if the character and digit sequence is displayed correctly. ▪ Invalid: select this option if the character and digit chain is not displayed correctly. In this instance, the device cannot be operated in the safe measuring mode.
CURRENT OUTPUT (875)	For displaying and querying the settings for CURR. CHARACT., OUTPUT FAIL MODE, ALT. CURR. OUTPUT., SET MAX. ALARM, SET MIN. CURRENT , ALARM DELAY, ALARM DISPLAY TIME parameters. Once you have entered the correct password for the SAFETY PASSWORD parameter, the following parameters, among others, are reset to the factory setting: ▪ CURR. CHARACT. = Linear ▪ OUTPUT FAIL MODE = Max. alarm ▪ ALT. CURR. OUTPUT. = Normal ▪ SET MAX. ALARM = 22 mA ▪ SET MIN. CURRENT = 3.8 mA ▪ ALARM DELAY = 0 s ▪ ALARM DISPLAY TIME = 0 s The CURRENT OUTPUT parameter displays these factory values as "LinMaxNorm22/3.8/0s". **Options:** ▪ Valid: select this option if the factory values displayed correspond to the desired values. ▪ Invalid: select this option if the factory values displayed do not correspond to the desired values. In this instance, the device cannot be operated in the safe measuring mode.

MEASURING MODE = Flow	
Parameter name	**Description**
ACK. ALARM MODE (844)	For displaying and querying the option selected for the ACK. ALARM MODE (MESSAGES group) **Possibilities:** ▪ On ▪ Off **Options:** ▪ Valid: select this option if the selected and desired value is displayed. ▪ Invalid: select this option if an incorrect value or a value that is not selected is displayed. In this instance, the device cannot be operated in the safe measuring mode. **NOTICE** **Proceed as follows if you selected the "On" option for the ACK. ALARM MODE parameter and an alarm occurs:** ▸ Eliminate the cause of the alarm. ▸ Unlock the device via the SAFETY LOCK and SAFETY PASSWORD parameters. ▸ Acknowledge the alarm by means of the ACK. ALARM parameter. ▸ Select the "Lock" option for the SAFETY LOCK parameter. ▸ Enter the password for the SAFETY PASSWORD parameter. ▸ Confirm the values and selection for the queried parameters. ▸ Lock the device via the password.
CALIB. OFFSET (847)	For displaying and querying the value entered or calculated for the CALIB. OFFSET parameter (POSITION ADJUSTMENT group) **Options:** ▪ Valid: select this option if the entered and desired value is displayed. ▪ Invalid: select this option if a desired value that is not entered is displayed. In this instance, the device cannot be operated in the safe measuring mode. You can also carry out position adjustment by means of the POS. ZERO ADJUST or POS. INPUT VALUE parameters. The CALIB. OFFSET parameter then displays the calculated value.
MEASURING MODE (845)	For displaying and querying the set measuring mode **Possibilities:** ▪ Pressure ▪ Level ▪ Flow **Options:** ▪ Valid (for "Flow" operating mode): select this option if the selected and desired value is displayed. ▪ Invalid (for "Pressure" operating mode and "Level" operating mode): select this option if an incorrect value or a value that is not selected is displayed. In this instance, the device cannot be operated in the safe measuring mode.
MAX. FLOW (848)	For displaying and querying the value entered for the MAX. FLOW parameter (BASIC SETUP group) **Options:** ▪ Valid: select this option if the entered and desired value is displayed. ▪ Invalid: select this option if a desired value that is not entered is displayed. In this instance, the device cannot be operated in the safe measuring mode.
MAX. PRESS. FLOW (849)	For displaying and querying the value entered for the MAX. PRESS. FLOW parameter (BASIC SETUP group) **Options:** ▪ Valid: select this option if the entered and desired value is displayed. ▪ Invalid: select this option if an incorrect value or a value that is not selected is displayed. In this instance, the device cannot be operated in the safe measuring mode.

MEASURING MODE = Flow	
Parameter name	**Description**
LOW FLOW CUT-OFF (850)	For displaying and querying the option selected for the LOW FLOW CUT-OFF parameter (EXTENDED SETUP group) **Options:** ▪ Valid: select this option if the selected and desired value is displayed. ▪ Invalid: select this option if a desired value that is not entered is displayed. In this instance, the device cannot be operated in the safe measuring mode.
SET L. FL. CUT-OFF (851)	For displaying and querying the value entered for the SET. L. FL. CUT-OFF parameter (EXTENDED SETUP group) **Prerequisite:** ▪ LOW FLOW CUT-OFF = On **Options:** ▪ Valid: select this option if the selected and desired value is displayed. ▪ Invalid: select this option if an incorrect value or a value that is not selected is displayed. In this instance, the device cannot be operated in the safe measuring mode.
LINEAR/SQROOT (854)	For displaying and querying the option selected for the LINEAR/SQROOT parameter (OUTPUT group) **Possibilities:** ▪ Differential pres. ▪ Flow (square root) **Options:** ▪ Valid: select this option if the selected and desired value is displayed. ▪ Invalid: select this option if an incorrect value or a value that is not selected is displayed. In this instance, the device cannot be operated in the safe measuring mode.
SET LRV (852)	For displaying and querying the value entered or calculated for the SET LRV parameter (BASIC SETUP or QUICK SETUP group) **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible.
SET URV (853)	For displaying and querying the value entered or calculated for the SET URV parameter (BASIC SETUP or QUICK SETUP group) **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible.
DAMPING VALUE (855)	For displaying and querying the value entered for the DAMPING VALUE parameter (BASIC SETUP group). **Options:** ▪ Valid: Select this option if the value entered and desired is displayed. ▪ Not valid: Select this option if a value that was not entered or desired is displayed. In this case, operation of the device in the safe measuring mode is not possible. Changing the "Damping" DIP switch on the electronic insert does not have any effect on the damping time when operation for the safe measuring mode is locked via SAFETY LOCK (836), SAFETY PASSWORD (838) and CONF. PASSWORD (856). A change only takes effect once operation has been unlocked.
CONF. PASSWORD (856)	Once the safety-related parameters have been successfully interrogated, the password " 7452" must be entered again via the CONF. PASSWORD parameter. Afterwards, the device is locked for the safe measuring mode. The SAFETY LOCKSTATE parameter displays the status "Locked".

Standard device configuration via on-site-display

1. Reset the parameters to their factory setting: with the "7864" reset code.
(→Operating Instructions BA00270P/00/EN, section "Factory setting (reset)".
Check default values, number formats and parameter designations using the "Form for device configuration" (column "factory settings", → 54ff).

NOTICE

The following operating steps may no longer be performed after this reset:
▸Position adjustment or setting the measuring range on site without using the on-site display
▸Download
▸Configuration backup using HistoROM®/M-DAT
▸Reset apart from reset code "7864"
▸Current trimming
▸Sensor recalibration ("note", → 40)
▸Selecting "Level Easy Height" and "Level Easy Standard" for the LEVEL SELECTION parameter.
▸Set the parameters as follows:
- with software version < 02.20 "Bus Address" unequal "0"
- with software version ≥ 02.20: "Output Fail Mode" = "Hold", "Current Mode" = "Fixed" (on-site display) or "Disabled" (HART handheld terminal)

2. By means of the DIGIT SETS parameter, check whether the characters and digits are displayed correctly on the user interface. "0123456789.-" is displayed if everything is displayed correctly.
(Menu path: (GROUP SELECTION →) OPERATING MENU → DISPLAY)

3. Configure the device and log settings manually.
For the configuration → Operating Instructions BA00270P/00/EN and BA00274P/00/EN.
Switch the device off and on to make sure that the parameter settings are stored.

   Observe the prescribed parameters in accordance with the "Form for device configuration:
   - for "Pressure", → 54
   - for "Level" ("Level Easy Pressure" level selection), → 56
   - for "flow", → 58

   In addition, the permitted parameter settings (→ 16, → 40) must be taken.

4. Check safety functions if necessary ("Checks", → 45).

5. Read out the specified parameters and compare it to the "Form for device configuration", → 54ff.

6. Lock the device via software and/or hardware.
→ Operating Instructions BA00270P/00/EN, section "Locking/unlocking operation".

7. Read out and log the CONFIG. COUNTER parameter.
(Menu path: (GROUP SELECTION →) OPERATING MENU → TRANSMITTERINFO → TRANSMITTER DATA)

Permitted parameter setting:

Functional group (menu path)	Parameter and setting
OUTPUT (GROUP SELECTION →) OPERATING MENU → OUTPUT	▪ CURR. CHARACT. = linear[1)] ▪ OUTPUT FAIL MODE = max. alarm[1)] or min. alarm[2)] ▪ ALT. CURR. OUTPUT = normal[1)] ▪ SET MAX. ALARM = 22 mA[1)] ▪ SET MIN. CURRENT = 3.8 mA[1)]
MESSAGES (GROUP SELECTION →) OPERATING MENU → DIAGNOSIS → MESSAGES	▪ ALARM DELAY = 0.0 s[1)] ▪ ALARM DISPLAY TIME = 0.0 s[1)] ▪ All configurable messages (Error-type message) have to be set to "Alarm" apart from messages 620, 730, 731, 732, 733 and 740.[1)] → Operating Instructions BA00270P/00/EN, section "Messages" and section "Response of the outputs to error" and Operating Instructions BA00274P/00/EN, parameter descriptions for MESSAGES and SELECT ALARM TYPE.
SIMULATION MODE (GROUP SELECTION →) OPERATING MENU → SIMULATION	– SIMULATION = none[3)]

1) With the "Increased security during parameter entry" method, these parameters are automatically set to the corresponding values once the correct password has been entered.

2) The "Min. alarm" setting is only possible with the "Standard device configuration" method.

3) With the "Increased security during parameter entry" method, any simulation running is terminated automatically once the correct password has been entered.

- If the device has assumed a fault condition, i.e. an alarm is output and the current output assumes the set value, the cause of the fault must first be eliminated.
- "Level" operating mode, "Level Easy Pressure" level selection: The PRESSURE EMPTY and PRESSURE FULL parameters are only displayed for the "Dry" CALIBRATION MODE. If you have performed a wet calibration, you subsequently have to select the "Dry" option by means of the CALIBRATION MODE parameter. You can read out the corresponding values for the PRESSURE EMPTY and PRESSURE FULL parameters here.
- The sensor can only be recalibrated by Endress+Hauser Service.
  All parameters, except the parameters for a sensor recalibration, are reset with the "7864" reset code. Therefore, the parameters have to be checked prior to locking via the SAFETY CONFIRM. menu.

Standard device configuration via handheld terminal Field Communicator 375, 475

When the connection to the handheld terminal has been established, proceed as follows:

1. Select "Main Menu" > "HART Communication" in "Hart application" > "Online". The device will automatically be found and opened online. Make sure that the bus address of the device is = 0.
2. Make sure the connection has been established to the correct device. This can be checked using the: measuring point, extended order code or serial number parameters.
3. Reset the parameters to their factory setting: with the "7864" reset code.
   (→Operating Instructions BA00270P/00/EN, section "Factory setting (reset)").
   Check default values, number formats and parameter designations using the "Form for standard device configuration" (column "Factory settings", → 54ff).

NOTICE

The following operating steps may no longer be performed after this reset:
- ▸Position adjustment or setting the measuring range on site without using the on-site display
- ▸Download
- ▸Configuration backup using HistoROM®/M-DAT
- ▸Reset apart from reset code "7864"
- ▸Current trimming
- ▸Sensor recalibration ("note", → 42)
- ▸Selecting "Level Easy Height" and "Level Easy Standard" for the LEVEL SELECTION parameter.
- ▸Set the parameters as follows:
  - with software version < 02.20 "Bus Address" unequal "0"
  - with software version ≥ 02.20: "Output Fail Mode" = "Hold", "Current Mode" = "Fixed" (on-site display) or "Disabled" (HART handheld terminal)

4. By means of the DIGIT SETS parameter, check whether the characters and digits are displayed correctly on the user interface. "0123456789.-" is displayed if everything is displayed correctly. (Menu path: (GROUP SELECTION →) OPERATING MENU → DISPLAY)
5. Configure the device and log settings manually.
   For the configuration → Operating Instructions BA00270P/00/EN and BA00274P/00/EN.
   Switch the device off and on to make sure that parameter settings are stored. Close the application on the handheld terminal. After switching off and on reestablished the connection between the device and the handheld terminal (see step 1).

   Observe the prescribed parameters in accordance with the form:
   - for "Pressure", → 54
   - for "Level" ("Level Easy Pressure" level selection), → 56
   - for "flow", → 58

   In addition, the permitted parameter settings (→ 16, → 42) must be taken.
6. Check safety functions if necessary. (→ 45, "Checks").
7. Read out the specified parameters and compare against the log. Observe the form.
8. Lock the device via software and/or hardware.
   → Operating Instructions BA00270P/00/EN, section "Locking/unlocking operation".
9. Read out and log the CONFIG. COUNTER parameter.
   (Menu path: (GROUP SELECTION →) OPERATING MENU → TRANSMITTERINFO → TRANSMITTER DATA)

The "Offline" operating option is not allowed for functional safety applications. Make sure that no messages as such "Device disconnected" occur during the configuration.

Permitted parameter setting:

Functional group (menu path)	Parameter and setting
OUTPUT (GROUP SELECTION →) OPERATING MENU → OUTPUT	▪ CURR. CHARACT. = linear[1)] ▪ OUTPUT FAIL MODE = max. alarm[1)] or min. alarm[2)] ▪ ALT. CURR. OUTPUT = normal[1)] ▪ SET MAX. ALARM = 22 mA[1)] ▪ SET MIN. CURRENT = 3.8 mA[1)]
MESSAGES (GROUP SELECTION →) OPERATING MENU → DIAGNOSIS → MESSAGES	▪ ALARM DELAY = 0.0 s[1)] ▪ ALARM DISPLAY TIME = 0.0 s[1)] ▪ All configurable messages (Error-type message) have to be set to "Alarm" apart from messages 620, 730, 731, 732, 733 and 740.[1)] → Operating Instructions BA00270P/00/EN, section "Messages" and section "Response of the outputs to error" and Operating Instructions BA00274P/00/EN, parameter descriptions for MESSAGES and SELECT ALARM TYPE.
SIMULATION MODE (GROUP SELECTION →) OPERATING MENU → SIMULATION	SIMULATION = none[3)]

1) With the "Increased security during parameter entry" method, these parameters are automatically set to the corresponding values once the correct password has been entered.

2) The "Min. alarm" setting is only possible with the "Standard device configuration" method.

3) With the "Increased security during parameter entry" method, any simulation running is terminated automatically once the correct password has been entered.

- If the device has assumed a fault condition, i.e. an alarm is output and the current output assumes the set value, the cause of the fault must first be eliminated.
- "Level" operating mode, "Level Easy Pressure" level selection: The PRESSURE EMPTY and PRESSURE FULL parameters are only displayed for the "Dry" CALIBRATION MODE. If you have performed a wet calibration, you subsequently have to select the "Dry" option by means of the CALIBRATION MODE parameter. You can read out the corresponding values for the PRESSURE EMPTY and PRESSURE FULL parameters here.
- The sensor can only be recalibrated by Endress+Hauser Service.
  All parameters, except the parameters for a sensor recalibration, are reset with the "7864" reset code. Therefore, the parameters have to be checked prior to locking via the SAFETY CONFIRM. menu.

Standard device configuration via the FieldCare operating program

After connecting FieldCare, proceed as follows:

1. There are the following two ways to established the communication:
   – Select the "HART communication" connection wizard. The device will automatically been found and opened online. Make sure that the bus address of the device is = 0.
   – Go to the tree structure and select "Create projects" > "Add device" > "HART communication" before selecting "Create network". The device is opened online. Make sure that the bus address of the device is = 0.
2. Make sure the connection has been established to the correct device. This can be checked using the: measuring point, extended order code or serial number parameters.
3. Reset the parameters to their factory setting: with the "7864" reset code.
   (→Operating Instructions BA00270P/00/EN, section "Factory setting (reset)".
   Check default values, number formats and parameter designations using the form for standard device configuration (column "factory settings", → 54ff).

NOTICE

The following operating steps may no longer be performed after this reset:
▸Position adjustment or setting the measuring range on site without using the on-site display
▸Download
▸Configuration backup using HistoROM®/M-DAT
▸Reset apart from reset code "7864"
▸Current trimming
▸Sensor recalibration ("note", → 44)
▸Selecting "Level Easy Height" and "Level Easy Standard" for the LEVEL SELECTION parameter.
▸Set the parameters as follows:
- with software version < 02.20 "Bus Address" unequal "0"
- with software version ≥ 02.20: "Output Fail Mode" = "Hold", "Current Mode" = "Fixed" (on-site display) or "Disabled" (HART handheld terminal)

4. By means of the DIGIT SETS parameter, check whether the characters and digits are displayed correctly on the user interface. "0123456789.-" is displayed if everything is displayed correctly.
   (Menu path: (GROUP SELECTION →) OPERATING MENU → DISPLAY)
5. Configure the device and log settings manually.
   For the configuration → Operating Instructions BA00270P/00/EN and BA00274P/00/EN.
   Switch the device off and on to make sure that parameter settings are stored. Close FieldCare.
   After switching the device off and on and after closing FieldCare, reestablished the connection between the device and FieldCare (see step 1).

   Observe the prescribed parameters in accordance with the form:
   - for "Pressure", → 54
   - for "Level" ("Level Easy Pressure" level selection), → 56
   - for "flow", → 58

   In addition, the permitted parameter settings (→ 16, → 44) must be taken.
6. Check safety functions if necessary ("Checks", → 45).
7. Read out the specified parameters and compare against the log. Observe the form.
8. Lock the device via software and/or hardware.
   → Operating Instructions BA00270P/00/EN, section "Locking/unlocking operation".
9. Read out and log the CONFIG. COUNTER parameter.
   (Menu path: (GROUP SELECTION →) OPERATING MENU → TRANSMITTERINFO→ TRANSMITTER DATA)

The "Offline" and "FDT-Up-Download" operating options are not allowed for functional safety options.

Observe the status when entering or reading parameters. The status is represented by icons or symbols and may indicate possible concerning the data input, the updating of parameters or the connection to the device.
For further information, refer to the FieldCare help.

Permitted parameter setting:

Functional group (menu path)	Parameter and setting
OUTPUT (GROUP SELECTION →) OPERATING MENU → OUTPUT	▪ CURR. CHARACT. = linear[1)] ▪ OUTPUT FAIL MODE = max. alarm[1)] or min. alarm[2)] ▪ ALT. CURR. OUTPUT = normal[1)] ▪ SET MAX. ALARM = 22 mA [1)] ▪ SET MIN. CURRENT = 3.8 mA [1)]
MESSAGES (GROUP SELECTION →) OPERATING MENU → DIAGNOSIS → MESSAGES	▪ ALARM DELAY = 0.0 s[1)] ▪ ALARM DISPLAY TIME = 0.0 s[1)] ▪ All configurable messages (Error-type message) have to be set to "Alarm" apart from messages 620, 730, 731, 732, 733 and 740.[1)] → Operating Instructions BA00270P/00/EN, section "Messages" and section "Response of the outputs to error" and Operating Instructions BA00274P/00/EN, parameter descriptions for MESSAGES and SELECT ALARM TYPE.
SIMULATION MODE (GROUP SELECTION →) OPERATING MENU → SIMULATION	SIMULATION = none[3)]

1) With the "Increased security during parameter entry" method, these parameters are automatically set to the corresponding values once the correct password has been entered.

2) The "Min. alarm" setting is only possible with the "Standard device configuration" method.

3) With the "Increased security during parameter entry" method, any simulation running is terminated automatically once the correct password has been entered.

- If the device has assumed a fault condition, i.e. an alarm is output and the current output assumes the set value, the cause of the fault must first be eliminated.
- "Level" operating mode, "Level Easy Pressure" level selection: The PRESSURE EMPTY and PRESSURE FULL parameters are only displayed for the "Dry" CALIBRATION MODE. If you have performed a wet calibration, you subsequently have to select the "Dry" option by means of the CALIBRATION MODE parameter. You can read out the corresponding values for the PRESSURE EMPTY and PRESSURE FULL parameters here.
- The sensor can only be recalibrated by Endress+Hauser Service.
  All parameters, except the parameters for a sensor recalibration, are reset with the "7864" reset code. Therefore, the parameters have to be checked prior to locking via the SAFETY CONFIRM. menu.

Checks

After entering all the parameters, check the safety function prior to the locking sequence by means of the SIMULATION MODE parameter or by approaching the limit pressure, for example.
(→ Operating Instructions BA00274P/00/EN SIMULATION MODE parameter description.)
The entire safety function should be checked after each change to the Deltabar S as part of a safety function, e.g. a change to the orientation of the device or the configuration.

Locking/Unlocking

⚠ WARNING

Changes to the measuring system or parameters can affect the safety function.

- ▸ After entering all the parameters and checking the safety function, the operation of the device must be locked since.

Increased security during parameter entry

Locking

With the "Increased security during parameter entry" method, the device is locked by a password at the end of the locking sequence.

- via local operation or handheld terminal Field Communicator 375, 475 , → 📄 21ff
- via operating tool, → 📄 27ff

Locking by password has the highest priority and can only be disabled via the SAFETY LOCK and SAFETY PASSWORD parameters.

Unlocking

1. Select the "SAFETY CONFIRM." group.
   (Menu path: (GROUP SELECTION →) OPERATING MENU → SAFETY CONFIRM.).
2. Select the "Unlock" option via the SAFETY LOCK parameter.
3. Enter the password "7452" via the SAFETY PASSWORD parameter. If the password entered is correct, the SAFETY LOCK or SAFETY LOCKSTATE parameter displays the status "Unlocked".

Standard device configuration

If you are using the "Standard device configuration" method (→ 📄 39), the device has to be locked via the software and/or the hardware.
→ Operating Instructions BA00270P/00/EN, section "Locking/Unlocking operation".

The damping setting via DIP switch 2 (damping on/off) is independent of software locking and/or hardware locking. Therefore the switch setting must be used as per the factory setting: on (damping on). The damping value can be set to 0 s where needed.

Proof-test

Proof-test

Safety functions must be tested at appropriate intervals to ensure that they are functioning correctly and are safe. The intervals have to be specified by the operator ("Proof-test interval" graphic, → 11). The test must be carried out in such a way that it is proven that the protection equipment functions perfectly in interaction with all the components.

The following section describes two possible procedures for recurrent testing to uncover dangerous undetected device failures. They differ in terms of the percent rate of detection.

If the device has assumed a fault condition, i.e. an alarm is output and the current output assumes the set value, the cause of the fault must first be eliminated.

Proof-test 1:

This test detects approx. 50% of the possible dangerous undetected device failures.

1. Bypass safety PLC or take other suitable measures to prevent alarms from being triggered by mistake.
2. Disable locking ("Locking/Unlocking", → 45).
3. Set the current output of the transmitter to HI alarm via a HART command or by means of the on-site display and check whether the analog current signal reaches this value.
   - e.g. simulate an alarm by means of the SIMULATION MODE and SIM. ERROR NO. parameters.

   This test detects problems based on voltages that are not compliant with the standard, e.g. due to too low a current loop supply voltage or increased cable resistance, and checks possible faults in the transmitter electronics.
4. Set the current output of the transmitter to LO alarm via a HART command or by means of the on-site display and check whether the analog current signal reaches this value.
   - e.g. set the ALARM RESPONSE parameter to "Min. alarm".
   - Simulate an alarm by means of the SIMULATION MODE and SIM. ERROR NO. parameters.

   This test detects any problems in conjunction with quiescent currents.
5. Restore the complete operativeness of the current loop.
6. Disable safety PLC bypassing or restore normal operation in some other way.
7. Once the recurrent test has been carried out, the results must be documented and stored in a suitable manner.

Proof-test 2:

This test detects approx. 99% of the possible dangerous undetected device failures.

1. Perform steps 1 to 4 outlined under recurrent test 1.
2. Compare the pressure measured value displayed to the pressure present and check the current output. During this test, suitable processes, measuring resources and references must be used.
   - For the lower-range value (4 mA value) and the upper-range value (20 mA value), compare the pressure present to the measured pressure.
   - If the measured pressure deviates from the pressure present at the device, the reference pressure present must be reassigned to the 4 mA value and the 20 mA value.
     FFor the 4 mA value, → Operating Instructions BA00274P/00/EN, parameter descriptions for SET LRV (245) and GET LRV (309) for pressure measurement, SET LRV (013) for level measurement (LEVEL SELECTION "Level Easy Pressure") and SET LRV (637) for flow measurement.
     For the 20 mA value, → Operating Instructions BA00274P/00/EN, parameter descriptions for SET URV (246) and GET URV (310) for pressure measurement, SET URV (012) for level measurement (LEVEL SELECTION "Level Easy Pressure") and SET URV (638) for flow measurement.
   - Compare the pressure measured value displayed to the pressure present and check the current output a second time. If there are any deviations, please contact Endress+Hauser Service.
3. Perform steps 5 to 7 outlined under proof-test 1.

Regarding step 2 of proof-test 2:
After this procedure, the current value is output correctly. The value displayed, e.g. on the on-site display, and the digital value via HART can deviate from the pressure actually present. If the display value and digital value are also to be corrected, please contact Endress+Hauser Service.

Repair

Repair

Repair means a one-to-one replacement of components.

Repairs on the devices must always be carried out by Endress+Hauser.
Safety functions cannot be guaranteed if repairs are carried out by anybode else.

Exceptions:
Qualified personnel may replace the following components on the condition that original spare parts are used and the relevant Installation Instructions are observed:

Component	Installation Instructions	Checking the device after repair
Adapter	EA01021P/00/A2	Proof-test 1 Proof-test 2 (alternative)
Display module	KA00601P/00/A2	
Push buttons of the housing	KA00610P/00/A2	
Cover	EA01062F/00/A2	
Set of gasket	EA01062F/00/A2	
Electronic[1)]	KA00678P/00/A2	
Vent valve		
Flange	EA01007P/00/A2	
	EA01011P/00/A2	
Housing	EA01013P/00/A2	
	EA01015P/00/A2	
Housing filter	EA01078P/00/A2	
	EA01062P/00/A2	
HistoROM	KA00599P/00/A2	
Cable	KA00671P/00/A2	
Cable entry	EA00006P/00/A2	
Cable gland	EA00006P/00/A2	
Clamp	KA00602F/00/A2	
Measuring range tag		
Mounting kit	EA00005P/00/A2	
	EA01016P/00/A2	
	KA00649P/00/A2	
O-ring	EA00005P/00/A2	
Sensor[1)]	EA01007P/00/A2	
	EA01009P/00/A2	
	EA00005P/00/A2	
Connector	EA00006P/00/A2	

1) Proof-test 2 is applied.

The replaced components must be sent to Endress+Hauser for the purpose of fault analysis, if the device has been operated in protective system.
In the event of failure of a SIL-labeled Endress+Hauser device, which has been operated in a protection function, the "Declaration of Contamination and Cleaning" with the corresponding note "Used as SIL device in protection system" must be enclosed when the defective device is returned
Please refer to the section "Return" in the Operating Instructions ("Supplementary device documentation", → 7).

Appendix

Notes on the redundant connection of multiple sensors for SIL 3

With redundant connection with HFT = 1 (e.g. coincidence logic 1oo2 or 2oo3), the Deltabar S meets the requirements for SIL 3.

The common cause factors β and β_D indicated in the table below are minimum values for the Deltabar S. These values should be used when calculating the failure probability of redundantly connected the device units as per IEC 61508-6.
The system-specific observation can return higher values depending on the actual installation and the use of other components (e.g. Ex barriers).

Minimum value β with homogeneous redundant use	5%
Minimum value β_D with homogeneous redundant use	2%

Failure Modes, Effects and Diagnostic Analysis

Project:

Smart Pressure Transmitter Cerabar S / Deltabar S Evolution

Customer:

Endress+Hauser GmbH+Co. KG
Maulburg
Germany

Contract No.: E+H 03/03-22
Report No.: E+H 03/03-22 R022
Version V1, Revision R1.1, April 2004
Stephan Aschenbrenner

Management summary for Deltabar S Evolution

This report summarizes the results of the FMEDA carried out on the smart pressure transmitter Deltabar S Evolution with 4..20 mA output / HART® electronics and software version V2.00. Table 1 gives an overview of the different types that belong to the considered pressure transmitter Deltabar S Evolution.

Table 1: Version overview

	Type	Application	Sensor	Electronics
V4	PMD70	Differential pressure, mass flow	capacitive ceramic sensor 1 mbar – 3 bar	928750-1000-A 928750-2000-A 928751-1000-A 928640-1000-c 928617-1000-b 928646-1000-b
	FMD76	Differential pressure, level	capacitive ceramic sensor -100..100 mbar -3..3 bar	
V5	PMD75	Differential pressure, mass flow, level	piezo resistive metal sensor -10..10 mbar, -40..40 bar	928750-1000-A 928750-2000-A 928751-1000-A 928640-1000-c 928617-1000-b 928643-1000-c
	FMD77	Differential pressure, level	piezo resistive metal sensor -100..100 mbar -16..16 bar	
	FMD78	Differential pressure, level	piezo resistive metal sensor -100..100 mbar -16..16 bar	

For safety applications only the 4..20 mA output / HART® electronics was considered. All other possible output variants or electronics are not covered by this report. The different devices can be equipped with or without display.

The failure rates used in this analysis are the basic failure rates from the Siemens standard SN 29500.

According to table 2 of IEC 61508-1 the average PFD for systems operating in low demand mode has to be $\geq 10^{-3}$ to $< 10^{-2}$ for SIL 2 safety functions. A generally accepted distribution of PFD_{AVG} values of a SIF over the sensor part, logic solver part, and final element part assumes that 35% of the total SIF PFD_{AVG} value is caused by the sensor part. For a SIL 2 application the total PFD_{AVG} value of the SIF should be smaller than 1,00E-02, hence the maximum allowable PFD_{AVG} value for the sensor part would then be 3,50E-03.

The smart pressure transmitter Deltabar S Evolution with 4..20 mA output / HART® electronics is considered to be a Type B[1] component with a hardware fault tolerance of 0.

For Type B components with a hardware fault tolerance of 0 the SFF shall be > 90% according to table 3 of IEC 61508-2 for SIL 2 (sub-) systems.

Type B component: "Complex" component (using micro controllers or programmable logic); for details see 7.4.3.1.3 of IEC 61508-2.

Endress+Hauser did a qualitative analysis of the sensors (see [D13] to [D16].This analysis was used by *exida.com* to calculate the failure rates of the sensors using different failure rate databases ([N5], [N6] and [N7]) for the different components of the sensors (see [R8] to [R11]). The results of the qualitative analysis based on field data evaluation of the process seal and the diaphragm (see [R12] to [R14]) are used for the calculations described in section 5.7 to 5.8.

Assuming that a connected logic solver can detect both over-range (fail high) and under-range (fail low), high and low failures can be classified as safe detected failures or dangerous detected failures depending on whether the smart pressure transmitter Deltabar S Evolution with 4..20 mA output / HART® electronics is used in an application for “low level monitoring”, “high level monitoring” or “range monitoring”. For these applications the following tables show how the above stated requirements are fulfilled.

Table 2: Summary for version V4 – Failure rates

Failure category (Failure rates in FIT)		Fail-safe state = “fail high”	Fail-safe state = “fail low”
Fail High (detected by the logic solver)		876	
Fail detected (int. diag.)	807		
Fail high (inherently)	69		69
Fail Low (detected by the logic solver)			859
Fail detected (int. diag.)	807		
Fail low (inherently)	52	52	
Fail Dangerous Undetected		57	57
No Effect		165	165
Annunciation Undetected		10	10
Not part		237	237
MTBF = MTTF + MTTR		82 years	82 years

Transmitter configured fail-safe state = “fail high” – Failure rates according to IEC 61508

Failure Categories	λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S [2]	DC_D [2]
$\lambda_{low} = \lambda_{Sd}$ $\lambda_{high} = \lambda_{dd}$	52 FIT	175 FIT	876 FIT	57 FIT	95,0%	22,9%	93,9%
$\lambda_{low} = \lambda_{dd}$ $\lambda_{high} = \lambda_{sd}$	876 FIT	175 FIT	52 FIT	57 FIT	95,0%	83,3%	47,7%
$\lambda_{low} = \lambda_{sd}$ $\lambda_{high} = \lambda_{sd}$	928 FIT	175 FIT	0 FIT	57 FIT	95,0%	84,1%	0%

Transmitter configured fail-safe state = “fail low” – Failure rates according to IEC 61508

Failure Categories	λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
$\lambda_{low} = \lambda_{sd}$ $\lambda_{high} = \lambda_{dd}$	859 FIT	175 FIT	69 FIT	57 FIT	95,0%	83,1%	54,8%
$\lambda_{low} = \lambda_{dd}$ $\lambda_{high} = \lambda_{sd}$	69 FIT	175 FIT	859 FIT	57 FIT	95,0%	28,3%	93,8%
$\lambda_{low} = \lambda_{sd}$ $\lambda_{high} = \lambda_{sd}$	928 FIT	175 FIT	0 FIT	57 FIT	95,0%	84,1%	0%

Table 3: Summary for version V4 – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 2,51E-04	PFD_{AVG} = 1,25E-03	PFD_{AVG} = 2,50E-03

[2] DC means the diagnostic coverage (safe or dangerous) of the safety logic solver for the smart pressure transmitter Deltabar S Evolution with 4..20 mA output / HART® electronics.

Table 4: Summary for version V5 – Failure rates

Failure category (Failure rates in FIT)		Fail-safe state = "fail high"	Fail-safe state = "fail low"
Fail High (detected by the logic solver)		396	
Fail detected (int. diag.)	327		
Fail high (inherently)	69		69
Fail Low (detected by the logic solver)			379
Fail detected (int. diag.)	327		
Fail low (inherently)	52	52	
Fail Dangerous Undetected		69	69
No Effect		430	430
Annunciation Undetected		10	10
Not part		237	237
MTBF = MTTF + MTTR		96 years	96 years

Transmitter configured fail-safe state = "fail high" – Failure rates according to IEC 61508

Failure Categories	λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
$\lambda_{low} = \lambda_{Sd}$ $\lambda_{high} = \lambda_{dd}$	52 FIT	440 FIT	396 FIT	69 FIT	92,8%	10,6%	85,2%
$\lambda_{low} = \lambda_{dd}$ $\lambda_{high} = \lambda_{sd}$	396 FIT	440 FIT	52 FIT	69 FIT	92,8%	47,4%	43,0%
$\lambda_{low} = \lambda_{sd}$ $\lambda_{high} = \lambda_{sd}$	448 FIT	440 FIT	0 FIT	69 FIT	92,8%	50,5%	0%

Transmitter configured fail-safe state = "fail low" – Failure rates according to IEC 61508

Failure Categories	λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_S	DC_D
$\lambda_{low} = \lambda_{sd}$ $\lambda_{high} = \lambda_{dd}$	379 FIT	440 FIT	69 FIT	69 FIT	92,8%	46,3%	50,0%
$\lambda_{low} = \lambda_{dd}$ $\lambda_{high} = \lambda_{sd}$	69 FIT	440 FIT	379 FIT	69 FIT	92,8%	13,6%	84,6%
$\lambda_{low} = \lambda_{sd}$ $\lambda_{high} = \lambda_{sd}$	448 FIT	440 FIT	0 FIT	69 FIT	92,8%	50,5%	0%

Table 5: Summary for version V5 – PFD_{AVG} values

T[Proof] = 1 year	T[Proof] = 5 years	T[Proof] = 10 years
PFD_{AVG} = 3,02E-04	PFD_{AVG} = 1,51E-03	PFD_{AVG} = 3,01E-03

The boxes marked in yellow ( ) mean that the calculated PFD_{AVG} values are within the allowed range for SIL 2 according to table 2 of IEC 61508-1 but do not fulfill the requirement to not claim more than 35% of this range, i.e. to be better than or equal to 3,50E-03. The boxes marked in green ( ) mean that the calculated PFD_{AVG} values are within the allowed range for SIL 2 according to table 2 of IEC 61508-1 and table 3.1 of ANSI/ISA–84.01–1996 and do fulfill the requirement to not claim more than 35% of this range, i.e. to be better than or equal to 3,50E-03.

Because the Safe Failure Fraction (SFF) is above 90% for all considered versions, also the architectural constraints requirements of table 3 of IEC 61508-2 for Type B subsystems with a Hardware Fault Tolerance (HFT) of 0 are fulfilled.

A user of the smart pressure transmitter Deltabar S Evolution with 4..20 mA output / HART® electronics can utilize these failure rates along with the failure rates for an impulse line, when required, in a probabilistic model of a safety instrumented function (SIF) to determine suitability in part for safety instrumented system (SIS) usage in a particular safety integrity level (SIL). A full table of failure rates for different operating conditions is presented in section 5.7 to 5.8 along with all assumptions.

It is important to realize that the "don't care" failures and the "annunciation" failures are included in the "safe undetected" failure category according to IEC 61508. Note that these failures on its own will not affect system reliability or safety, and should not be included in spurious trip calculations.

Certificate

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Product Service

CERTIFICATE

No. Z10 16 09 20351 005

Holder of Certificate: Endress+Hauser GmbH+Co. KG
Hauptstr. 1
79689 Maulburg
GERMANY

Factory(ies): 20351

Certification Mark:

Product: Pressure Meters

Model(s): Pressure Transmitter
S-Class Evolution

Parameters:

Software:	SIL3
Structure-SIL:	1oo1 – SIL2
Output:	4 … 20mA
Error current:	<=3,6mA or >=21,0mA
Protection class:	IP66/67

The report and the user documentation in the current valid revision are mandatory part of this certificate. The product complies with the following safety requirements only if the specifications documentent in the currently valid Revision of this report are met. The certified components are listed in report EM64891C-A in the current valid revision.

Tested according to:
IEC 61508-1(ed.2)
IEC 61508-2(ed.2)
IEC 61508-3(ed.2)
IEC 61508-4(ed.2)

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. See also notes overleaf.

Test report no.: EM64891C

Valid until: 2021-09-11

Date, 2016-09-12 (Peter Weiss)

719620

Page 1 of 1

TÜV SÜD Product Service GmbH · Zertifizierstelle · Ridlerstraße 65 · 80339 München · Germany

TÜV®

A1 / 04.11

TUEV_EN

Form for device configuration – Pressure

Operation via: Handheld terminal ☐ FieldCare ☐ On-Site display ☐
Device designation: _____ Serial number: _____
Measuring point: _____ Upper range limit (URL Sensor): _____

Parameter name	Display ID	Groupe	Factory setting[1)]	Permitted settings	Specified value	Read-out actual value	Checked
Digits Set	840	→ Display			01234567890.-		
Calib. Offset	319	→ Position Adjustm.	0.0	[2)]			
Measuring Mode	389		Pressure		Pressure		
Set LRV	245	→ Quick Setup/ Basic Setup	0.0[3)]	[2)]			
Set URV	246		URL Sensor[3)]	[2)]			
Damping Value	247		2.0 s	0 to 999 s			
Press Eng. Unit	060	→ Basic Setup	mbar / bar[3), 4)]	all, except "User unit"			
Curr. Charact.	695	→ Output	Linear	Linear			
Output Fail Mode	388		Max. alarm	Max. alarm Min. alarm			
Alt. Current Output	597		Normal	Normal			
Max. Alarm Current	342		22 mA	22 mA			
Set Min. Current	343		3.8 mA	3.8 mA			
Simulation Mode	413	→ Simulation	None	None			
Ack. Alarm Mode	401	→ Messages	Off	Off / On			
Error no. Select alarm type The following messages must be set to "Alarm":	595 / 600						
115 Sensor over pressure			Warning	Alarm			
120 Sensor low pressure			Warning				
715 Sensor over temperature			Warning				
716 Proce. iso. diaphrg. broken			Alarm				
717 Transmitter over pressure			Warning				
718 Transmitter under temp.			Warning				
720 Sensor under temperature			Warning				
726 Sens. temp. error-overrange			Warning				
727 Sens. pres. error-overrange			Warning				
The following message must be set to "Alarm" or "Warning"							
620 Current output out of range			Warning	Alarm or Warning			
Alarm Delay	336		0.0 s	0.0 s			
Alarm Displ. Time	480		0.0 s	0.0 s			

Parameter name	Display ID	Groupe	Factory setting[1)]	Permitted settings	Specified value	Read-out actual value	Checked
Current Mode[5)]	052	→ HART Data	▪ Signaling[6)] ▪ Enabled[7)]	▪ Signaling[6)] ▪ Enabled[7)]			
Bus address	345		0	0			
After locking: Config. Recorder	352	→ Transmitter data					

1) After performing the reset with the reset code "7864"

2) Within sensor range

3) According to ordering specifications

4) Depending on the "Press. Sens. Hilim (485)" parameter

5) Only for software version ≥ 02.20

6) On-site display and FieldCare

7) HART handheld terminal

Company: _____ Date: _____ Signature: _____

Form for device configuration – Level

Operation via: Handheld terminal ☐ FieldCare ☐ On-Site display ☐
Device designation: _____ Serial number: _____
Measuring point: _____ Upper range limit (URL Sensor): _____

Parameter name	Display ID	Groupe	Factory setting[1)]	Permitted settings	Specified value	Read-out actual value	Checked
Digits Set	840	→ Display			01234567890.-		
Calib. Offset	319	→ Position Adjustm.	0.0	[2)]			
Measuring mode	389		Pressure		Level		
Level Selection	020		Level Easy Pressure	Level Easy Pressure			
Empty Calib.	010	→ Basic Setup	0.0%[3)]				
Empty Pressure	011		0.0[3)]	[2)]			
Full Calib.	004		100.0%[3)]				
Full Pressure	005		URL Sensor[3)]	[2)]			
Set LRV	013		0.0%[3)]				
Set URV	012		100.0%[3)]				
Damping Value	247		2.0 s	0 to 999 s			
Press. Eng. Unit	060		mbar / bar [3), 4)]	all, except "User unit"			
Output Unit	023		%[3)]				
Adjust Density	007	→ Extended Setup	1.0 kg/dm³	= Process Density (025)			
Current Carract.	695	→ Output	Linear	Linear			
Output Fail Mode	388		Max. Alarm	Max. Alarm Min. Alarm			
Alt. Current Output	597		Normal	Normal			
Max. Alarm Current	342		22 mA	22 mA			
Set Min. Current	343		3.8 mA	3.8 mA			
Simulation Mode	413	→ Simulation	None	None			

Parameter name	Display ID	Groupe	Factory setting[1)]	Permitted settings	Specified value	Read-out actual value	Checked
Ack. Alarm Mode	401	→ Messages	Off	Off / On			
Error no. Select alarm types The following messages must be set to "Alarm":	595 / 600						
115 Sensor over pressure			Warning	Alarm			
120 Sensor low pressure			Warning				
715 Sensor over temperature			Warning				
716 Proce. iso. diaphrg. broken			Alarm				
717 Transmitter over pressure			Warning				
718 Transmitter under temp.			Warning				
720 Sensor under temperature			Warning				
726 Sens. temp. error-overrange			Warning				
727 Sens. pres. error-overrange			Warning				
The following message must be set to "Alarm" or "Warning"							
620 Current output out of range			Warning	Alarm or Warning			
Alarm Delay	336		0.0 s	0.0 s			
Alarm Display Time	480		0.0 s	0.0 s			
Current Mode[5)]	052	→ HART Data	▪ Signaling[6)] ▪ Enabled[7)]	▪ Signaling[6)] ▪ Enabled[7)]			
Bus Address	345		0	0			
after locking: Config. Recorder	352	→ Transmitter data					

1) After performing the reset with the reset code "7864"

2) Within sensor range

3) According to ordering specifications

4) Depending on the "Press. Sens. Hilim (485)" parameter

5) Only for software version ≥ 02.20

6) On-site display and FieldCare

7) HART handheld terminal

Company: _____ Date: _____ Signature: _____

Form for device configuration – Flow

Operation via: Handheld terminal ☐ FieldCare ☐ On-Site display ☐
Device designation: _____ Serial number: _____
Measuring point: _____ Upper range limit (URL Sensor): _____

Parameter name	Display ID	Groupe	Factory setting[1)]	Permitted settings	Specified value	Read-out actual value	Checked
Digits Set	840	→ Display			01234567890.-		
Calib. Offset	319	→ Position Adjustm.	0.0	[2)]			
Measuring Mode	389		Pressure		Flow		
Max. Flow	311	→ Quick Setup / Basic Setup	1.0[3)]				
Max. Press. Flow	634		URL Sensor[3)]	[2)]			
Damping Value	247		2.0 s	0 to 999 s			
Press. Eng. Unit	060		mbar / bar[3),4)]	all, except "User unit"			
Flow-Meas. Type	640	→ Extended Setup	Volume p. cond.[3)]				
Unit Flow[3), 5)]	391		m^3/s	all, except "User unit"			
Norm Flow Unit[3), 5)]	661		Nm^3/s				
Std. Flow Unit[3), 5)]	660		Sm^3/s				
Mass Flow Unit[3), 5)]	571		kg/s				
Low Flow Cut-Off	442		Off	Off / On			
Set L. Fl. Cut-Off	323		5%	0 to 50% of Max. Flow			
Set LRV[6)]	637		0.0[3)]				
Set URV[6)]	638		Max. Flow[3)]				
Set LRV[7)]	245		0.0[3)]	[2)]			
Set URV[7)]	246		URL Sensor[3)]	[2)]			
Curr. Carract.	695	→ Output	Linear	Linear			
Output Fail Mode	388		Max. Alarm	Max. Alarm Min. Alarm			
Alt. Current Output	597		Normal	Normal			
Max. Alarm Current	342		22 mA	22 mA			
Set Min. Current	343		3.8 mA	3.8 mA			
Linear/Sqroot.	390		Flow (square root)	Differential pressure/ Flow (square root)			
Simulation mode	413	→ Simulation	None	None			

Parameter name	Display ID	Groupe	Factory setting[1)]	Permitted settings	Specified value	Read-out actual value	Checked
Ack. Alarm Mode	401	→ Messages	Off	Off / On			
Error no. Select alarm types The following messages must be set to "Alarm":	595 / 600						
115 Sensor over pressure			Warning	Alarm			
120 Sensor low pressure			Warning				
715 Sensor over temperature			Warning				
716 Proce. iso. diaphrg. broken			Alarm				
717 Transmitter over pressure			Warning				
718 Transmitter under temp.			Warning				
720 Sensor under temperature			Warning				
726 Sens. temp. error-overrange			Warning				
727 Sens. pres. error-overrange			Warning				
The following message must be set to "Alarm" or "Warning"							
620 Current output out of range			Warning	Alarm or Warning			
Alarm Delay	336		0.0 s	0.0 s			
Alarm Display Time	480		0.0 s	0.0 s			
Current Mode[8)]	052	→ HART Data	▪ Signaling[9)] ▪ Enabled[10)]	▪ Signaling[9)] ▪ Enabled[10)]			
Bus Address	345		0	0			
after locking: Config. Recorder	352	→ Transmitter data					

1) After performing the reset with the reset code "7864"

2) Within sensor range

3) According to ordering specifications

4) Depending on the "Press. Sens. Hilim (485)" parameter

5) Only one value can be entered. Which one it is, is dependent on the "Flow Meas. Type (640)" parameter.

6) Linear / Sqroot. = Flow (square root)

7) Linear / Sqroot. = Differential pressure

8) Only for software version ≥ 02.20

9) On-site display and FieldCare

10) HART handheld terminal

Company: _____ Date: _____ Signature: _____

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