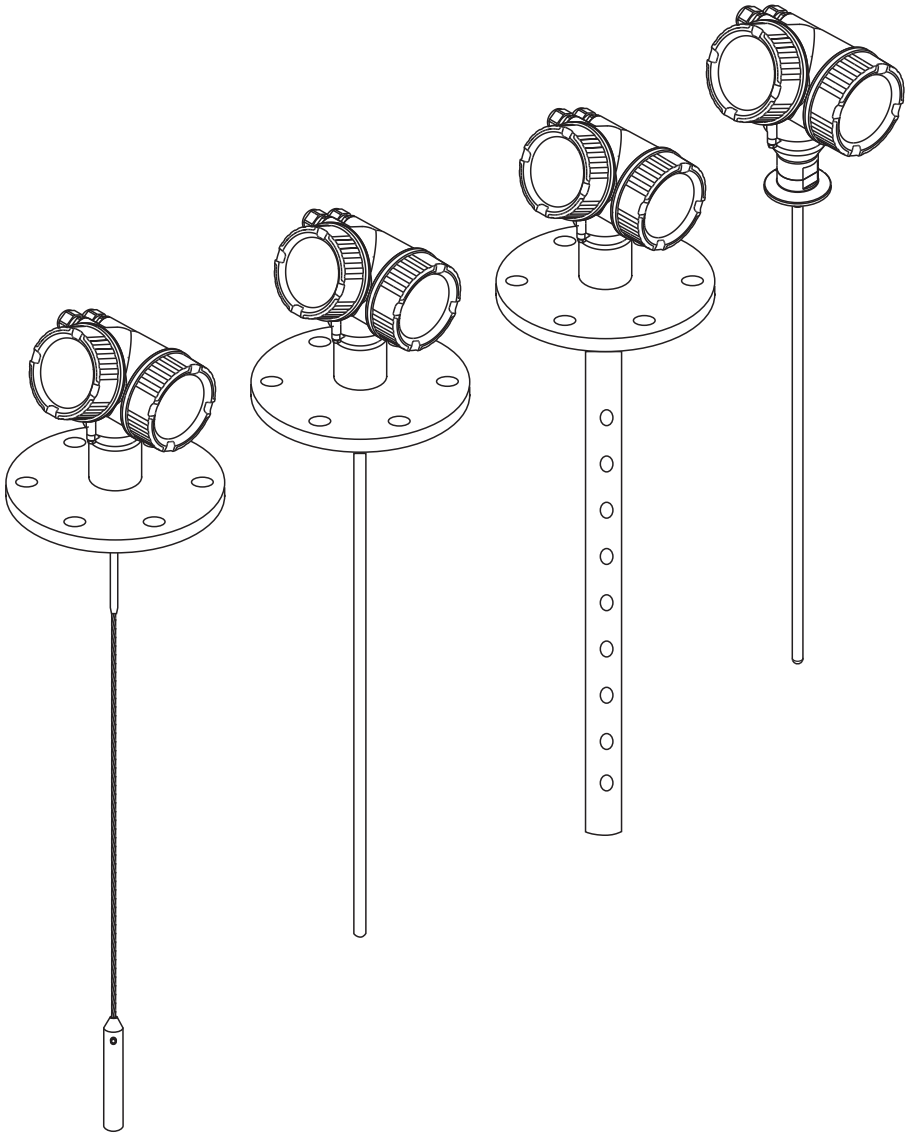
GP01015F/00/EN/02.15
71293584
01.01.zz (Device software)

Description of Device Parameters
Levelflex FMP50, FMP51, FMP52, FMP53, FMP54, FMP55, FMP56, FMP57
FOUNDATION Fieldbus

Guided wave radar



Endress+Hauser
People for Process Automation

Table of contents

1 Important document information

1.1 Document function

The document is part of the Operating Instructions and serves as a reference for parameters, providing a detailed explanation of each individual parameter of the operating menu.

1.2 Symbols

1.2.1 Symbols for certain types of information

Symbol	Meaning
	**Tip** Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
	Operation via local display
	Operation via operating tool
	Write-protected parameter

1.2.2 Symbols in graphics

Symbol	Meaning	Symbol	Meaning
1, 2, 3 ...	Item numbers	A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections		

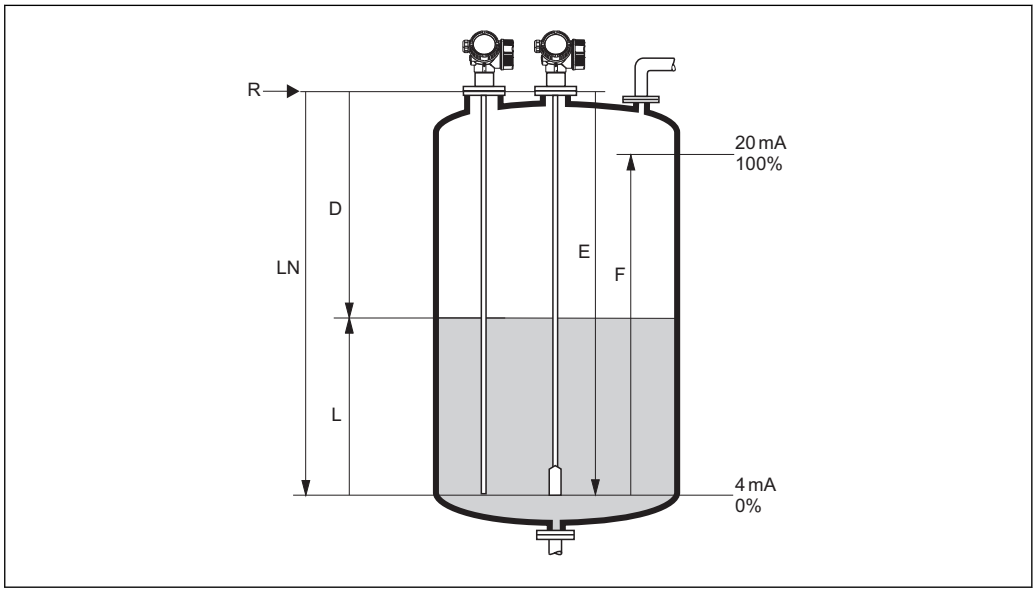
2 Basic principles

2.1 Time-of-Flight principle

The Levelflex uses the guided propagation and reflection of electromagnetic pulses in order to determine the distance to a target object. The time that passes between emitting and receiving the pulses is a measurement for the distance to the object. Since the pulses have to travel to the object and back, the distance D is the result of half of the product of the duration t and the velocity of propagation c:

$D = \Delta t \times c/2$

From D, the level is then calculated with the help of the calibration parameters.



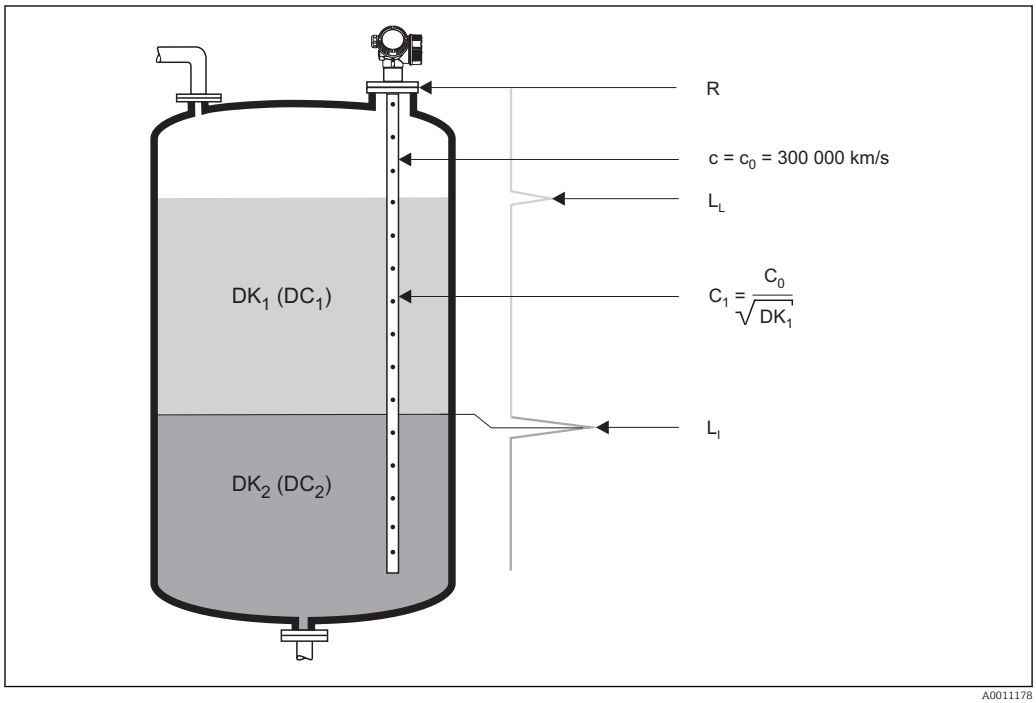
1 *Calibration parameters for the time-of-flight principle*

LN Length of the probe
D Distance
L Level
R Reference point of the measurement
E Empty calibration (= zero)
F Full calibration (= span)

2.2 Interface measurement

Interface measurement is possible with FMP51, FMP52, FMP54 and FMP55. It can be activated via the **Operating mode** parameter (→ 45).

When the high-frequency pulses hit the surface of the medium, only a percentage of the transmission pulse is reflected. In the case of media with a low dielectric constant DC_1, in particular, the other part penetrates the medium. The pulse is reflected once more at the interface point to a second medium with a higher dielectric constant, DC_2. The distance to the interface layer can now also be determined taking into account the delayed time-of-flight of the pulse through the upper medium.



2 *Interface measurement with the guided radar*

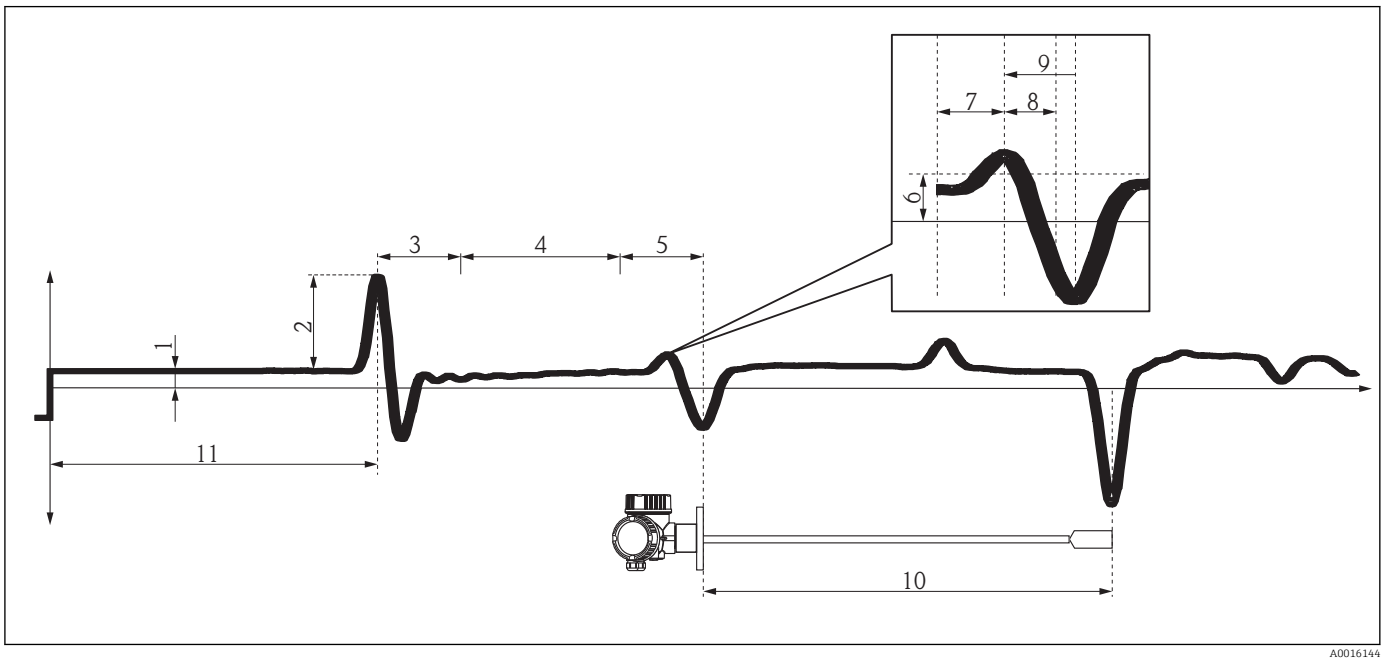
Preconditions for an interface measurement

- The dielectric constant (DC) of the upper medium must be known and constant. Dielectric constants for many media commonly used in the industry are summarized in the document CD00019F, which can be downloaded from the Endress+Hauser web page (www.endress.com). In addition, if the interface thickness is existing and known, the DC can be calculated automatically via FieldCare.
- The DC of the upper medium may not be greater than 10.
- The DC difference between the upper medium and lower medium must be > 10
- The upper medium must have a minimum thickness of 60 mm (2.4 in).

For dielectric constants (DC values) of many media commonly used in various industries refer to:
- the Endress+Hauser DC manual (CP01076F)
- the Endress+Hauser "DC Values App" (available for Android and iOS)

2.3 Envelope curve

The Levelflex emits individual pulses in quick succession and scans their reflection again with a fluctuating delay. The amounts of entergy received are arranged according to their time of flight. The graphic represenataion of this sequence is called "envelope curve". The following diagram shows a sketch of a typical envelope curve:



3 *Important features of the envelope curve*

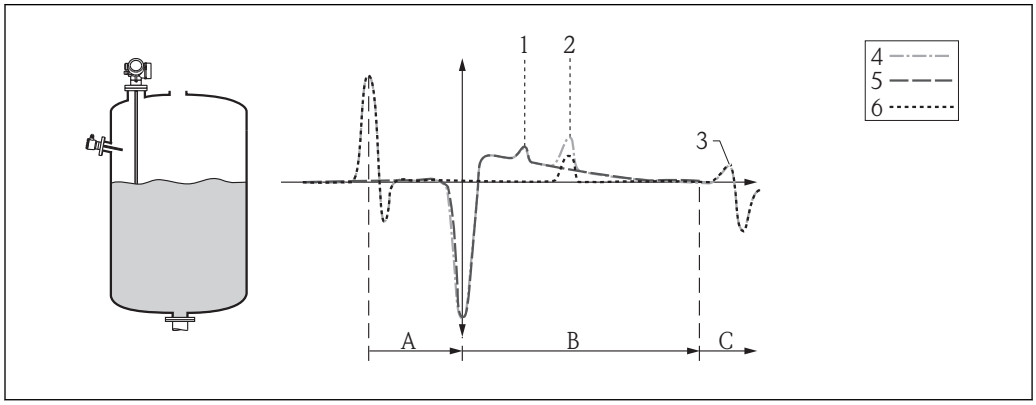
1 *Envelope curve offset*
2 *Reference echo amplitude*
3 *Electronics zero distance*
4 *Cable zero distance*
5 *Antenna zero distance*
6 *Threshold fine zero distance*
7 *Fine zero distance window left*
8 *Fine zero distance window right*
9 *Fine zero distance*
10 *Physical length of the probe (LN)*
11 *Reference echo position*

2.4 Mapping and subtracted curve

The mapping is used to suppress static interference signals which may be generatet by internal tank or silo fittings. A **mapping curve**, representing the **envelope curve** of an empty tank or silo as precisely as possible, is used for the mapping.

After a mapping, the signal evaluation does not use the envelope curve but the **subtracted curve**, instead:

Subtracted curve = Envelope curve - Mapping curve



4 *Mapping and subtracted curve*

1 Interference echo
2 Level echo
3 End-of-probe echo
4 Envelope curve
5 Mapping curve
6 Subtracted curve
A Internal area (Z distances)
B Level area
C End-of-probe area (EOP)

2.5 Echo tracking

Levelflex uses an echo tracking algorithm. This means, echoes in subsequent envelope curves are not evaluated independently but are considered to be a sequence of moving echos. To do so, each echo is surrounded by a window of a certain width and the echo is searched for within this window in the next envelope curve. If an echo of this type is found, it is allocated to the "track" of the previous echo. Each track can be assigned a specific meaning (level echo track, interface echo track, end-of-probe echo track, multiple echo track).

For a given installation, these tracks are in a well-defined relationship to each other. This relationship is recorded during the measuruement such that later on reliable measuring values can be obtained even if the echo is temporarily lost or if the device is temporarily switched off.

For details on the echo tracking refer to: → 138.

2.6 Capacitance measurement (only for FMP55)

In the case of FMP55, the guided radar can be combined with a capacitance measurement. The capaciatance measurement can be used to increase the reliability of the guided radar or to obtain interface values even if the interface echo is lost.

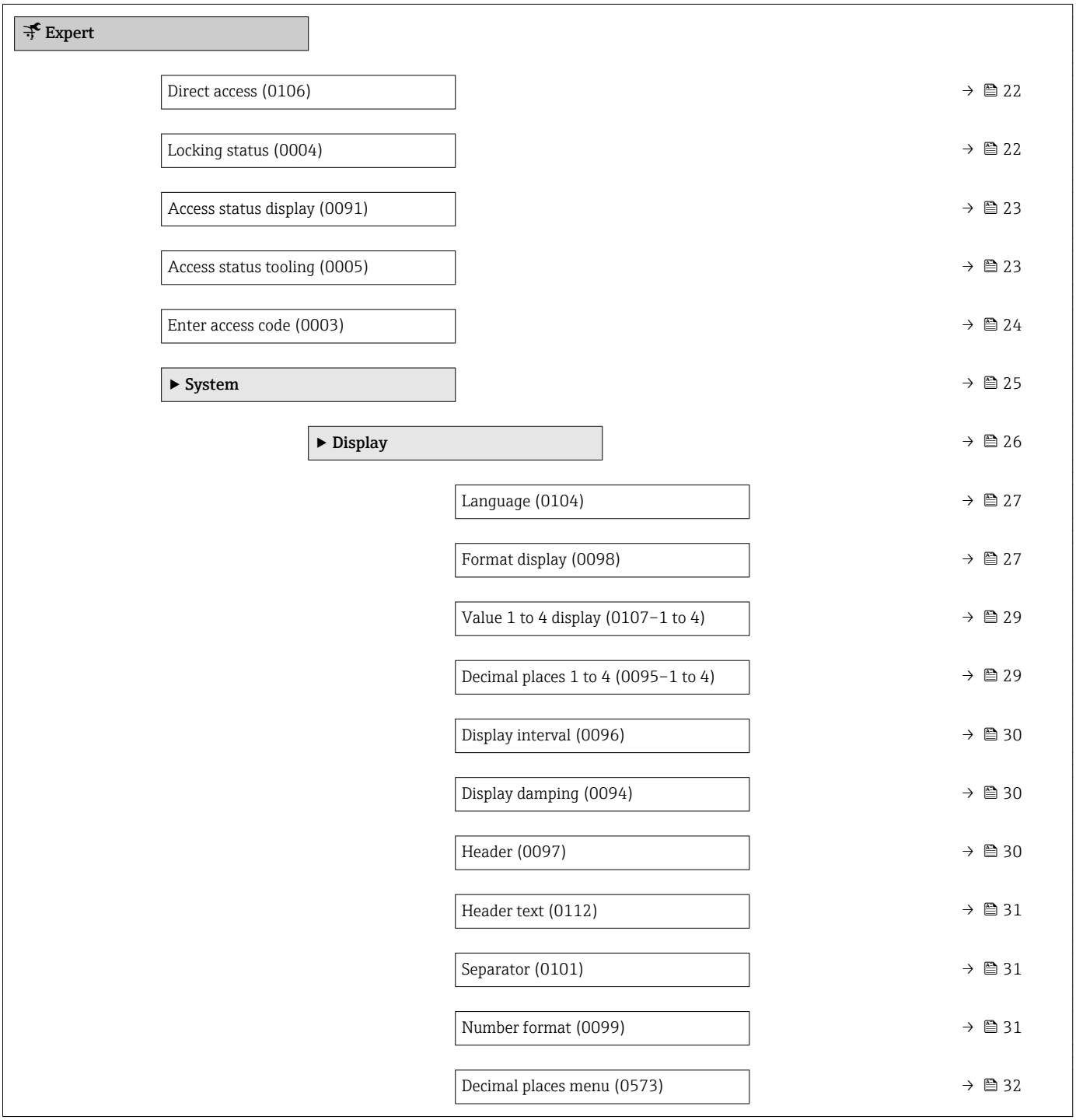
For details on the combination of guided radar and capacitance measurement refer to:
→ 🖹 148

Capacitance measurement is only possible if the electrical conductivity of the two media fulfills the following conditions:
- Conductivity of the upper medium: < 1 µS/cm
- Conductivity of the lower medium: > 100 µS/cm

3 Overview of the operating menu

- The following table lists all parameters the "Expert" menu may contain. The page number refers to where a description of the parameter can be found.
- Depending on the device version and parametrization some parameters will not be available in a given situation. For details on the conditions refer to the "Prerequisite" category in the description of the respective parameter.
- The representation essentially corresponds to the menu seen when using an operating tool (e.g. FieldCare). On the local display there may be minor differences in the menu structure. Details are mentioned in the description of the respective submenu.

Navigation Expert

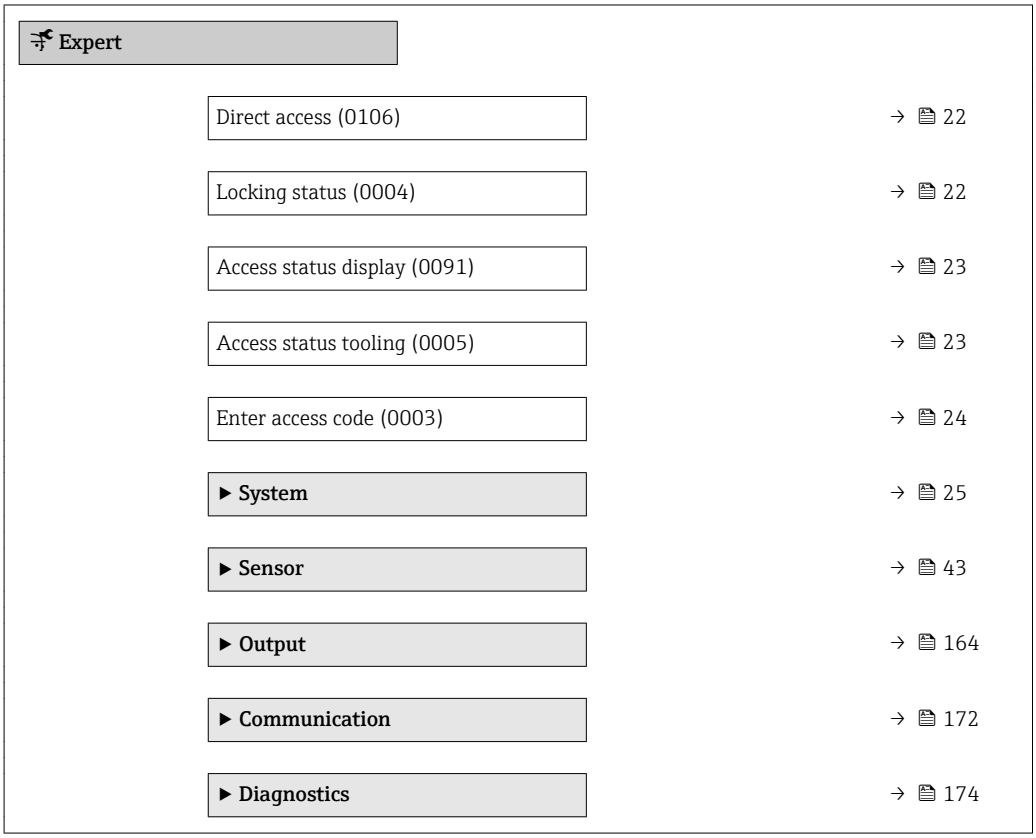


4 "Expert" menu

The **Expert** menu contains all parameters of the device. It is structured according to the function blocks of the device.

4.1 Structure of the menu

Navigation Expert



4.2 Description of parameters

Navigation Expert

Direct access

Navigation Expert → Direct access (0106)

Description Enter the access code of a parameter in order to access this parameter directly (i.e. without navigation).

User entry 0 to 65 535

Factory setting 0

Additional information The direct access code consists of a five digit number and an optional channel code, which specifies an input or output channel, e.g. 00353-2
- Leading zeros need not to be entered.
  Example: You may enter "353" instead of "00353"
- If the channel code is not entered, channel 1 is automatically selected.
  Example: By entering "353" you access the following parameter: Curr.output 1 → Current span (0353–1)
- In order to access a different channel: Enter the direct access code with the channel code.
  Example: By entering "353-2" you access the following parameter: Curr.output 2 → Current span (0353–2)

In this document, the direct access code is added in brackets after the parameter name in the *Navigation* category.

Locking status

Navigation Expert → Locking status (0004)

Description Indicates the write protection with the highest priority that is currently active.

User interface
- Hardware locked
- Temporarily locked

Additional information

Meaning and priorities of the types of write protection

- **Hardware locked (priority 1)**
  The DIP switch for hardware locking is activated on the main electronics module. This locks write access to the parameters.
- **SIL locked (priority 2)**
  The SIL mode is activated. Writing access to the relevant parameters is denied.
- **WHG locked (priority 3)**
  The WHG mode is activated. Writing access to the relevant parameters is denied.
- **Temporarily locked (priority 4)**
  Write access to the parameters is temporarily locked on account of internal processes in progress in the device (e.g. data upload/download, reset etc.). The parameters can be modified as soon as the processes are complete.

On the display module, the 🔒-symbol appears in front of parameters that cannot be modified since they are write-protected.

Access status display

Navigation Expert → Access stat.disp (0091)

Prerequsite The device has a local display.

Description Indicates access authorization to parameters via local display.

User interface

- Operator
- Maintenance
- Service

Additional information

If a 🔒 symbol appears in front of a parameter, the parameter cannot be changed via the local display with the current access authorization.

The access authorization can be changed via the **Enter access code** parameter (→ 24).

If additional write protection is active, this restricts the current access authorization even further. The write protection status can be viewed via the **Locking status** parameter (→ 22).

Access status tooling

Navigation Expert → Access stat.tool (0005)

Description Indicates access authorization to parameters via operating tool (e.g. FieldCare).

User interface

- Operator
- Maintenance
- Service

Additional information

The access authorization can be changed via the **Enter access code** parameter (→ 24).

If additional write protection is active, this restricts the current access authorization even further. The write protection status can be viewed via the **Locking status** parameter (→ 22).

Enter access code

Navigation

Expert → Ent. access code (0003)

Description

Enter access code to disable write protection of parameters.

User entry

0 to 9 999

Additional information

- For local operation, the customer-specific access code, which has been defined in the **Define access code** parameter (→ 40), has to be entered.
- If an incorrect access code is entered, the user retains his current access authorization.
- The write protection affects all parameters marked with the -symbol in this document. On the local display, the -symbol in front of a parameter indicates that the parameter is write-protected.
- If no key is pressed for 10 min, or the user switches from the navigation and editing mode back to the measured value display mode, the device automatically locks the write-protected parameters after another 60 s.

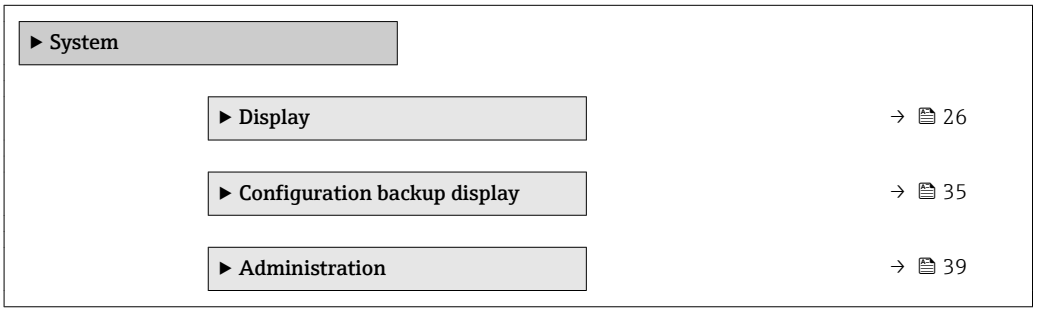
Please contact your Endress+Hauser Sales Center if you lose your access code.

4.3 "System" submenu

The **System** submenu contains all general parameters which affect neither the measurement nor the measured value communication.

4.3.1 Structure of the submenu

Navigation Expert → System



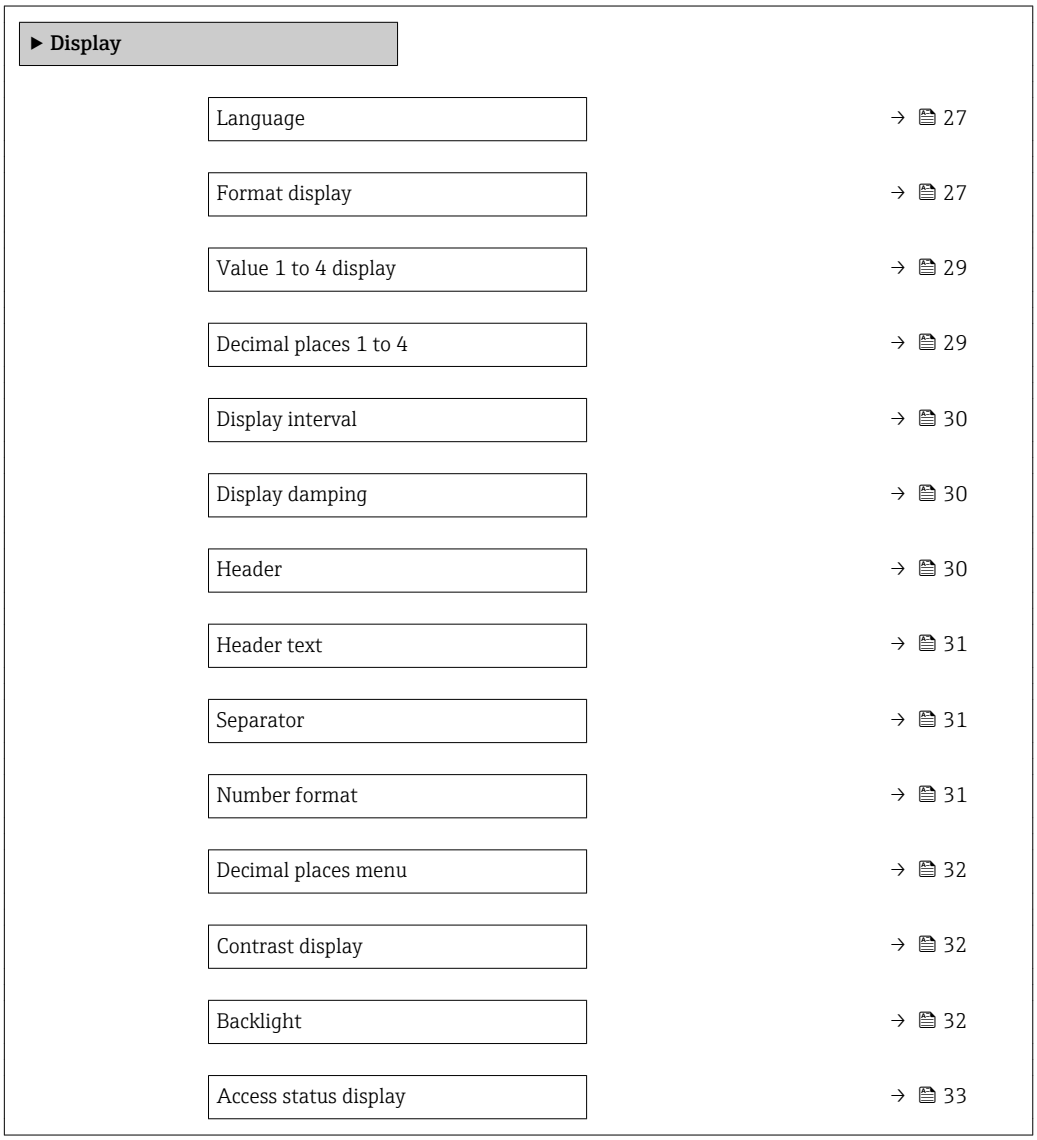
4.3.2 "Display" submenu

The **Display** submenu is used to configure the representation of measured values on the local display module. Up to four measured values can be allocated to the local display module. Additionally, display characteristics such as the format of numbers, the associated texts or the display contrast can be configured.

This submenu is only visible if a display module is connected to the device.

Structure of the submenu

Navigation Expert → System → Display



Description of parameters

Navigation Expert → System → Display

Language

Navigation Expert → System → Display → Language (0104)

Description Set display language.

Selection
- English
- Deutsch *
- Français *
- Español *
- Italiano *
- Nederlands *
- Portuguesa *
- Polski *
- русский язык (Russian) *
- Svenska *
- Türkçe *
- 中文 (Chinese) *
- 日本語 (Japanese) *
- 한국어 (Korean) *
- العَرَبيّة (Arabic) *
- Bahasa Indonesia *
- ภาษาไทย (Thai) *
- tiếng Việt (Vietnamese) *
- čeština (Czech) *

Factory setting The additional language selected in feature 500 of the product structure.
If no additional language has been selected: **English**

Additional information The **English** option can be selected in every device. One additional operating language can be selected in the product structure when ordering a device (feature 500 "Additional Operation Language") and will be selectable in the **Language** parameter.

Format display

Navigation Expert → System → Display → Format display (0098)

Description Select how measured values are shown on the display.

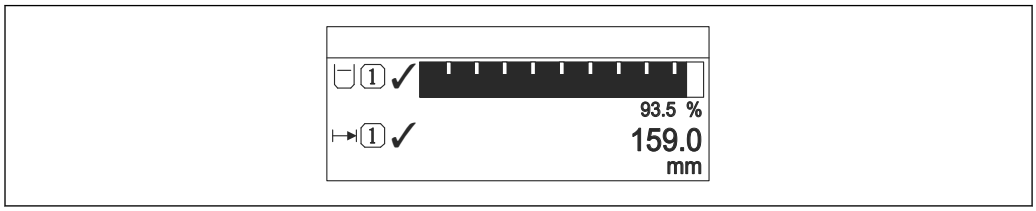
Selection
- 1 value, max. size
- 1 bargraph + 1 value
- 2 values
- 1 value large + 2 values
- 4 values

* Visibility depends on order options or device settings

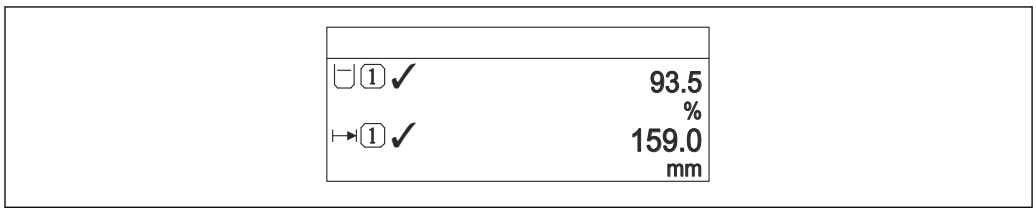
Factory setting 1 value, max. size

Additional information

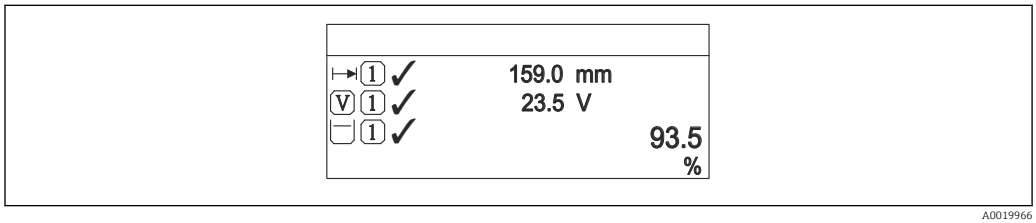
5 *"Format display" = "1 value, max. size"*



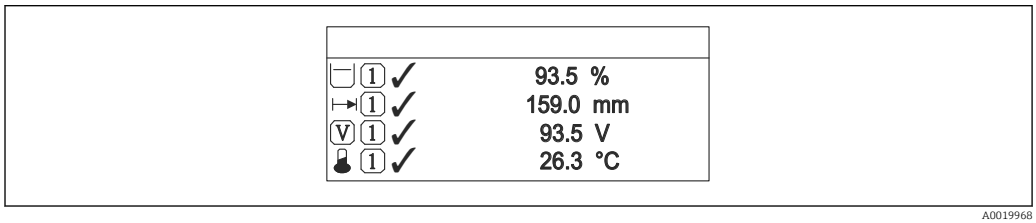
6 *"Format display" = "1 bargraph + 1 value"*



7 *"Format display" = "2 values"*



8 *"Format display" = "1 value large + 2 values"*



9 *"Format display" = "4 values"*

- The **Value 1 to 4 display** → 29 parameters specify which measured values are shown on the display and in which order.
- If more measured values are specified than the current display mode permits, the values alternate on the device display. The display time until the next change is configured in the **Display interval** parameter (→ 30).

Value 1 to 4 display

Navigation Expert → System → Display → Value 1 display (0107)

Description Select the measured value that is shown on the local display.

Selection
- None [19]
- Level linearized
- Distance
- Interface linearized
- Interface distance
- Thickness upper layer
- Current output 1 [20]
- Measured current
- Current output 2
- Terminal voltage
- Electronic temperature
- Measured capacitance
- Analog output adv. diagnostics 1
- Analog output adv. diagnostics 2

Factory setting

For level measurements
- Value 1 display: Level linearized
- Value 2 display: Distance
- Value 3 display: Current output 1
- Value 4 display: None

For interface measurements and one current output
- Value 1 display: Interface linearized
- Value 2 display: Level linearized
- Value 3 display: Thickness upper layer
- Value 4 display: Current output 1

For interface measurements and two current outputs
- Value 1 display: Interface linearized
- Value 2 display: Level linearized
- Value 3 display: Current output 1
- Value 4 display: Current output 2

Decimal places 1 to 4

Navigation Expert → System → Display → Decimal places 1 to 4 (0095–1 to 4)

Description Select the number of decimal places for the display value.

Selection
- x
- x.x
- x.xx
- x.xxx
- x.xxxx

19) can not be selected for the 'Value 1 display" parameter.
20) "Visibility depends on order options or device settings"

Factory setting x.xx

Additional information The setting does not affect the measuring or computational accuracy of the device.

Display interval

Navigation Expert → System → Display → Display interval (0096)

Description Set time measured values are shown on display if display alternates between values.

User entry 1 to 10 s

Factory setting 5 s

Additional information This parameter is only relevant if the number of selected measuring values exceeds the number of values the selected display format can display simultaneously.

Display damping

Navigation Expert → System → Display → Display damping (0094)

Description Define display reaction time to fluctuations in the measured value.

User entry 0.0 to 999.9 s

Factory setting 0.0 s

Header

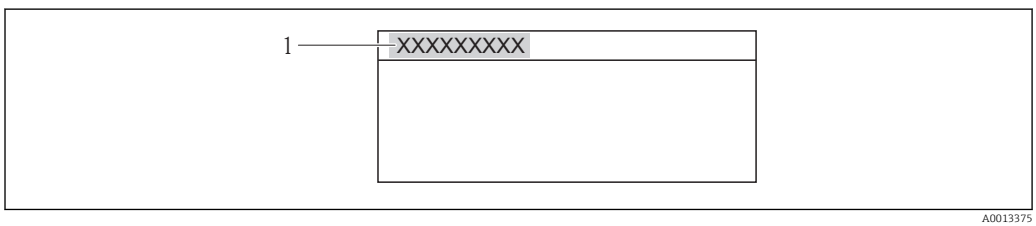
Navigation Expert → System → Display → Header (0097)

Description Select header contents on local display.

Selection
- Device tag
- Free text

Factory setting Device tag

Additional information



1 Position of the header text on the display

Meaning of the options

- **Device tag**
  Is defined in the **Device tag** parameter.
- **Free text**
  Is defined in the **Header text** parameter (→ 31).

Header text

Navigation Expert → System → Display → Header text (0112)

Prerequsite **Header (→ 30)** = **Free text**

Description Enter display header text.

Factory setting ----------

Additional information The number of characters which can be displayed depends on the characters used.

Separator

Navigation Expert → System → Display → Separator (0101)

Description Select decimal separator for displaying numerical values.

Selection
- .
- ,

Factory setting .

Number format

Navigation Expert → System → Display → Number format (0099)

Description Choose number format for the display.

Selection
- Decimal
- ft-in-1/16"

Factory setting Decimal

Additional information The **ft-in-1/16"** option is only valid for distance units.

Decimal places menu

Navigation Expert → System → Display → Dec. places menu (0573)

Description Select number of decimal places for the representation of numbers within the operating menu.

Selection
- x
- x.x
- x.xx
- x.xxx
- x.xxxx

Factory setting x.xxxx

Additional information
- Is only valid for numbers in the operating menu (e.g. **Empty calibration**, **Full calibration**), but not for the measured value display. The number of decimal places for the measured value display is defined in the **Decimal places 1 to 4** → 29 parameters.
- The setting does not affect the accuracy of the measurement or the calculations.

Contrast display

Navigation Expert → System → Display → Contrast display (0105)

Description Adjust local display contrast setting to ambient conditions (e.g. lighting or reading angle).

User entry 20 to 80 %

Factory setting Dependent on the display.

Additional information Setting the contrast via push-buttons:
- Darker: press the ⊖ and Ⓔ buttons simultaneously.
- Brighter: press the ⊕ and Ⓔ buttons simultaneously.

Backlight

Navigation Expert → System → Display → Backlight (0111)

Prerequsite The device has the SD03 local display (with optical keys).

Description Switch the local display backlight on and off.

Selection
- Disable
- Enable

Factory setting Disable

Additional information

Meaning of the options
- **Disable**
  Switches the backlight off.
- **Enable**
  Switches the backlight on.

Regardless of the setting in this parameter the backlight may be automatically switched off by the device if the supply voltage is too low.

Access status display

Navigation Expert → System → Display → Access stat.disp (0091)

Prerequsite The device has a local display.

Description Indicates access authorization to parameters via local display.

User interface
- Operator
- Maintenance
- Service

Additional information

If a symbol appears in front of a parameter, the parameter cannot be changed via the local display with the current access authorization.

The access authorization can be changed via the **Enter access code** parameter (→ 24).

If additional write protection is active, this restricts the current access authorization even further. The write protection status can be viewed via the **Locking status** parameter (→ 22).

4.3.3 "Configuration backup display" submenu

This submenu is only visible if a display module is connected to the device.

All software configurations are initially stored in a memory module (HistoROM) in the housing and are thus permanently connected with the device. As an additional option, the display module contains a backup memory for the device configuration. The transmission of configuration data between these two memory modules is controlled by the **Configuration management** parameter (→ 36). It provides the following options:

- **Execute backup**
  Saves the current device configuration in the display module.
- **Restore**
  This option can be used to restore a configuration back into the device which has previously been saved in the display module.
- **Duplicate**
  If the configuration has been saved into the display module, the module can be connected to a different device and the configuration can be duplicated to this device. This allows to efficiently configure a number of devices in the same way.
- **Compare**
  The comparison result indicates whether the device configuration has been changed since the last backup.

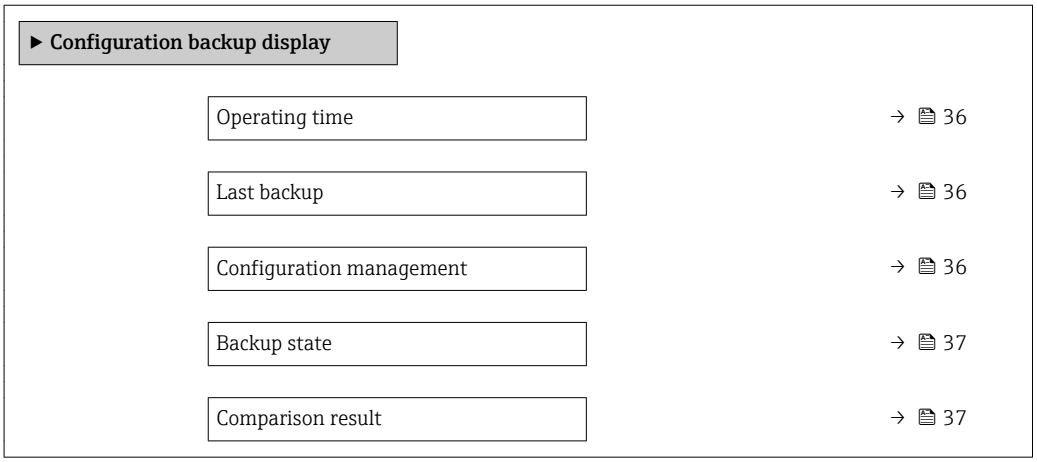
For FMP51, FMP52, FMP54, FMP55: Configurations can only be exchanged between devices which are in the same operating mode (see the **Operating mode** parameter (→ 45)).

If an existing backup is restored to a different device using the **Restore** option, it may occur that some device functionalities are no longer available. Even a reset to the delivery state won't restore the original state in some cases.

In order to transfer the configuration to a different device only the **Duplicate** option should be used.

Structure of the submenu

Navigation Expert → System → Conf.backup disp



Description of parameters

Navigation Expert → System → Conf.backup disp

Operating time

Navigation Expert → System → Conf.backup disp → Operating time (0652)

Description Indicates how long the device has been in operation.

User interface Days (d), hours (h), minutes (m), seconds (s)

Additional information *Maximum time*
9 999 d (≈ 27 years)

Last backup

Navigation Expert → System → Conf.backup disp → Last backup (0102)

Description Indicates when the last data backup was saved to the display module.

User interface Days (d), hours (h), minutes (m), seconds (s)

Configuration management

Navigation Expert → System → Conf.backup disp → Config. managem. (0100)

Description Select action for managing the device data in the display module.

Selection
- Cancel
- Execute backup
- Restore
- Duplicate
- Compare
- Clear backup data
- Display incompatible

Factory setting Cancel

Additional information

Meaning of the options

- **Cancel**
  No action is executed and the user exits the parameter.
- **Execute backup**
  A backup copy of the current device configuration in the HistoROM (built-in in the device) is saved to the display module of the device.
- **Restore**
  The last backup copy of the device configuration is copied from the display module to the HistoROM of the device.
- **Duplicate**
  The transmitter configuration is duplicated to another device using the transmitter display module. The following parameters, which characterize the individual measuring point are **not** included in the transmitted configuration:
  Medium type
- **Compare**
  The device configuration saved in the display module is compared to the current device configuration of the HistoROM. The result of this comparison is displayed in the **Comparison result** parameter (→ 37).
- **Clear backup data**
  The backup copy of the device configuration is deleted from the display module of the device.

While this action is in progress, the configuration cannot be edited via the local display and a message on the processing status appears on the display.

If an existing backup is restored to a different device using the **Restore** option, it may occur that some device functionalities are no longer available. In some cases even a device reset will not restore the original status.

In order to transmit a configuration to a different device, the **Duplicate** option should always be used.

Backup state

Navigation Expert → System → Conf.backup disp → Backup state (0121)

Description Displays which backup action is currently in progress.

Comparison result

Navigation Expert → System → Conf.backup disp → Compar. result (0103)

Description Displays the comparison result between the device and the display.

Additional information

Meaning of the display options

- **Settings identical**
  The current device configuration of the HistoROM is identical to the backup copy in the display module.
- **Settings not identical**
  The current device configuration of the HistoROM is not identical to the backup copy in the display module.
- **No backup available**
  There is no backup copy of the device configuration of the HistoROM in the display module.
- **Backup settings corrupt**
  The current device configuration of the HistoROM is corrupt or not compatible with the backup copy in the display module.
- **Check not done**
  The device configuration of the HistoROM has not yet been compared to the backup copy in the display module.
- **Dataset incompatible**
  The data sets are incompatible and can not be compared.

To start the comparison, set **Configuration management (→ 36)** = **Compare**.

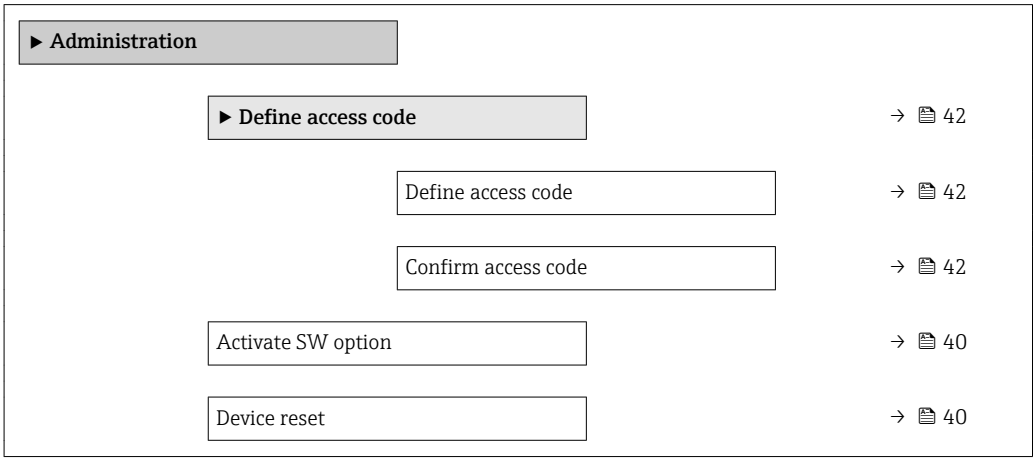
If the transmitter configuration has been duplicated from a different device by **Configuration management (→ 36)** = **Duplicate**, the new device configuration in the HistoROM is only partially identical to the configuration stored in the display module: Sensor specific properties (e.g. the mapping curve) are not duplicated. Thus, the result of the comparison will be **Settings not identical**.

4.3.4 "Administration" submenu

The **Administration** submenu contains all parameters for the management of the device. Its structure depends on the user interface:

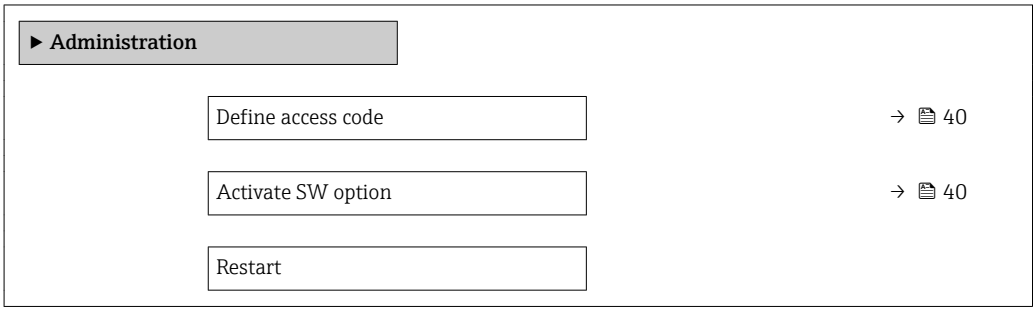
Structure of the submenu on the local display

Navigation Expert → System → Administration



Structure of the submenu in an operating tool

Navigation Expert → System → Administration



Description of parameters

Navigation Expert → System → Administration

Define access code

Navigation Expert → System → Administration → Def. access code (0093)

Description Define release code for write access to parameters.

User entry 0 to 9 999

Factory setting 0

Additional information

If the factory setting is not changed or 0 is defined as the access code, the parameters are not write-protected and the configuration data of the device can then always be modified. The user is logged on in the *Maintenance* role.

The write protection affects all parameters marked with the symbol in this document. On the local display, the symbol in front of a parameter indicates that the parameter is write-protected.

Once the access code has been defined, write-protected parameters can only be modified if the access code is entered in the **Enter access code** parameter (→ 24).

Please contact your Endress+Hauser Sales Center if you lose your access code.

For display operation: The new access code is only valid after it has been confirmed in the **Confirm access code** parameter (→ 42).

Activate SW option

Navigation Expert → System → Administration → Activate SW opt. (0029)

Description Enter code to unlock specific software options.

User entry Positive integer

Factory setting 0

Device reset

Navigation Expert → System → Administration → Device reset (0000)

Description Select to which state the device is to be reset.

Selection

- Cancel
- To fieldbus defaults
- To factory defaults

- To delivery settings
- Of customer settings
- To transducer defaults
- Restart device

Factory setting

Cancel

Additional information

Meaning of the options

- **Cancel**
  No action
- **To factory defaults**
  All parameters are reset to the order-code specific factory setting.
- **To delivery settings**
  All parameters are reset to the delivery setting. The delivery setting may differ from the factory default if customer specific settings have been ordered.
  This option is only visible if customer specific settings have been ordered.
- **Of customer settings**
  All customer parameters are reset to their factory setting. Service parameters, however, remain unchanged.
- **To transducer defaults**
  Every measurment-related parameter is reset to its factory setting. Service parameters and communication-related parameters, however, remain unchanged.
- **Restart device**
  The restart resets every parameter which is stored in the volatile memory (RAM) to the factory setting (e.g. measured value data). The device configuration remains unchanged.

"Define access code" wizard

Navigation Expert → System → Administration → Def. access code

Define access code	
Navigation	Expert → System → Administration → Def. access code → Def. access code
Description	→ 40

Confirm access code	
Navigation	Expert → System → Administration → Def. access code → Confirm code
Description	Confirm the entered access code.
User entry	0 to 9 999
Factory setting	0

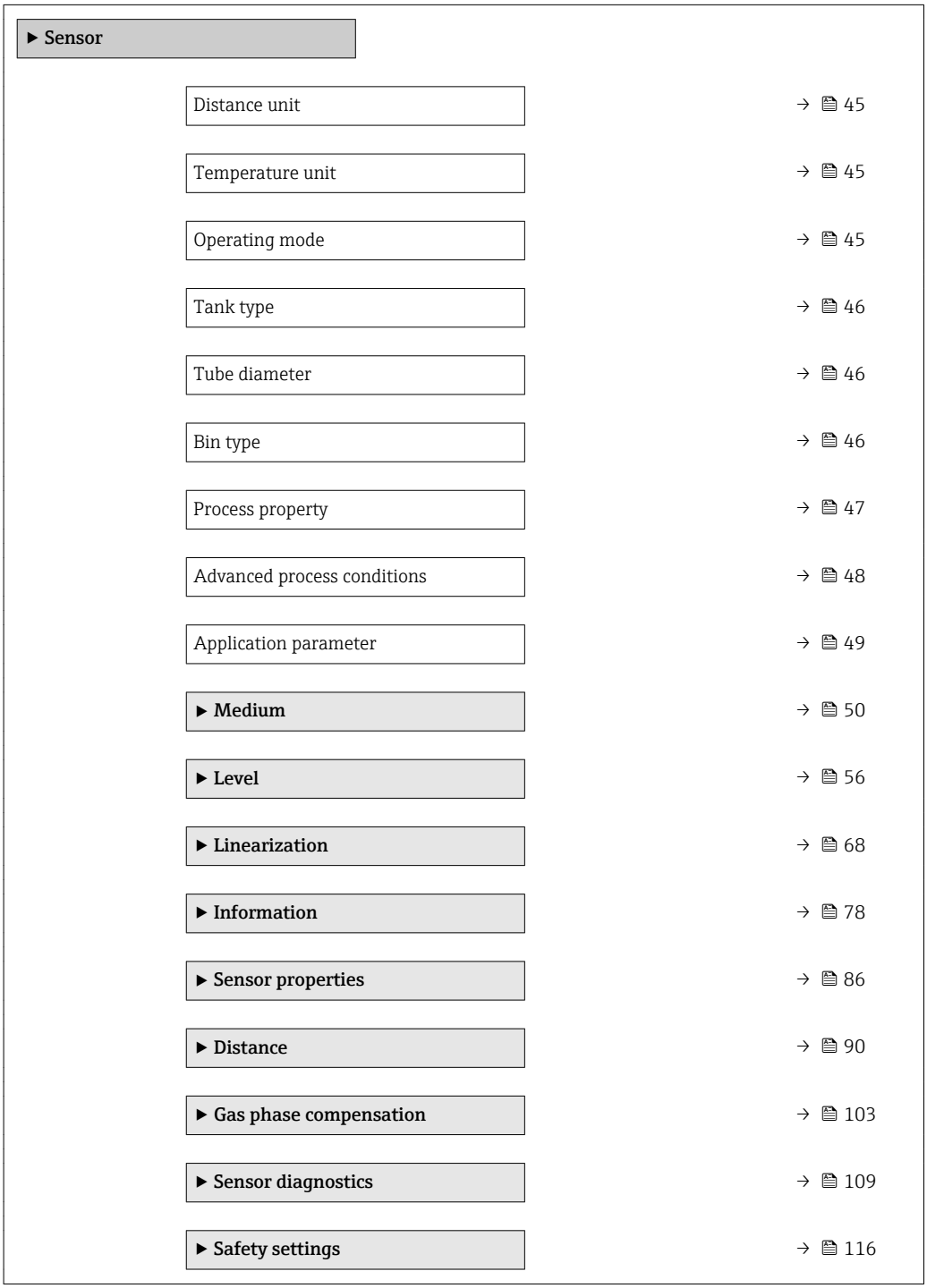
4.4 "Sensor" submenu

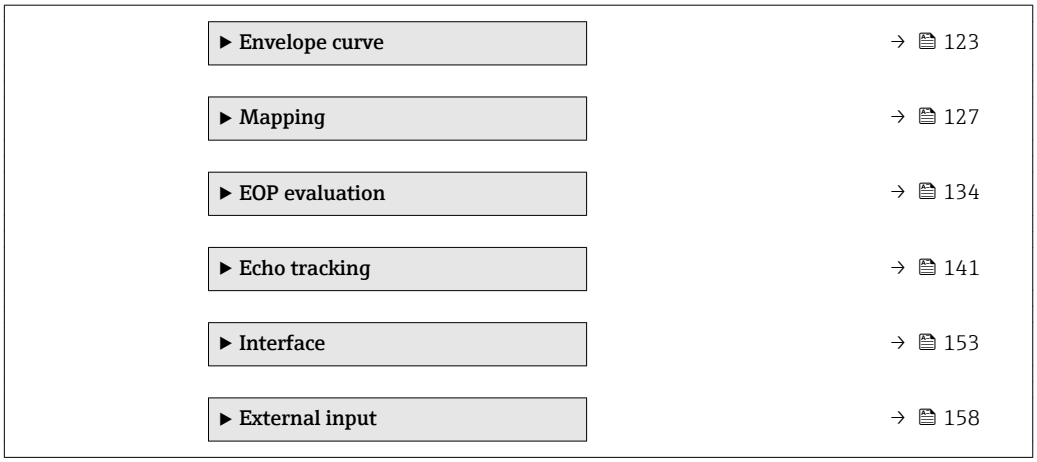
The **Sensor** submenu contains all parameters related to the measurement and the sensor settings.

Navigation Expert → Sensor

4.4.1 Structure of the submenu

Navigation Expert → Sensor




▶ Envelope curve
→ 123
▶ Mapping
→ 127
▶ EOP evaluation
→ 134
▶ Echo tracking
→ 141
▶ Interface
→ 153
▶ External input
→ 158

4.4.2 Description of parameters

Navigation Expert → Sensor

Distance unit

Navigation Expert → Sensor → Distance unit (0551)

Description Select distance unit.

Selection

SI units	*US units*
▪ mm	▪ ft
▪ m	▪ in

Factory setting m

Temperature unit

Navigation Expert → Sensor → Temperature unit (0557)

Description Select temperature unit.

Selection

SI units	*US units*
▪ °C	▪ °F
▪ K	▪ °R

Factory setting °C

Operating mode

Navigation Expert → Sensor → Operating mode (1046)

Prerequsite The device has the "interface measurement" application package (available for FMP51, FMP52, FMP54) [21]. FMP55 always contains this package.

Description Select operating mode.

Selection
- Level
- Interface with capacitance *
- Interface *

21) Product structure: Feature 540 "Application Package", Option EB "Interface measurement"
* Visibility depends on order options or device settings

Factory setting
- FMP51/FMP52/FMP54: **Level**
- FMP55: **Interface with capacitance**

Additional information The **Interface with capacitance** option is only available for FMP55.

Tank type

Navigation Expert → Sensor → Tank type (1175)

Prerequsite **Medium type (→ 51)** = **Liquid**

Description Select tank type.

Selection
- Metallic
- Bypass / pipe
- Non metallic
- Mounted outside
- Coaxial

Factory setting Depending on the probe

Additional information
- Depending on the probe some of the options mentioned above may not be available or there may be additional options.
- For coax probes, the default setting is **Tank type = Coaxial** and can not be changed.
- For probes with metallic center washer, **Tank type = Bypass / pipe** is preset and can not be changed.

Tube diameter

Navigation Expert → Sensor → Tube diameter (1117)

Prerequsite
- **Tank type (→ 46)** = **Bypass / pipe**
- The probe is coated.

Description Specify diameter of bypass or stilling well.

User entry 0 to 9.999 m

Factory setting 0.0384 m

Bin type

Navigation Expert → Sensor → Bin type (1176)

Prerequsite **Medium type (→ 51)** = **Solid**

Description Specify bin type.

Selection
- Concrete
- Plastic wood
- Metallic
- Aluminium

Factory setting Metallic

Process property

Navigation Expert → Sensor → Process property (1081)

Description Specify typical rate of level change.

Selection

For "Medium type" = "Liquid"
- Very fast > 10 m (400 in)/min
- Fast > 1 m (40 in)/min
- Standard < 1 m (40in) /min
- Medium < 10 cm (4in) /min
- Slow < 1 cm (0.4in) /min
- No filter / test

For "Medium type" = "Solid"
- Very fast > 100 m (333 ft) /h
- Fast > 10 m (33 ft) /h
- Standard < 10 m (33 ft) /h
- Medium < 1 m (3ft) /h
- Slow < 0.1 m (0.3ft) /h
- No filter / test

Factory setting Standard < 1 m (40in) /min

Additional information The device adjusts the signal evaluation filters and the damping of the output signal to the typical rate of level change defined in this parameter:

For "Operating mode" = "Level" and "Medium type" = "Liquid"

Process property	Step response time / s
Very fast > 10 m (400 in)/min	5
Fast > 1 m (40 in)/min	5
Standard < 1 m (40in) /min	14
Medium < 10 cm (4in) /min	39
Slow < 1 cm (0.4in) /min	76
No filter / test	< 1

For "Operating mode" = "Level" and "Medium type" = "Solid"

Process property	Step response time / s
Very fast > 100 m (333 ft) /h	37
Fast > 10 m (33 ft) /h	37
Standard < 10 m (33 ft) /h	74

Process property	Step response time / s
Medium < 1 m (3ft) /h	146
Slow < 0.1 m (0.3ft) /h	290
No filter / test	< 1

For "Operating mode" = "Interface" or "Interface with capacitance"

Process property	Step response time / s
Very fast > 10 m (400 in)/min	5
Fast > 1 m (40 in)/min	5
Standard < 1 m (40in) /min	23
Medium < 10 cm (4in) /min	47
Slow < 1 cm (0.4in) /min	81
No filter / test	2.2

Other values of the step-response time (e.g. intermediate values) can be defined by the following parameters:
- **Dead time (→ 93)**
- **Integration time (→ 94)**

Advanced process conditions

Navigation Expert → Sensor → Adv. conditions (1177)

Prerequsite **Operating mode (→ 45)** = **Level**

Description Specify additional process conditions (if required).

Selection
- None
- Oil/Water condensate
- Probe near tank bottom
- Build up
- Foam (>5cm/0,16ft)

Factory setting None

Additional information

Meaning of the options
- **Oil/Water condensate** (only **Medium type** = **Liquid**)
  Makes sure that in the case of two-phase media only the total level is detected (example: oil/condensate application).
- **Probe near tank bottom** (only for **Medium type** = **Liquid**)
  Improves the empty detection, especially if the probe is mounted close to the tank bottom.
- **Build up**
  Enables a safe empty-detection even if the end-of-probe signal has shifted due to build-up.
- **Foam (>5cm/0,16ft)** (only for **Medium type** = **Liquid**)
  Optimizes the signal evaluation in applications with foam formation.

Application parameter

Navigation Expert → Sensor → Applicat. param. (1126)

Description Indicates whether settings depending on the application parameters (e.g. **Advanced process conditions (→ 48)**, **Tank type (→ 46)** and **Tube diameter (→ 46)**) have been changed after the basic setup.

User interface
- Changed
- Not changed

Additional information

Meaning of the options
- **Changed**
  Parameters have been changed. The device is no longer in the state defined by the application parameters.
- **Not changed**
  There have been no changes. The device is still in the state defined by the application parameters.

4.4.3 "Medium" submenu

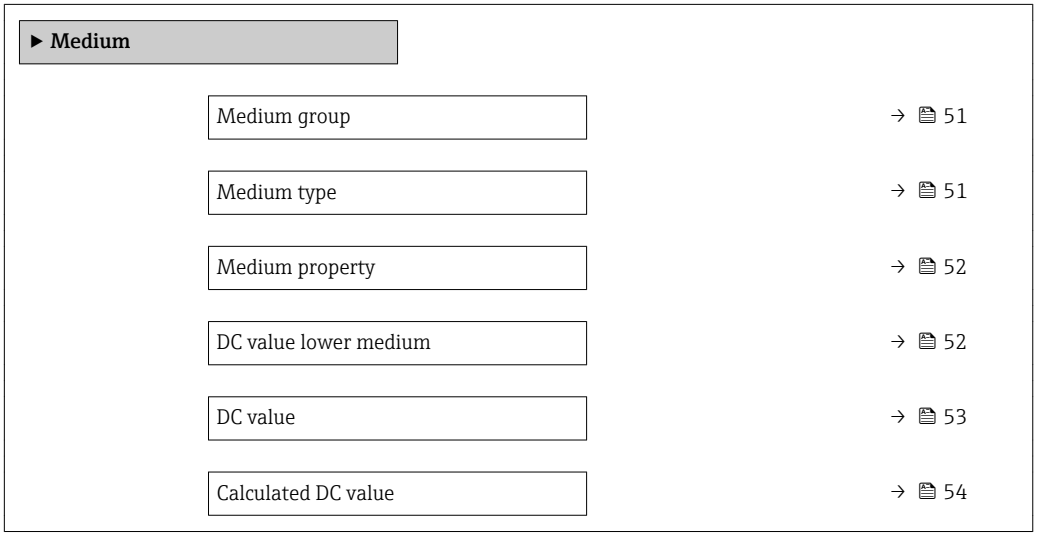
The **Medium** submenu is used to specify the relevant properties of the measured medium, especially the dielectric constant (DC).

The dielectric constant is used to calculate the threshold for the level echo and (if applicable) the interface echo.

For FMP51/FMP52/FMP54/FMP55: The **Operating mode** parameter (→ 45) determines which parameters this submenu contains.

Structure of the submenu

Navigation Expert → Sensor → Medium



Description of parameters

Navigation Expert → Sensor → Medium

Medium group

Navigation Expert → Sensor → Medium → Medium group (1208)

Prerequsite
- For FMP51/FMP52/FMP54/FMP55: **Operating mode (→ 45)** = **Level**
- **Medium type (→ 51)** = **Liquid**

Description Select medium group.

Selection
- Others
- Water based (DC >= 4)

Factory setting Others

Additional information This parameter roughly specifies the dielectric constant (DC) of the medium. For a more detailed definition of the DC use the **Medium property** parameter (→ 52).

The **Medium group** parameter presets the **Medium property** parameter (→ 52) as follows:

Medium group	Medium property (→ 52)
Others	Unknown
Water based (DC >= 4)	DC 4 … 7

The **Medium property** parameter can be changed at a later point of time. However, when doing so, the **Medium group** parameter retains its value. Only the **Medium property** parameter is relevant for the signal evaluation.

The measuring range may be reduced for small dielectric constants. For details refer to the Technical Information (TI) of the respective device.

Medium type

Navigation Expert → Sensor → Medium → Medium type (1049)

Description Specify type of medium.

User interface
- Liquid
- Solid

Factory setting
- FMP50, FMP51, FMP52, FMP53, FMP54, FMP55: **Liquid**
- FMP56, FMP57: **Solid**

Additional information The **Solid** option is only available for **Operating mode (→ 45)** = **Level**

This parameter determines the value of several other parameters and strongly influences the complete signal evaluation. Therefore, it is strongly recommended **not to change** the factory setting.

Medium property

Navigation Expert → Sensor → Medium → Medium property (1165)

Prerequsite
- **Operating mode (→ 45)** = **Level**
- **EOP level evaluation** ≠ **Fix DC**

Description Specify relative dielectric constant ε_r of the medium.

Selection
- Unknown
- DC 1.4 ... 1.6
- DC 1.6 ... 1.9
- DC 1.9 ... 2.5
- DC 2.5 ... 4
- DC 4 ... 7
- DC 7 ... 15
- DC > 15

Factory setting Dependent on **Medium type (→ 51)** and **Medium group (→ 51)**.

Additional information *Dependency on "Medium type" and "Medium group"*

Medium type (→ 51)	Medium group (→ 51)	Medium property
Solid		Unknown
Liquid	Water based (DC >= 4)	DC 4 ... 7
	Others	Unknown

For dielectric constants (DC values) of many media commonly used in various industries refer to:
- the Endress+Hauser DC manual (CP01076F)
- the Endress+Hauser "DC Values App" (available for Android and iOS)

For **EOP level evaluation** = **Fix DC**, the exact dielectric constant has to be entered into the **DC value** parameter. Therefore, the **Medium property** parameter is not available in this case.

DC value lower medium

Navigation Expert → Sensor → Medium → DC lower medium (1154)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Specify the relative dielectric ocnstant ε_r of the lower medium.

User entry 1 to 100

Factory setting 80.0

Additional information

For dielectric constants (DC values) of many media commonly used in various industries refer to:
- the Endress+Hauser DC manual (CP01076F)
- the Endress+Hauser "DC Values App" (available for Android and iOS)

The factory setting, $\varepsilon_r = 80$, is valid for water at 20 °C (68 °F).

DC value

Navigation Expert → Sensor → Medium → DC value (1201)

Description
- For level measurements:
  Specify dielectric constant ε_r.
- For interface measurements:
  Specify dielectric constant ε_r of the upper medium.

User entry Signed floating-point number

Factory setting

Dependent on the following parameters:
- Operating mode (→ 45)
- Medium property (→ 52)
- Medium type (→ 51)
- Bin type (→ 46)or Tank type (→ 46)

Additional information

Dependence of the factory settings on other parameters

For "Operating mode" = "Level"

Medium property (→ 52)	Medium type (→ 51)	Bin type (→ 46) or Tank type (→ 46)	DC value
Unknown	Solid	Bin type (→ 46) ▪ Aluminium ▪ Plastic wood	1.9
		Bin type (→ 46) ▪ Concrete ▪ Metallic	1.6
	Liquid	Tank type (→ 46) Coaxial	1.4
		Any other tank type	1.9
DC 1.4 ... 1.6	Solid	Bin type (→ 46) ▪ Concrete ▪ Aluminium ▪ Plastic wood	1.6
		Bin type (→ 46) Metallic	1.4
	Liquid	Tank type (→ 46) ▪ Non metallic ▪ Mounted outside	1.6
		Any other tank type	1.4

Medium property (→ 52)	Medium type (→ 51)	Bin type (→ 46) or Tank type (→ 46)	DC value
DC 1.6 ... 1.9			1.6
DC 1.9 ... 2.5			1.9
DC 2.5 ... 4			2.5
DC 4 ... 7			4
DC 7 ... 15			7
DC > 15			15

For "Operating mode" = "Interface with capacitance" or "Interface":
DC value = 1.9

As the value defines the echo threshold, it may not exceed the actual DC of the medium. Dielectric constants above DC = 15 have only a very limited influence on the echo threshold.

Calculated DC value

Navigation Expert → Sensor → Medium → Calc. DC value (1118)

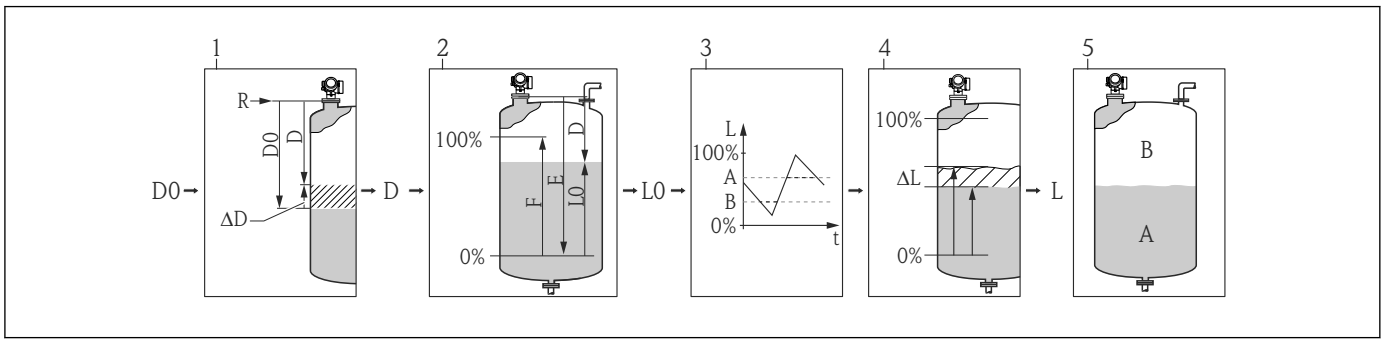
Prerequsite **EOP level evaluation** = **Automatic DC**

Description
- For **Operating mode (→ 45)** = **Level:**
  Displays the dielectric constant calculated from the level and end-of-probe signals.
- For **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**:
  - For **Interface property (→ 154)** = **Special: automatic DC**:
    Displays the dielectric constant of the upper medium which has been calculated from the level and interface signal.
  - Else:
    Identical to **DC value (→ 53)**.

User interface 1.0 to 100.0

4.4.4 "Level" submenu

The **Level** submenu (→ 56) is used to configure the calculation of the level from the measured distance.

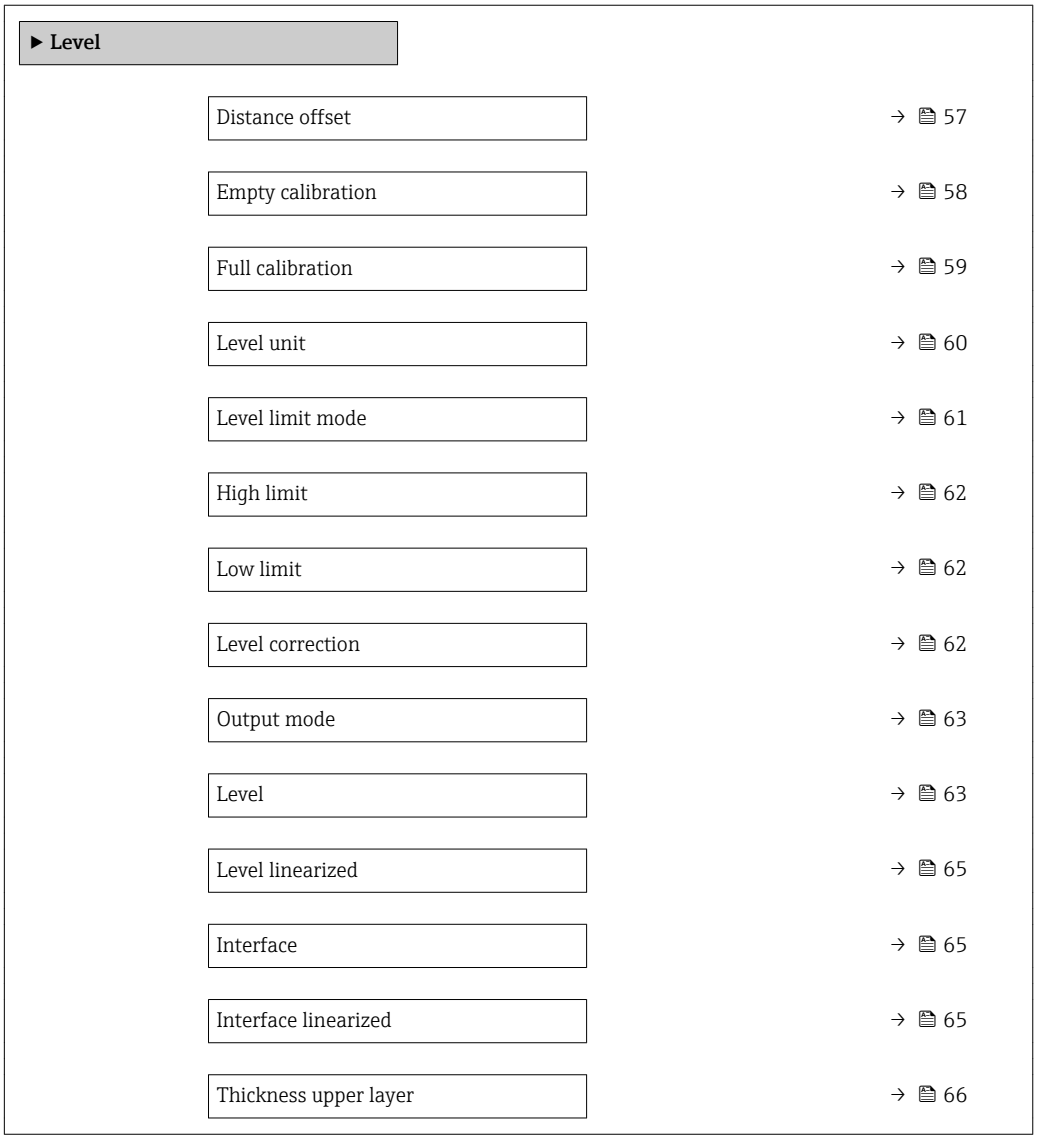


10 Calculation of the level from the measured distance

1 Correction of the measured distance
2 Level calculation
3 Level limitation
4 Correction of the level
5 Definition of the output value: Level (A) or Ullage (B)

Structure of the submenu

Navigation Expert → Sensor → Level



Description of parameters

Navigation Expert → Sensor → Level

Distance offset

Navigation Expert → Sensor → Level → Distance offset (2309)

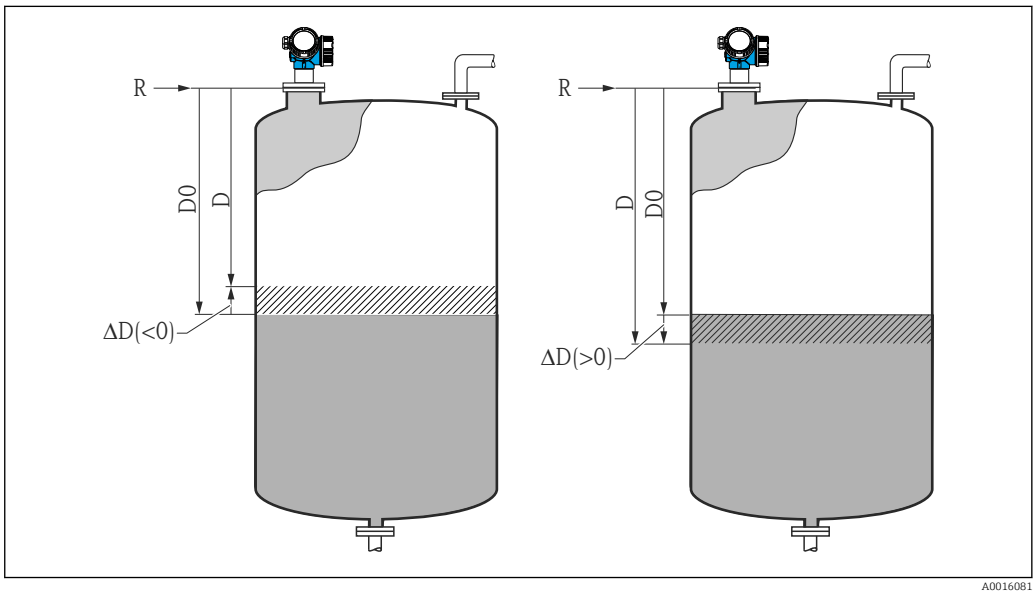
Description Specify distance offset.

User entry −200 to 200 m

Factory setting 0 m

Additional information The value specified in this parameter is added to the measured distance between the reference point of the measurement and the level echo.

- Positive values increase the distance and thus decrease the level.
- Negative values decrease the distance and thus increase the level.



11 Effect of "Distance offset (→ 57)"

ΔD Distance offset
D0 Measured distance
D Corrected distance (is used to calculate the level)
R Reference point

The value entered in this parameter changes the distance input into the level block and thus influences the measured level.This change, however, is not taken into account in the displayed distance.

Empty calibration

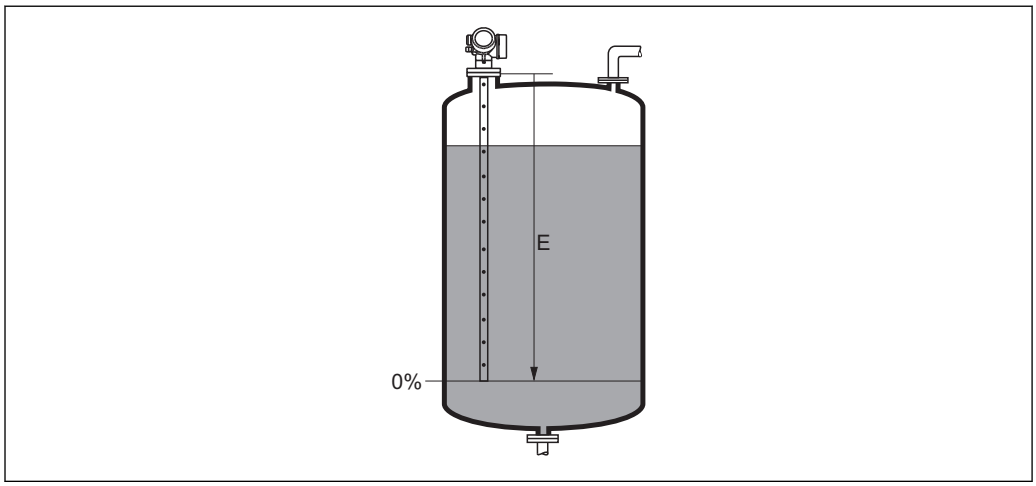
Navigation Expert → Sensor → Level → Empty calibr. (2343)

Description Specify the distance E between the process connection and the minimum level (0%). This defines the starting point of the measuring range.

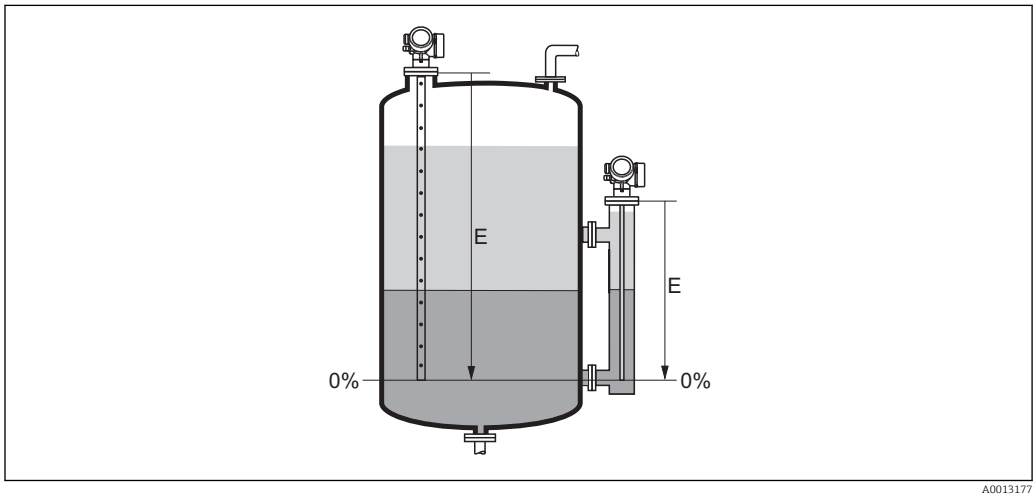
User entry Depending on the probe

Factory setting Depending on the probe

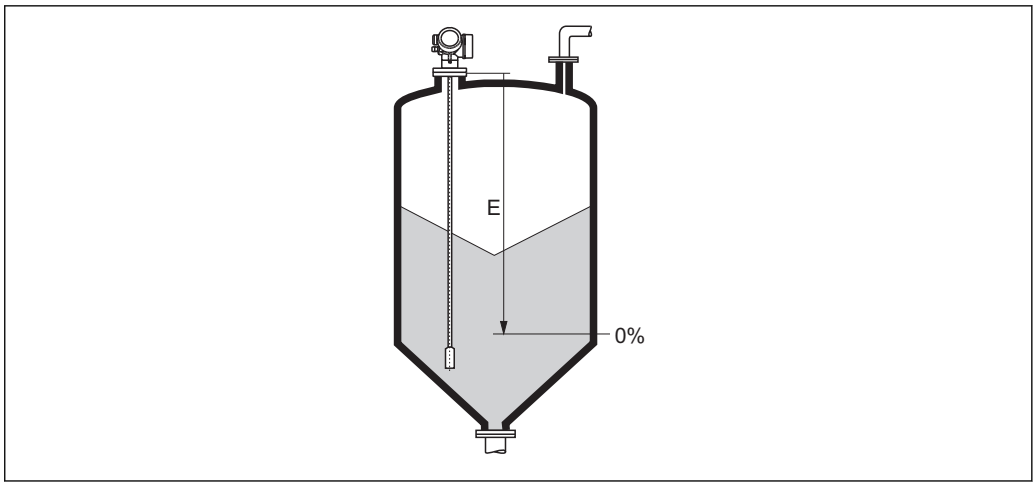
Additional information



12 *Empty calibration (E) for level measurements in liquids*



13 *Empty calibration (E) for interface measurements*



14 *Empty calibration (E) for level measurements in bulk solids.*

In the case of interface measurements the **Empty calibration** parameter is valid for both, the total and the interface level.

Full calibration

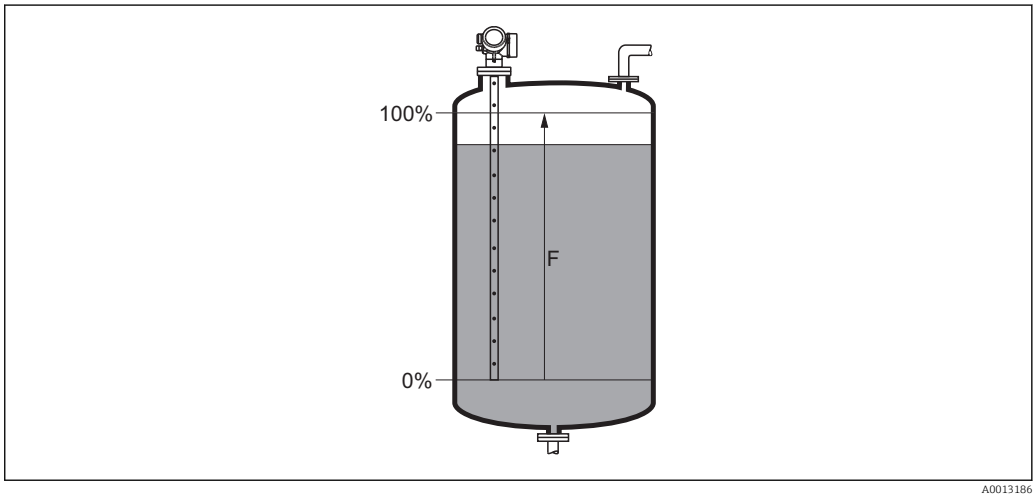
Navigation Expert → Sensor → Level → Full calibr. (2308)

Description Specify the distance F between the minimum level (0%) and the maximum level (100%).

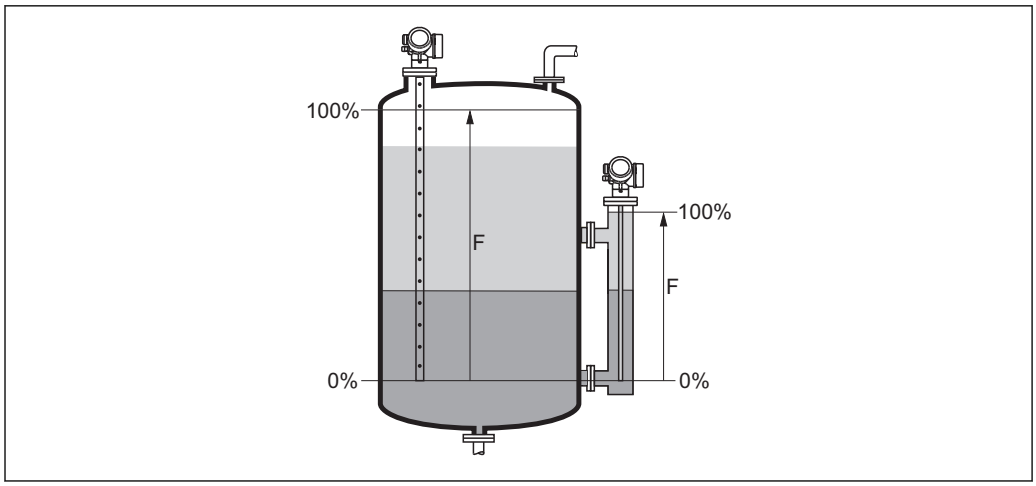
User entry Depending on the probe

Factory setting Depending on the probe

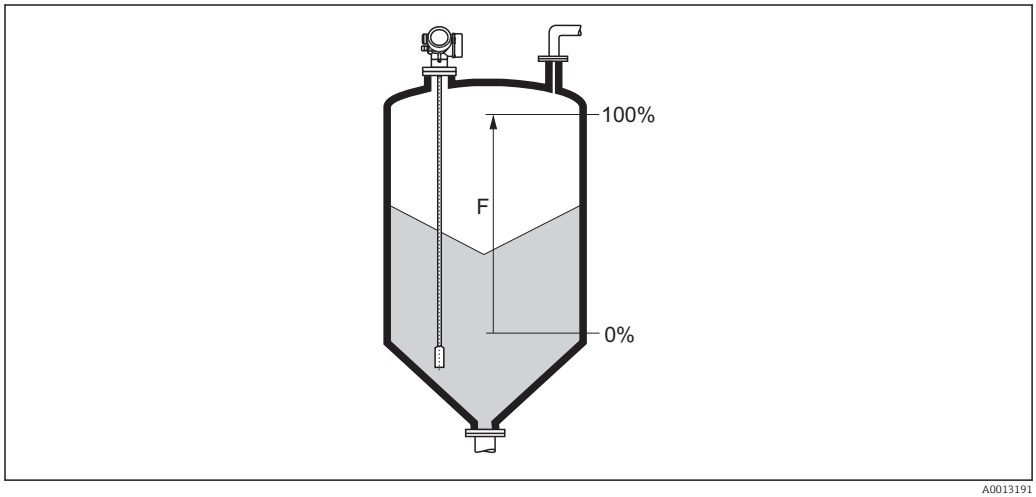
Additional information



15 *Full calibration (F) for level measurements in liquids*



16 *Full calibration (F) for interface measurements*



17 *Full calibration (F) for level measurements in bulk solids*

In the case of interface measurements the **Full calibration** parameter is valid for both, the total and the interface level.

Level unit

Navigation Expert → Sensor → Level → Level unit (0576)

Description Select level unit.

Selection

SI units
- %
- m
- mm

US units
- ft
- in

Factory setting %

Additional information The level unit may differ from the distance unit defined in the **Distance unit** parameter (→ 45):

- The unit defined in the **Distance unit** parameter is used for the basic calibration (**Empty calibration (→ 58)** and **Full calibration (→ 59)**).
- The unit defined in the **Level unit** parameter is used to display the (unlinearized) level.

Level limit mode

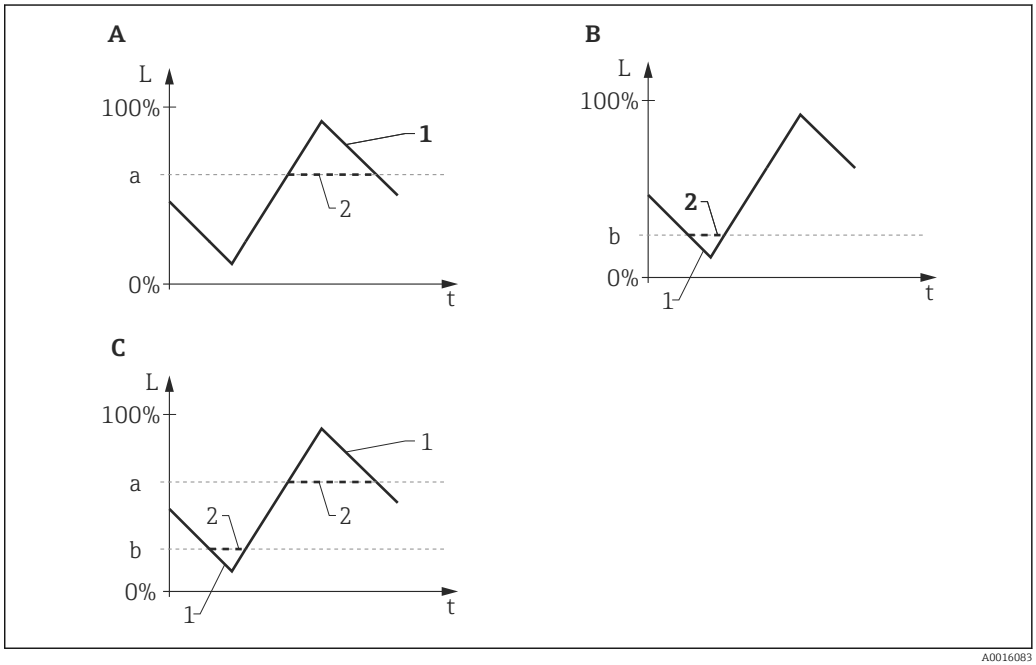
Navigation Expert → Sensor → Level → Level limit mode (2314)

Description Select the type of level limitation.

Selection
- Off
- Low limit
- High limit
- Low and High Limit

Factory setting Low limit

Additional information The parameter determines to which direction the level is limited. The exact limits are defined in the **High limit (→ 62)** und **Low limit (→ 62)** parameters.



18 *Effect of the "Level limit mode", "High limit" and "Low limit" parameters*

A "Level limit mode" = "High limit"
B "Level limit mode" = "Low limit"
C "Level limit mode" = "Low and High Limit"
a "High limit"
b "Low limit"
1 Level before limitation
2 Level after limitation

High limit

Navigation Expert → Sensor → Level → High limit (2312)

Prerequsite **Level limit mode (→ 61)** = **High limit** or **Low and High Limit**

Description Specify upper limit.

User entry Signed floating-point number

Factory setting 0 %

Additional information Levels exceeding the value specified in this parameter will be ignored. Instead, the device uses the maximum level specified in this parameter (for measured value transformation and output).

Low limit

Navigation Expert → Sensor → Level → Low limit (2313)

Prerequsite **Level limit mode (→ 61)** = **Low limit** or **Low and High Limit**

Description Specify lower level limit.

User entry −200 000.0 to 200 000.0 %

Factory setting 0.0 %

Additional information Levels falling below the value specified in this parameter will be ignored. Instead, the device uses the minimum level specified in this parameter (for measured value transformation and output).

Level correction

Navigation Expert → Sensor → Level → Level correction (2325)

Description Specify level correction (if required).

User entry −200 000.0 to 200 000.0 %

Factory setting 0.0 %

Additional information The value specified in this parameter is added to the measured level (before linearization).

Output mode

Navigation Expert → Sensor → Level → Output mode (2317)

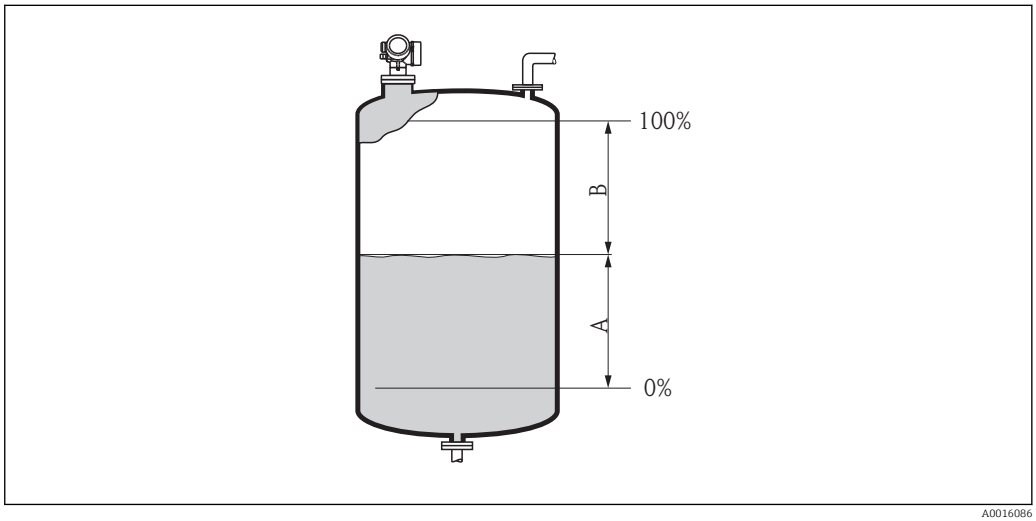
Description Select output mode.

Selection
- Ullage
- Level linearized

Factory setting Level linearized

Additional information

Meaning of the options
- **Ullage**
  The remaining space in the tank or silo is indicated.
- **Level linearized**
  The level is indicated (more precisely: the linearized value if a linearization has been activated).



19 Definition of the "Output mode (→ 63)" parameter

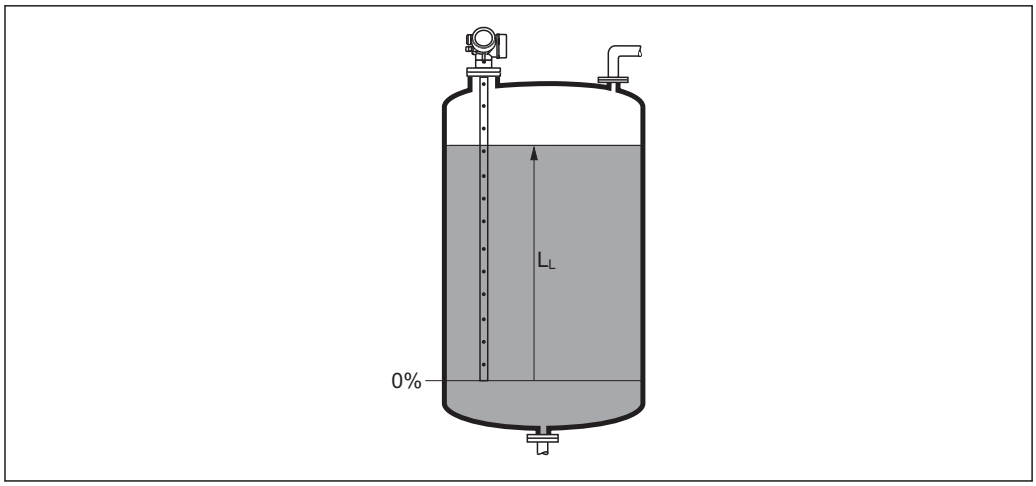
A Level linearized
B Ullage

Level

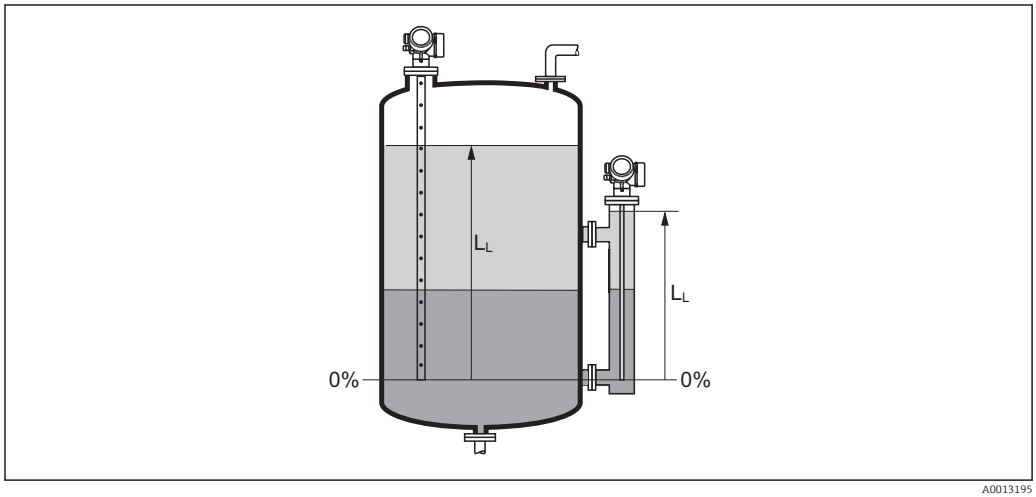
Navigation Expert → Sensor → Level → Level (2319)

Description Displays measured level L_L (before linearization).

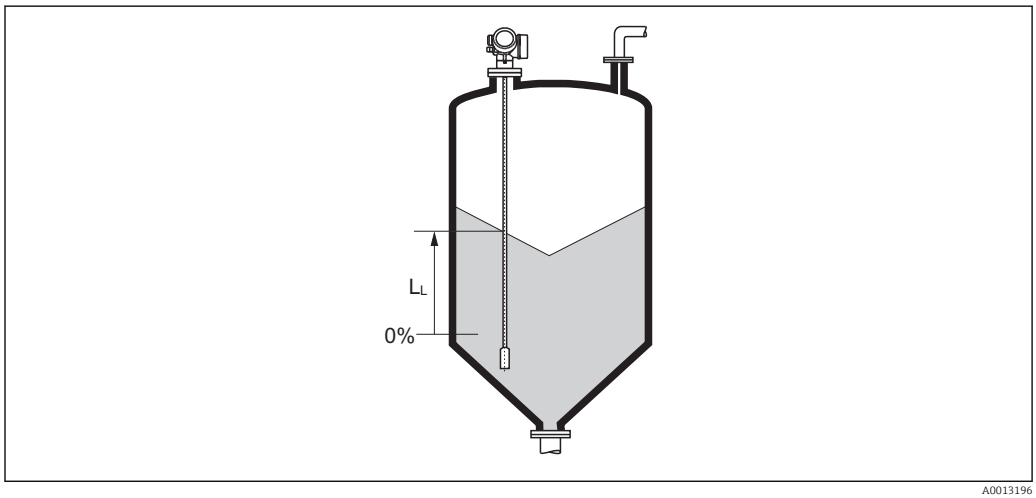
Additional information



20 *Level in case of liquid measurements*



21 *Level in case of interface measurements*



22 *Level in case of bulk solid measurements*

- The unit is defined in the **Level unit** parameter (→ 60).
- In case of interface measurements, this parameter always refers to the total level.

Level linearized

Navigation Expert → Sensor → Level → Level linearized (2318)

Description Displays linearized level.

Additional information

- The unit is defined by the **Unit after linearization** parameter → 71.
- For interface measurements, this parameter always refers to the total level.

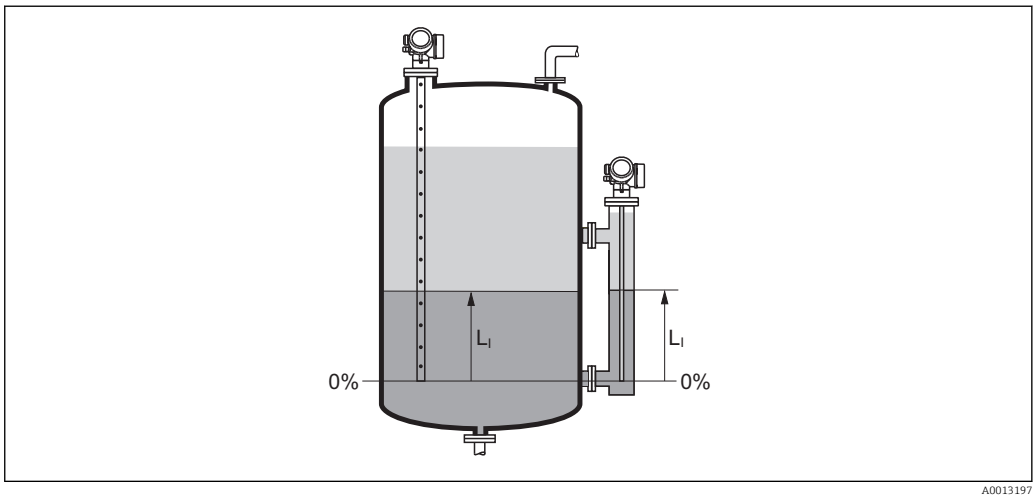
Interface

Navigation Expert → Sensor → Level → Interface (2352)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays the measured interface level L_I (before linearization).

Additional information



A0013197

The unit is defined in the **Level unit** parameter (→ 60).

Interface linearized

Navigation Expert → Sensor → Level → Interf. lineariz (2382)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays the linearized interface height.

Additional information The unit is defined in the **Unit after linearization** parameter → 71.

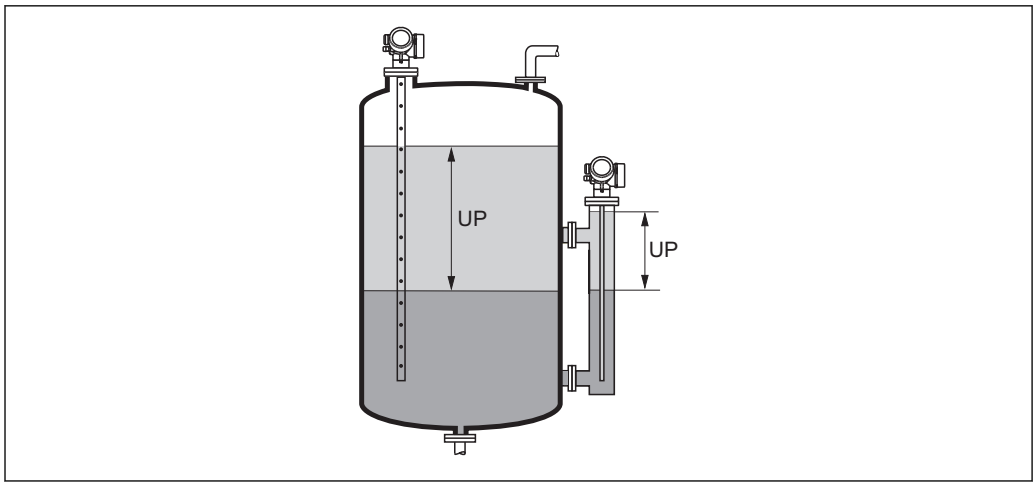
Thickness upper layer

Navigation Expert → Sensor → Level → Thickn.upp.layer (2330)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays the upper interface thickness (UP).

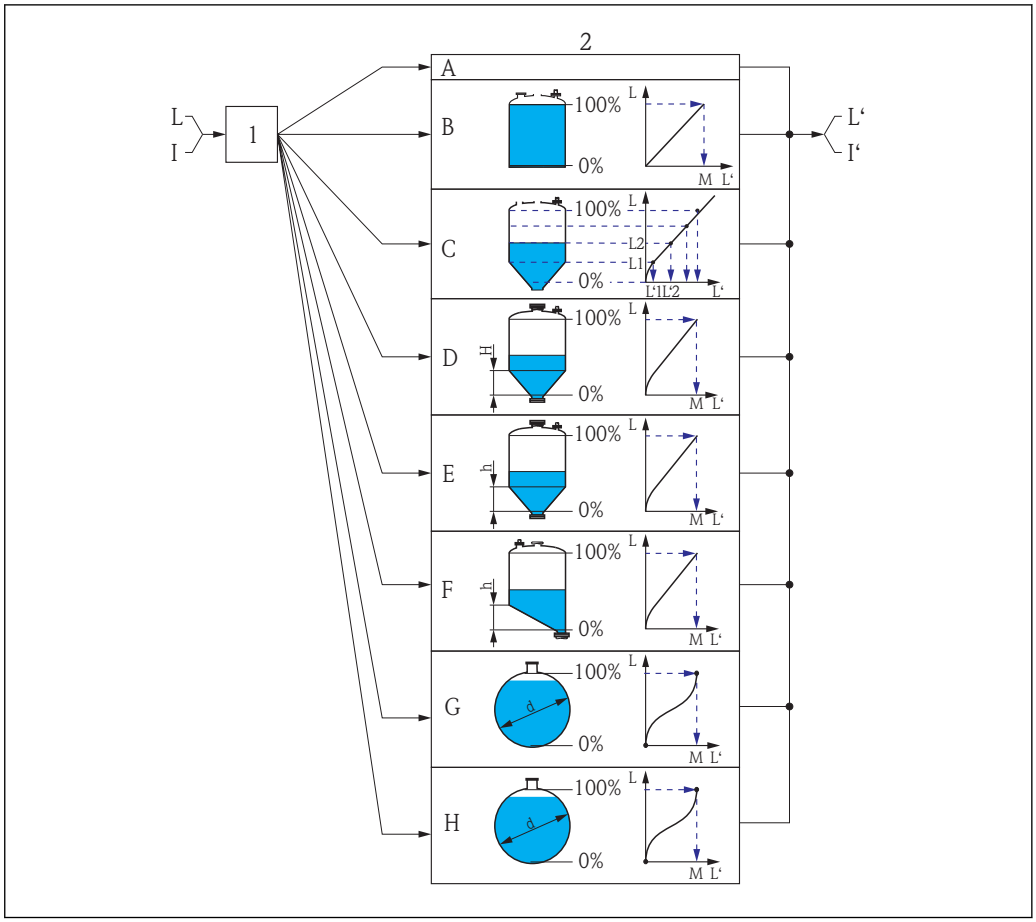
Additional information



UP Thickness upper layer

The unit is defined by the **Unit after linearization** parameter → 71.

4.4.5 "Linearization" submenu



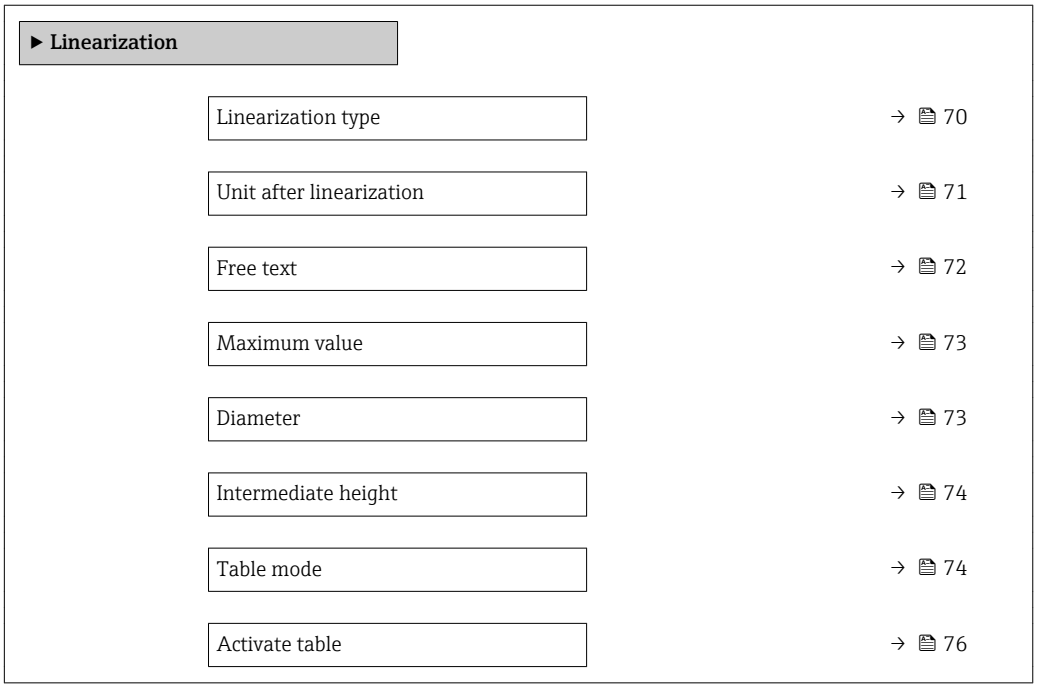
A0016084

23 *Linearization: Transformation of the level and (if relevant) the interface height into a volume or weight; the transformation is dependent on the shape of the vessel.*

1 Selection of linearization type and unit
2 Configuration of the linearization
A Linearization type (→ 70) = None
B Linearization type (→ 70) = Linear
C Linearization type (→ 70) = Table
D Linearization type (→ 70) = Pyramid bottom
E Linearization type (→ 70) = Conical bottom
F Linearization type (→ 70) = Angled bottom
G Linearization type (→ 70) = Horizontal cylinder
H Linearization type (→ 70) = Sphere
I For "Operating mode (→ 45)" = "Interface" or "Interface with capacitance": Interface before linearization (measured in distance units)
I' For "Operating mode (→ 45)" = "Interface" or "Interface with capacitance": Interface after linearization (corresponds to volume or weight)
L Level before linearization (measured in distance units)
L' Level linearized (→ 65) (corresponds to volume or weight)
M Maximum value (→ 73)
d Diameter (→ 73)
h Intermediate height (→ 74)

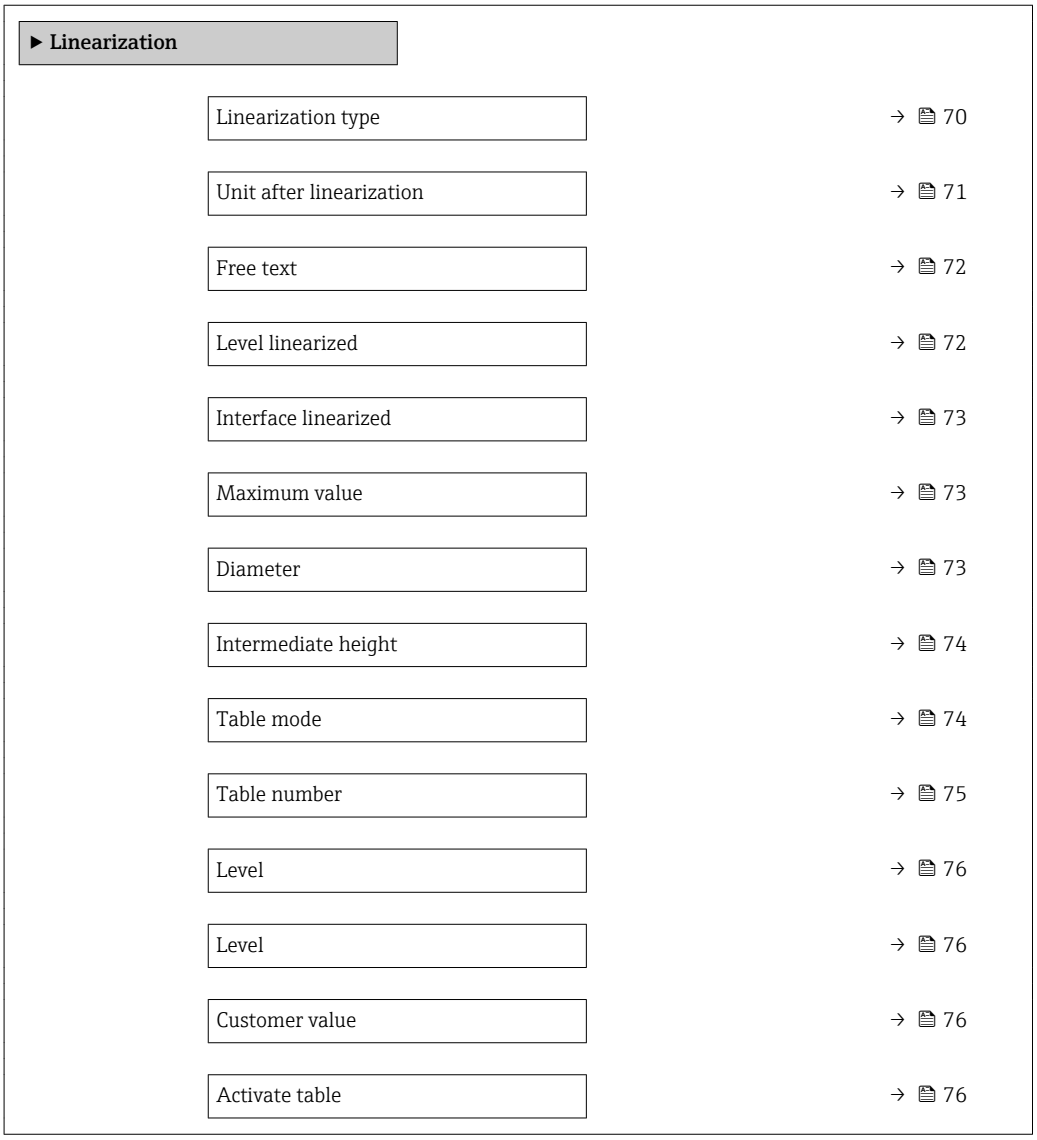
Structure of the submenu on the local display

Navigation Expert → Sensor → Linearization



Structure of the submenu in an operating tool (e.g. FieldCare)

Navigation Expert → Sensor → Linearization



Description of parameters

Navigation Expert → Sensor → Linearization

Linearization type

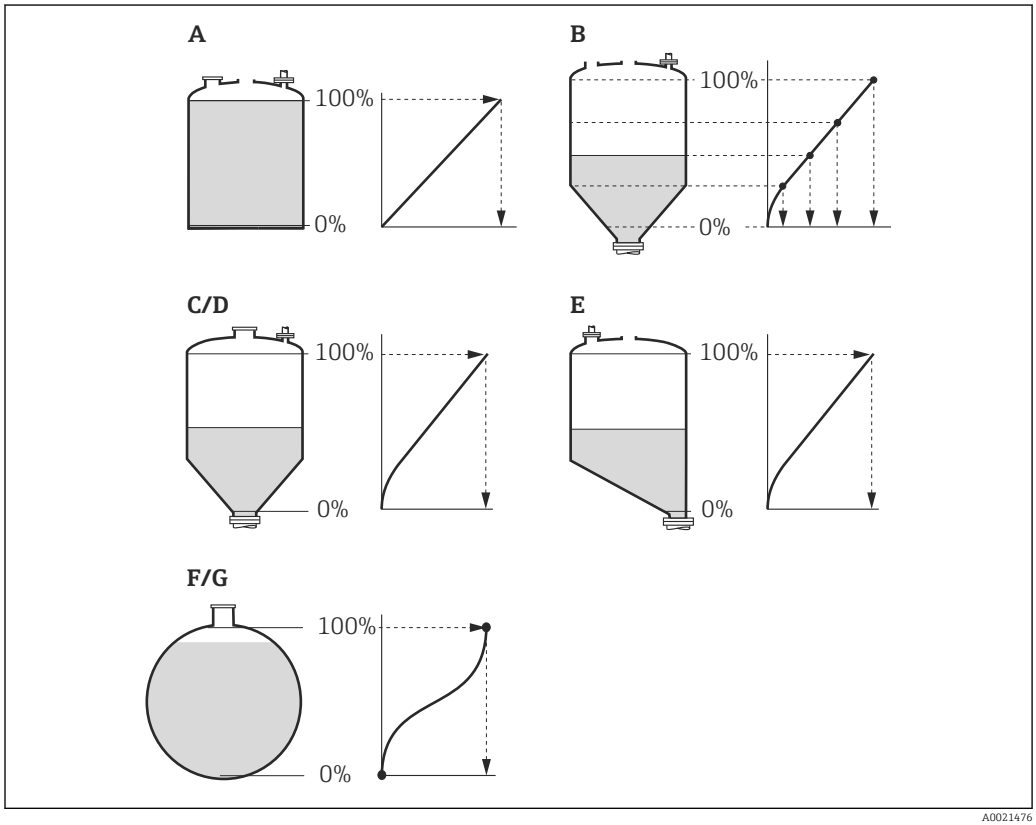
Navigation Expert → Sensor → Linearization → Lineariz. type (2339)

Description Select linearization type.

Selection
- None
- Linear
- Table
- Pyramid bottom
- Conical bottom
- Angled bottom
- Horizontal cylinder
- Sphere

Factory setting None

Additional information



24 *Linearization types*

A None
B Table
C Pyramid bottom
D Conical bottom
E Angled bottom
F Sphere
G Horizontal cylinder

Meaning of the options

- **None**
  The level is transmitted in the level unit without linearization.
- **Linear**
  The output value (volume/weight) is directly proportional to the level L. This is valid, for example, for vertical cylinders. The following additional parameters have to be specified:
  – **Unit after linearization (→ 71)**
  – **Maximum value (→ 73)**: Maximum volume or weight
- **Table**
  The relationship between the measured level L and the output value (volume/weight) is given by a linearization table consisting of up to 32 pairs of values "level - volume" or "level - weight", respectively. The following additional parameters have to be specified:
  – **Unit after linearization (→ 71)**
  – **Table mode (→ 74)**
  – For each table point: **Level (→ 76)**
  – For each table point: **Customer value (→ 76)**
  – **Activate table (→ 76)**
- **Pyramid bottom**
  The output value corresponds to the volume or weight in a silo with pyramid bottom. The following additional parameters have to be specified:
  – **Unit after linearization (→ 71)**
  – **Maximum value (→ 73)**: Maximum volume or weight
  – **Intermediate height (→ 74)**: The height of the pyramid
- **Conical bottom**
  The output value corresponds to the volume or weight in a tank with conical bottom. The following additional parameters have to be specified:
  – **Unit after linearization (→ 71)**
  – **Maximum value (→ 73)**: Maximum volume or weight
  – **Intermediate height (→ 74)**: The height of the conical part of the tank
- **Angled bottom**
  The output value corresponds to the volume or weight in a silo with an angled bottom. The following additional parameters have to be specified:
  – **Unit after linearization (→ 71)**
  – **Maximum value (→ 73)**: Maximum volume or weight
  – **Intermediate height (→ 74)**: Height of the angled bottom
- **Horizontal cylinder**
  The output value corresponds to the volume or weight in a horizontal cylinder. The following additional parameters have to be specified:
  – **Unit after linearization (→ 71)**
  – **Maximum value (→ 73)**: Maximum volume or weight
  – **Diameter (→ 73)**
- **Sphere**
  The output value corresponds to the volume or weight in a spherical tank. The following additional parameters have to be specified:
  – **Unit after linearization (→ 71)**
  – **Maximum value (→ 73)**: Maximum volume or weight
  – **Diameter (→ 73)**

Unit after linearization

Navigation Expert → Sensor → Linearization → Unit lineariz. (2340)

Prerequsite **Linearization type (→ 70)** ≠ None

Description Select unit of the lineaized value.

Selection

SI units
- STon
- t
- kg
- cm^3
- dm^3
- m^3
- hl
- l
- %

US units
- lb
- UsGal
- ft^3

Imperial units
impGal

Custom-specific units
Free text

Factory setting

%

Additional information

The selected unit is only used to be indicated on the display. The measured value is **not** transformed according to the selected unit.

It is also possible to configure a distance-to-distance linearization, i.e. a transformation from the level unit to a different distance unit. To do so, select the **Linear** linearization mode. In order to define the new level unit, select the **Free text** option in the **Unit after linearization** parameter and enter the required unit into the **Free text** parameter (→ 72).

Free text

Navigation

Expert → Sensor → Linearization → Free text (2341)

Prerequsite

Unit after linearization (→ 71) = Free text

Description

Enter unit symbol.

User entry

Up to 32 alphanumerical characters (letters, numbers, special characters)

Factory setting

Free text

Level linearized

Navigation

Expert → Sensor → Linearization → Level linearized (2318)

Description

Displays linearized level.

Additional information

- The unit is defined by the **Unit after linearization** parameter → 71.
- For interface measurements, this parameter always refers to the total level.

Interface linearized

Navigation Expert → Sensor → Linearization → Interf. lineariz (2382)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays the linearized interface height.

Additional information The unit is defined in the **Unit after linearization** parameter → 71.

Maximum value

Navigation Expert → Sensor → Linearization → Maximum value (2315)

Prerequsite **Linearization type (→ 70)** has one of the following values:
- Linear
- Pyramid bottom
- Conical bottom
- Angled bottom
- Horizontal cylinder
- Sphere

Description Specify the maximum content of the vessel (100%) measured in the units after linearization.

User entry −50 000.0 to 50 000.0 %

Factory setting 100.0 %

Diameter

Navigation Expert → Sensor → Linearization → Diameter (2342)

Prerequsite **Linearization type (→ 70)** has one of the following values:
- Horizontal cylinder
- Sphere

Description Specify tank diameter.

User entry 0 to 9 999.999 m

Factory setting 2 m

Additional information The unit is defined in the **Distance unit** parameter (→ 45).

Intermediate height

Navigation Expert → Sensor → Linearization → Intermed. height (2310)

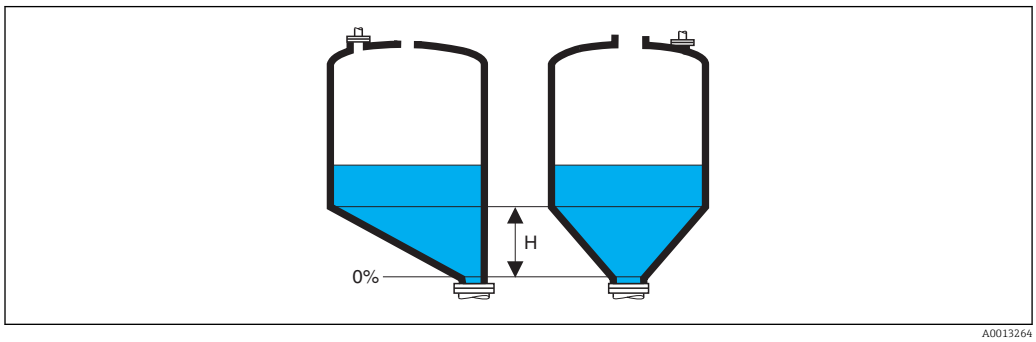
Prerequisite **Linearization type (→ 70)** has one of the following values:
- Pyramid bottom
- Conical bottom
- Angled bottom

Description Specify intermediate height H.

User entry 0 to 200 m

Factory setting 0 m

Additional information



H Intermediate height

The unit is defined in the **Distance unit** parameter (→ 45).

Table mode

Navigation Expert → Sensor → Linearization → Table mode (2303)

Prerequisite **Linearization type (→ 70)** = **Table**

Description Select editing mode of the linearization table.

Selection
- Manual
- Semiautomatic *
- Clear table
- Sort table

Factory setting Manual

* Visibility depends on order options or device settings

Additional information

Meaning of the options
- **Manual**
  The level and the associated linearized value are entered manually for each linearization point.
- **Semiautomatic**
  The level is measured by the device for each linearization point. The associated linearized value is entered manually.
- **Clear table**
  Deletes the existing linearization table.
- **Sort table**
  Rearranges the linerization points into an ascending order.

Conditions the linearization table must meet:
- The table may consist of up to 32 pairs of values "Level - Linearized Value".
- The table must be monotonic (monotonically increasing or decreasing).
- The first linearization point must refer to the minimum level.
- The last linearization point must refer to the maximum level.

Before entering a linearization table, the values for **Empty calibration (→ 58)** and **Full calibration (→ 59)** must be set correctly.

If values of the table need to be changed after the full or empty calibration have been changed, a correct evaluation is only ensured if the existing table is deleted and the complete table is entered again. To do so delete the existing table (**Table mode (→ 74)** = **Clear table**). Then enter a new table.

How to enter the table
- Via FieldCare
  The table points can be entered via the **Table number (→ 75)**, **Level (→ 76)** and **Customer value (→ 76)** parameters. As an alternative, the graphic table editor may be used: Device Operation → Device Functions → Additional Functions → Linearization (Online/Offline)
- Via local display
  Select the **Edit table** submenu to call up the graphic table editor. The table is displayed and can be edited line by line.

The factory setting for the level unit is "%". If you want to enter the linearization table in physical units, you must select the appropriate unit in the **Level unit** parameter (→ 60) beforehand.

Table number

Navigation Expert → Sensor → Linearization → Table number (2370)

Prerequsite **Linearization type (→ 70)** = **Table**

Description Select table point you are going to enter or change.

User entry 1 to 32

Factory setting 1

Level (Manual)

Navigation Expert → Sensor → Linearization → Level (2383)

Prerequsite
- **Linearization type (→ 70)** = **Table**
- **Table mode (→ 74)** = **Manual**

Description Enter level value of the table point (value before linearization).

User entry Signed floating-point number

Factory setting 0 %

Level (Semiautomatic)

Navigation Expert → Sensor → Linearization → Level (2389)

Prerequsite
- **Linearization type (→ 70)** = **Table**
- **Table mode (→ 74)** = **Semiautomatic**

Description Displays measured level (value before linearization). This value is transmitted to the table.

Customer value

Navigation Expert → Sensor → Linearization → Customer value (2384)

Prerequsite **Linearization type (→ 70)** = **Table**

Description Enter linearized value for the table point.

User entry Signed floating-point number

Factory setting 0 %

Activate table

Navigation Expert → Sensor → Linearization → Activate table (2304)

Prerequsite **Linearization type (→ 70)** = **Table**

Description Activate (enable) or deactivate (disable) the linearization table.

Selection
- Disable
- Enable

Factory setting Disable

Additional information

Meaning of the options

- **Disable**
  The measured level is not linearized.
  If **Linearization type (→ 70)** = **Table** at the same time, the device issues error message F435.
- **Enable**
  The measured level is linearized according to the table.

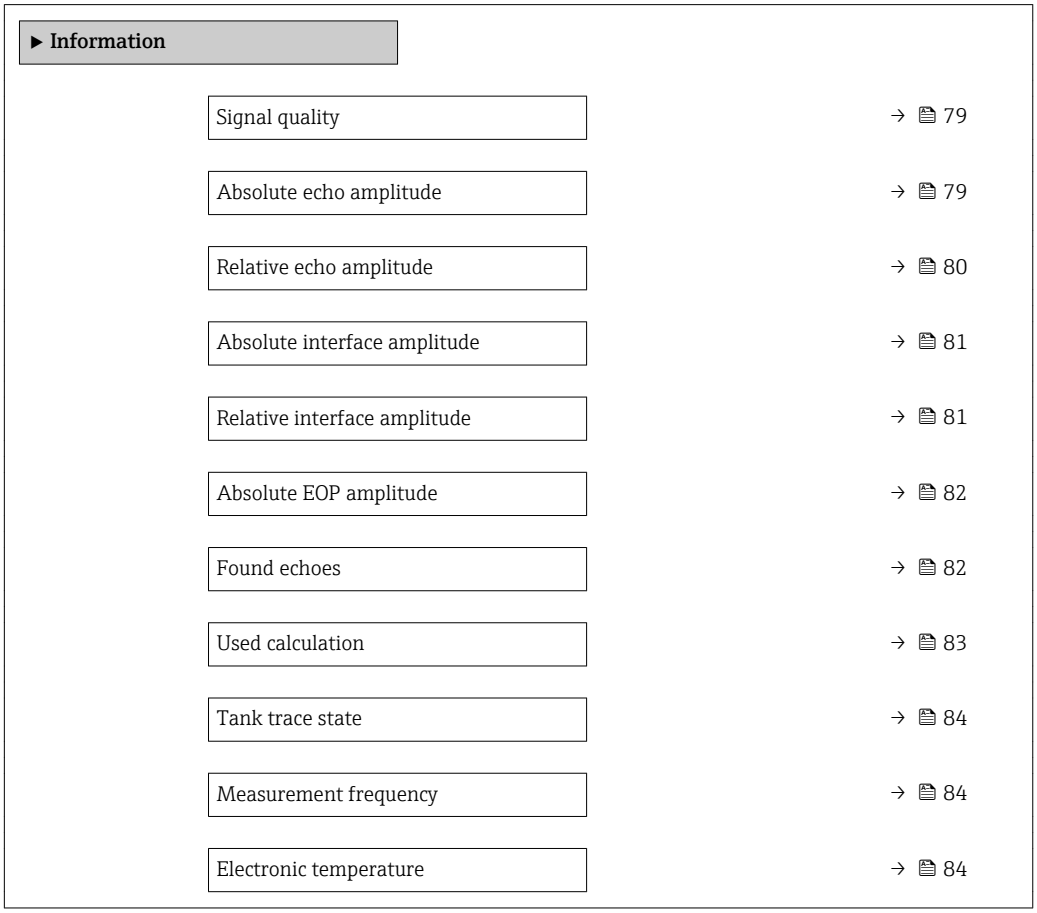
When editing the table, the **Activate table** parameter is automatically reset to **Disable** and must be reset to **Enable** after the table has been entered.

4.4.6 "Information" submenu

The **Information** submenu comprises all display parameters which give information about the current state of the measurement.

Structure of the submenu

Navigation Expert → Sensor → Information



Description of parameters

Navigation Expert → Sensor → Information

Signal quality

Navigation Expert → Sensor → Information → Signal quality (1047)

Description Displays the signal quality of the evaluated echo.

Additional information

Meaning of the display options
- **Strong**
  The evaluated echo exceeds the threshold by at least 10 mV.
- **Medium**
  The evaluated echo exceeds the threshold by at least 5 mV.
- **Weak**
  The evaluated echo exceeds the threshold by less than 5 mV.
- **No signal**
  The device does not find a usable echo.

The signal quality indicated in this parameter always refers to the currently evaluated echo: either the level/interface echo [25] or the end-of-probe echo. To differentiate between these two, the quality of the end-of-probe echo is always displayed in brackets.

In case of a lost echo (**Signal quality = No signal**) the device generates the following error message:
- F941, for **Output echo lost (→ 117) = Alarm**.
- S941, if another option has been selected in **Output echo lost (→ 117)**.

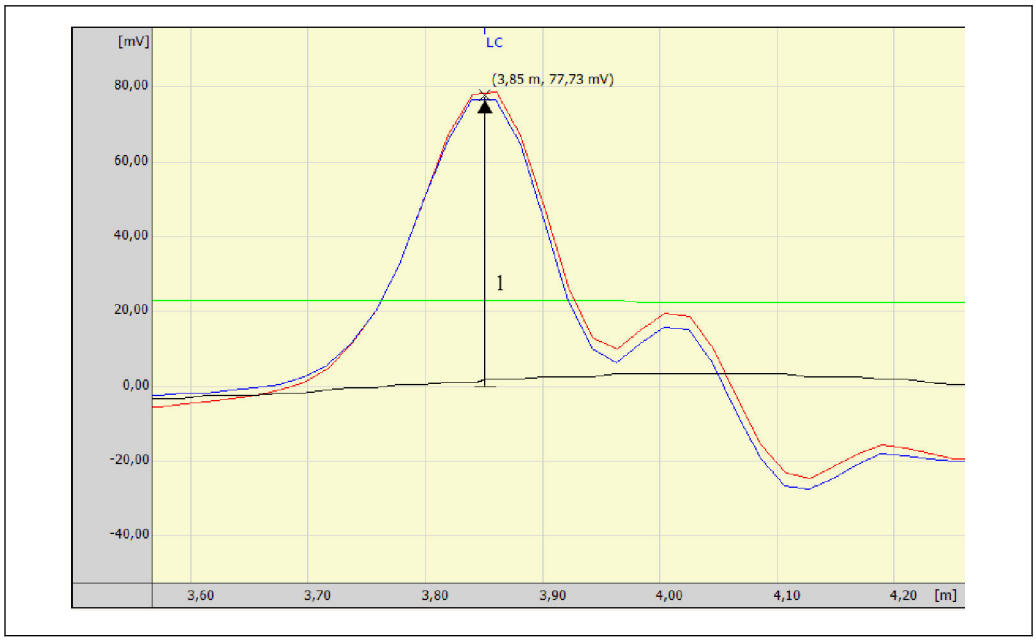
Absolute echo amplitude

Navigation Expert → Sensor → Information → Abs. echo ampl. (1127)

Description Displays the absolute amplitude of the level echo in the subtracted curve.

25) Of these two echos the one with the lower quality is indicated.

Additional information



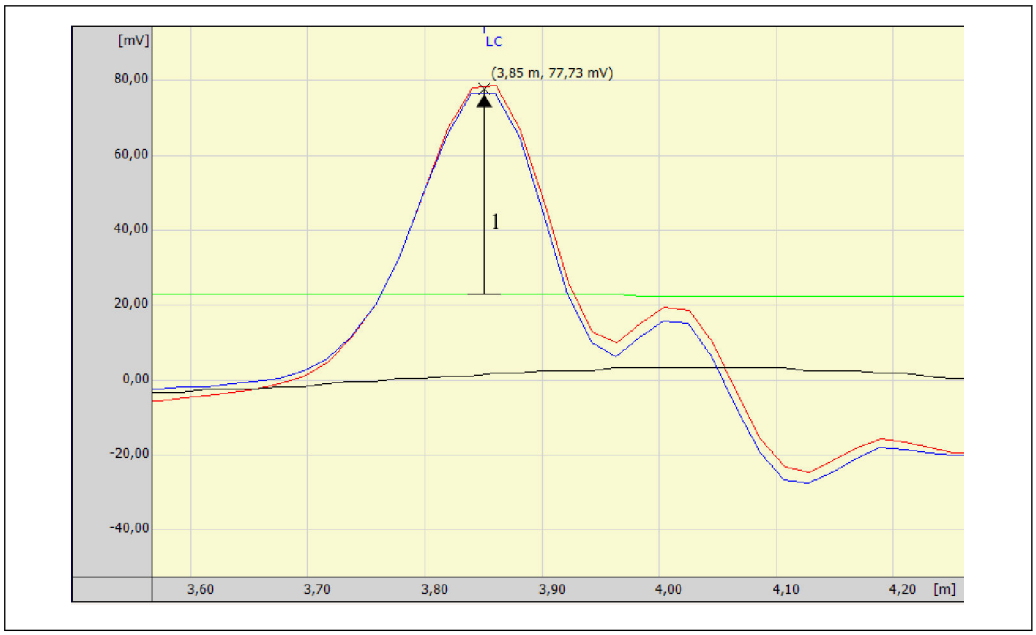
1 Absolute echo amplitude in the envelope curve as measured from the 0mV line

Relative echo amplitude

Navigation Expert → Sensor → Information → Relat.echo ampl. (1089)

Description Displays the relative amplitude of the level echo in the subtracted curve. The relative amplitude is the difference between the level echo and the echo threshold.

Additional information



1 The relative echo amplitude is the difference between the amplitude in the envelope curve (blue) and the echo threshold (green).

In the envelope curve display of FieldCare, the absolute echo amplitude is indicated instead of the relative amplitude (see the number on the top right of the echo peak in the example).

Absolute interface amplitude

Navigation Expert → Sensor → Information → Abs.interf.ampl. (1129)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays the absolute amplitude of the interface echo in the subtracted curve.

Relative interface amplitude

Navigation Expert → Sensor → Information → Rel.interf.ampl. (1090)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

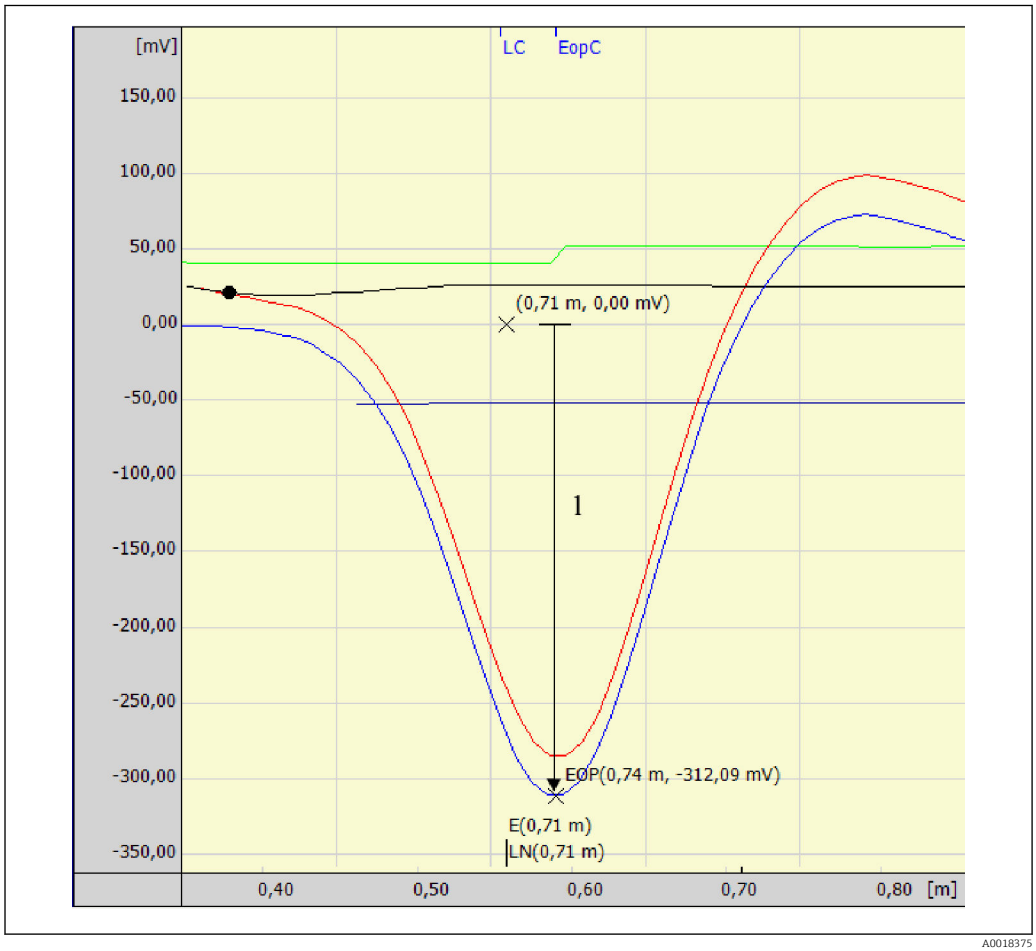
Description Displays the relative amplitude of the interface echo in the subtracted curve.

Absolute EOP amplitude

Navigation Expert → Sensor → Information → Abs. EOP ampl. (1128)

Description Displays the absolute amplitude of the end-of-probe signal in the subtracted curve.

Additional information



1 Absolute EOP amplitude (example for an insulated end-of-probe)

Polarity of the end-of-probe signal

- For probe ends which are freely suspended in the medium or insulated against the tank, the end-of-probe signal is negative.
- For probe ends which are grounded to the tank potential, the end-of-probe signal is positive.

To ensure correct evaluation of the end-of-probe signal, its polarity must be specified in the **EOP search mode** parameter (→ 135).

Found echoes

Navigation Expert → Sensor → Information → Found echoes (1068)

Description Indicates which echoes have been found.

User interface

- None
- Level
- Interface
- EOP
- Level and interface
- Level and EOP
- Interface and EOP
- Level, interface and EOP
- EOP
- EOP (TT)
- EOP (LN)
- Level and EOP
- Multiple echo (TT)
- Level and interface with capa.
- Level with capa. and interface

Used calculation

Navigation Expert → Sensor → Information → Used calculation (1115)

Description Indicates which echoes are used for the calculation of the measured value.

Additional information

Meaning of the options

- **None**
  The measured value is not calculated (e.g. due to a lost echo)
- **Level**
  The level is calculated from the direct level echo.
- **EOP**
  The level is calculated from the end-of-probe signal (EOP).
- **EOP (TT)**
  The level is calculated from the end-of-probe signal (EOP) taking into account the tank table (TT).
- **Multiple echo (TT)**
  The level is calculated from the multiple echo, taking into account the tank table (TT).
- **EOP (LN)**
  An empty tank is detected from the end-of-probe signal (EOP) in the interface mode.
- **Level and EOP**
  The level is calculated from the direct level echo. Its plausibility is checked by the end-of-probe signal (EOP). This situation may occur if the device is in the interface mode and the tank contains only one medium.
- **Interface**
  The interface height is calculated from the direct interface echo. This situation may occur if **Tank level (→ 154)** = **Fully flooded**.
- **Measured capacitance** (only for FMP55)
  The level is calculated from the measured capacitance without taking into account any echoes.
- **Level and interface**
  The level is calculated from the direct level echo. The interface height is calculated from the direct interface echo.
- **Level and interface with capa.**
  The level is calculated from the direct level echo. The interface height is calculated from the measured capacitance.

Tank trace state

Navigation Expert → Sensor → Information → Tank trace state (1206)

Description Indicates the current state of the tank trace.

Additional information

Meaning of the options
- **Not active**
  A valid tank trace is not available.
- **EOP (TT)**
  A valid EOP tank trace is available.
- **Multiple echo (TT)**
  A valid multiple echo tank trace is available.
- **EOP + Multiple echo (TT)**
  A valid EOP and multiple echo tank trace are available.

Measurement frequency

Navigation Expert → Sensor → Information → Measurm. freq. (1180)

Description Displays the current measurement frequency (number of pulses per second).

Additional information The measurement frequency is dependent on the length of the probe. Refer to the Technical Information (TI) of the respective device for details.

Electronic temperature

Navigation Expert → Sensor → Information → Electronic temp. (1062)

Description Displays the current temperature of the electronics.

Additional information The unit is defined in the **Temperature unit** parameter (→ 45).

4.4.7 "Sensor properties" submenu

The **Sensor properties** submenu comprises all parameters which describe the measurement-related properties of the probe and the envelope curve.

Probe length correction

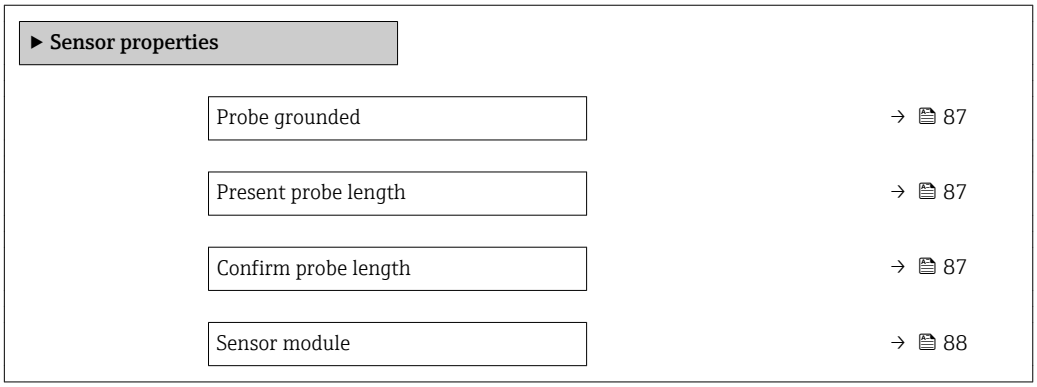
For the signal evaluation it is essential that the Levelflex allocates the end-of-probe signal correctly. To ensure this one can manually enter the actual length of the probe or one can perform a probe length correctionn several times until the displayed length of the probe matches the actual length of the probe (LN). To do so one needs the following parameters:

- **Present probe length** (→ 87)
- **Confirm probe length** (→ 87)

When operating via the local display module, the **Confirm probe length** (→ 87) and **Present probe length** (→ 87) parameters are comprised in the **Probe length correction** sequence.

Structure of the submenu

Navigation Expert → Sensor → Sensor prop.



Description of parameters

Navigation Expert → Sensor → Sensor prop.

Probe grounded

Navigation Expert → Sensor → Sensor prop. → Probe grounded (1222)

Prerequsite **Operating mode (→ 45) = Level**

Description Specify whether the probe is grounded.

Selection
- No
- Yes

Factory setting No

Present probe length

Navigation Expert → Sensor → Sensor prop. → Pres. length (1078)

Description
- In most cases:
  Displays the length of the probe according to the currently measured end-of-probe signal.
- For **Confirm probe length (→ 87) = Manual input**:
  Enter actual length of probe.

User entry 0 to 200 m

Factory setting 4 m

Confirm probe length

Navigation Expert → Sensor → Sensor prop. → Confirm length (1080)

Description Select, whether the value displayed in the **Present probe length** parameter → 87 matches the actual length of the probe. Based on this input, the device performs a probe length correction.

Selection
- Probe length OK
- Probe length too small
- Probe length too big
- Probe covered
- Manual input
- Probe length unknown

Factory setting Probe length OK

Additional information

Meaning of the options

- **Probe length OK**
  To be selected if the indicated length is correct. An adjustment is not required. The device quits the sequence.
- **Probe length too small**
  To be selected if the displayed length is smaller than the actual length of the probe. A different end of probe signal is allocated and the newly calculated length is displayed in the **Present probe length** parameter → 📄 87. This procedure has to be repeated until the displayed value matches the actual length of the probe.
- **Probe length too big**
  To be selected if the displayed length is bigger than the actual length of the probe. A different end of probe signal is allocated and the newly calculated length is indicated in the **Present probe length** parameter → 📄 87. This procedure has to be repeated until the displayed value matches the actual length of the probe.
- **Probe covered**
  To be selected if the probe is (partially or completely) covered. A probe length correction is impossible in this case. The device quits the sequence.
- **Manual input**
  To be selected if no automatic probe length correction is to be performed. Instead, the actual length of the probe must be entered manually into the **Present probe length** parameter → 📄 87 [26].
- **Probe length unknown**
  To be selected if the acutal length of the probe is unknown. A probe length correction is impossible in this case and the device quits the sequence.
  .

Sensor module

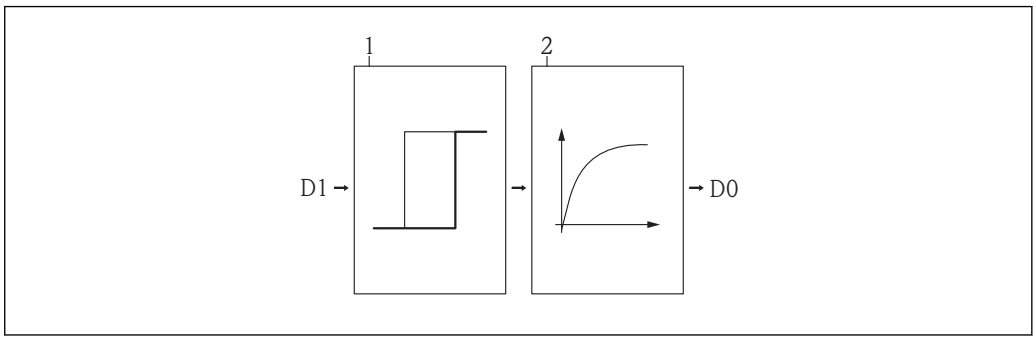
Navigation Expert → Sensor → Sensor prop. → Sensor module (1101)

Description Displays the type of sensor module.

26) When operated via FieldCare, the **Manual input** option needs not to be selected explicitly. In FieldCare the length of the probe can always be edited.

4.4.8 "Distance" submenu

The **Distance** submenu contains all parameters which control the filtering of the raw distance D1. The resulting distance D0 is used for the subsequent calculation of the level.

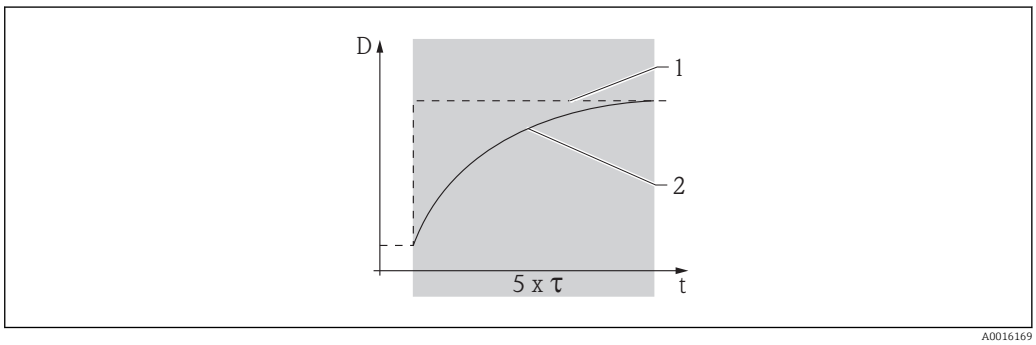


25 The configurable distance filters

1 Dead time (→ 93)
2 Integration time (→ 94) (low pass filter)

Low pass filter

The low pass filter dampens the distance signal with a user defined integration time τ (**Integration time** parameter (→ 94)). After a sudden change of the level, it takes about 5 x τ, until the new measured value is obtained.

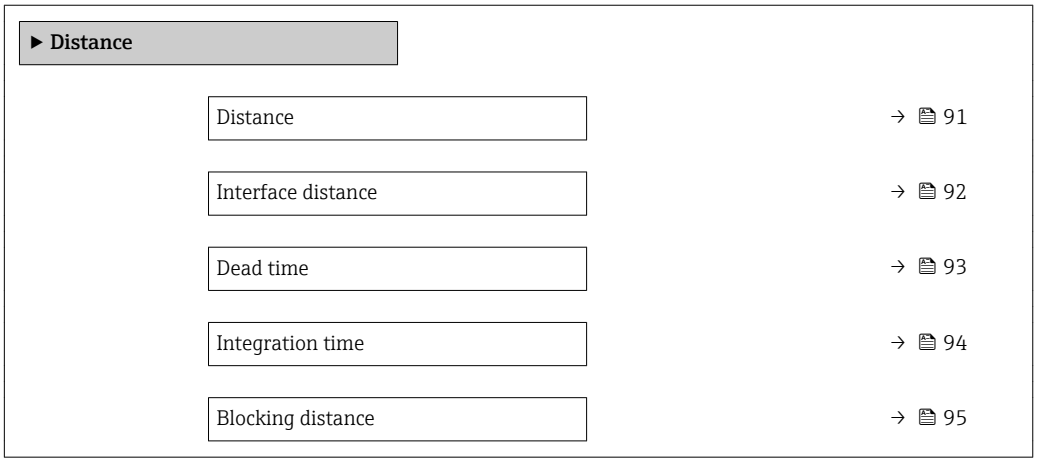


26 Low pass filter

1 Signal before the low pass filter
2 Signal after the low pass filter
τ Integration time (→ 94)

Structure of the submenu

Navigation Expert → Sensor → Distance



Description of parameters

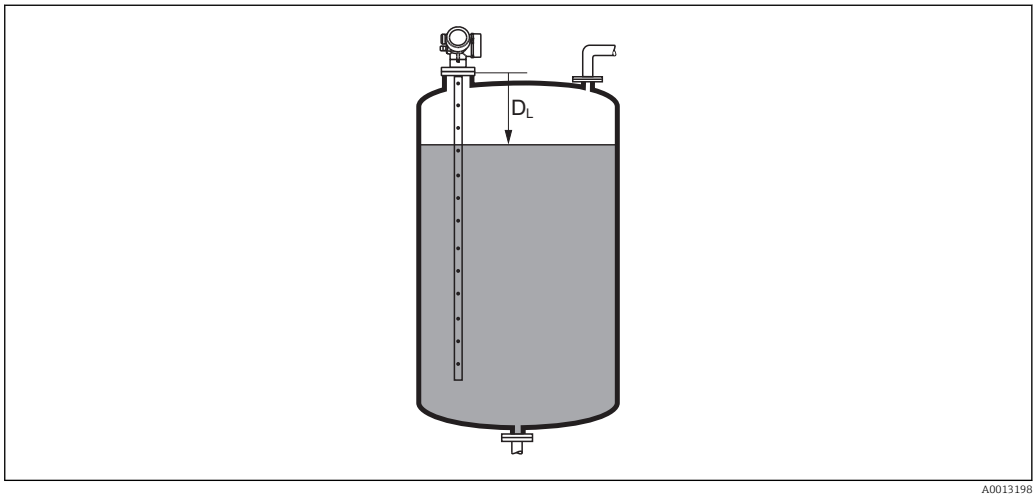
Navigation Expert → Sensor → Distance

Distance

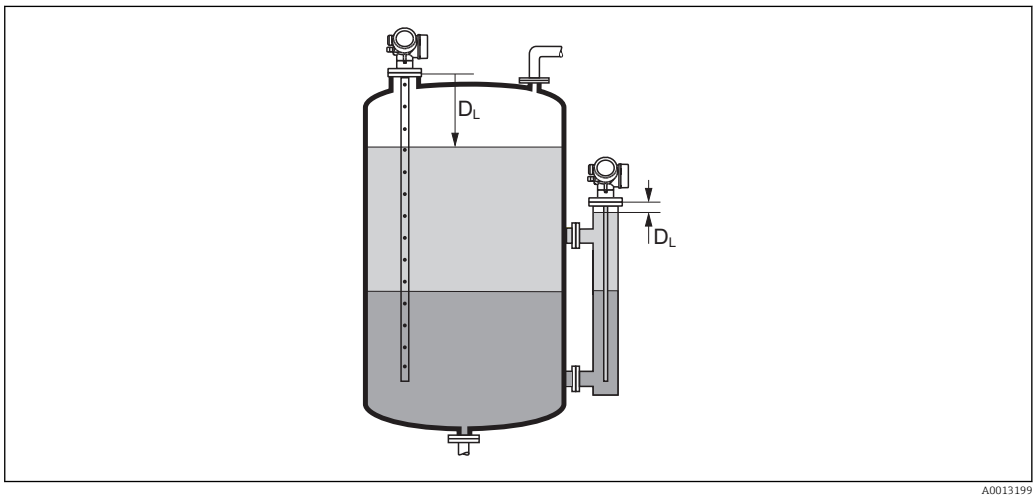
Navigation Expert → Sensor → Distance → Distance (1124)

Description Displays the measured distance D_L between the reference point (lower edge of the flange or threaded connection) and the level.

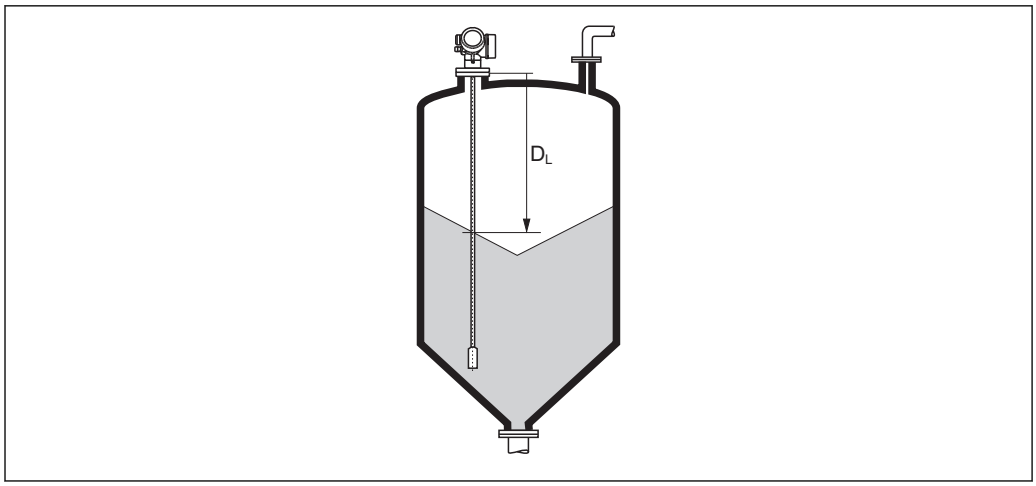
Additional information



27 Distance for liquid measurements



28 Distance for interface measurements



29 Distance for bulk solid measurements

The unit is defined in the **Distance unit** parameter (→ 45).

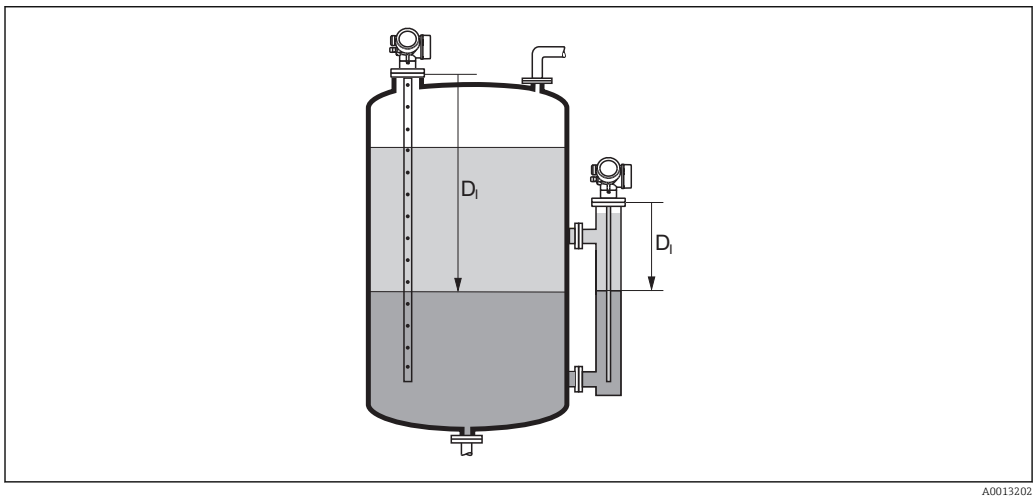
Interface distance

Navigation Expert → Sensor → Distance → Interface dist. (1067)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays the measured distance D_I between the reference point (lower edge of flange or threaded connection) and the interface.

Additional information



The unit is defined in the **Distance unit** parameter (→ 45).

Dead time

Navigation Expert → Sensor → Distance → Dead time (1199)

Description Define the dead time (in seconds).

User entry 0 to 60 s

Factory setting **Dependent on the following parameters:**
- **Medium type (→ 51)**
- **Process property (→ 47)**

Additional information

Factory setting for level measurements with "Medium type" = "Liquid"

Process property (→ 47)	Dead time
Fast > 1 m (40 in)/min	0 s
Standard < 1 m (40in) /min	1 s
Medium < 10 cm (4in) /min	3 s
Slow < 1 cm (0.4in) /min	6 s
No filter / test	0 s

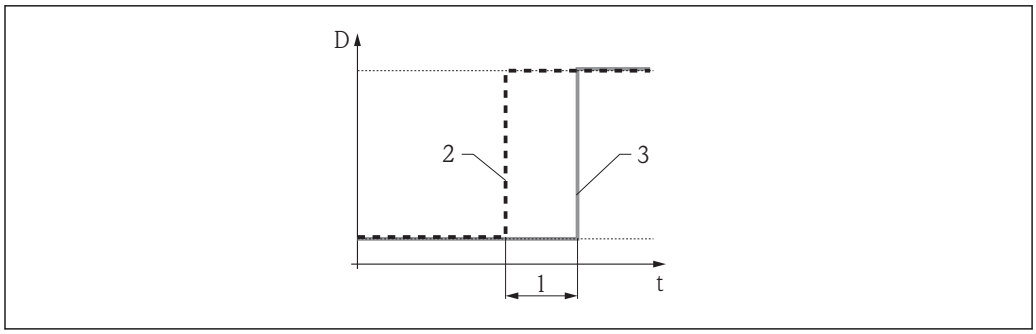
Factory setting for level measurements with "Medium type" = "Solid"

Process property (→ 47)	Dead time
Fast > 10 m (33 ft) /h	1 s
Standard < 10 m (33 ft) /h	3 s
Medium < 1 m (3ft) /h	5 s
Slow < 0.1 m (0.3ft) /h	10 s
No filter / test	0 s

Factory setting for interface measurements

Process property (→ 47)	Dead time
Fast > 1 m (40 in)/min	0 s
Standard < 1 m (40in) /min	10 s
Medium < 10 cm (4in) /min	10 s
Slow < 1 cm (0.4in) /min	10 s
No filter / test	0 s

Application
Sudden changes of the measured distance are ignored during the time span defined in this parameter. In this way it is possible to prevent short-term interferences form disturbing the output signal.



30 Effect of the dead time

1 Dead time
2 Signal before the dead time filter
3 Signal after the dead time filter

Disadvantages
- The device slows down.
- Fast level changes are registered with a delay.

Integration time

Navigation Expert → Sensor → Distance → Integration time (1092)

Description Define the integration time (in seconds).

User entry 0.0 to 200 000.0 s

Factory setting **Dependent on the following parameters:**
- **Medium type (→ 51)**
- **Process property (→ 47)**

Additional information *Factory setting for "Medium type" = "Liquid"*

Process property (→ 47)	Integration time
Fast > 1 m (40 in)/min	1 s
Standard < 1 m (40in) /min	5 s
Medium < 10 cm (4in) /min	15 s
Slow < 1 cm (0.4in) /min	30 s
No filter / test	0 s

Factory setting for "Medium type" = "Solid"

Process property (→ 47)	Integration time
Fast > 10 m (33 ft) /h	37 s
Standard < 10 m (33 ft) /h	74 s
Medium < 1 m (3ft) /h	145 s

Process property (→ 47)	Integration time
Slow < 0.1 m (0.3ft) /h	290 s
No filter / test	< 0.8 s

Increasing the integration time results in a calmer measuring signal. However, it also causes a delayed reaction to level changes.

Blocking distance

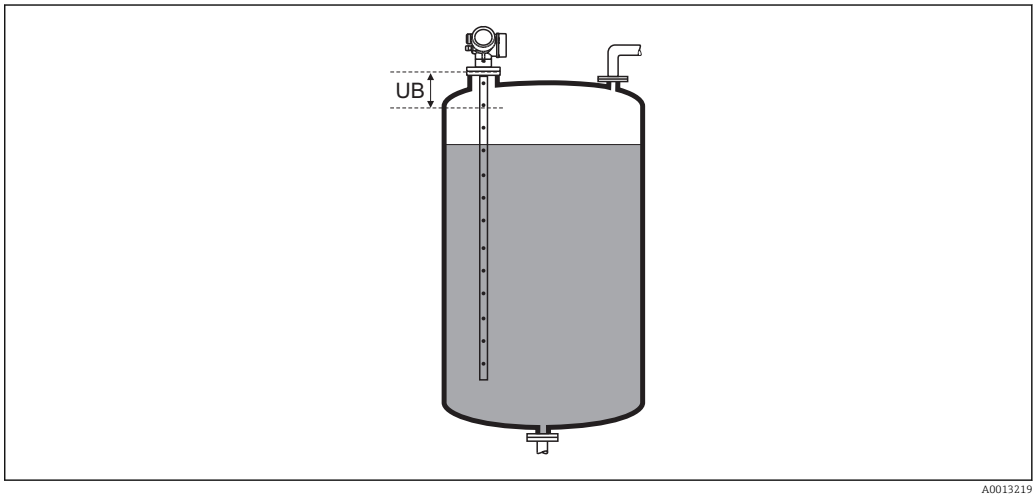
Navigation Expert → Sensor → Distance → Blocking dist. (1144)

Description Specify upper blocking distance UB.

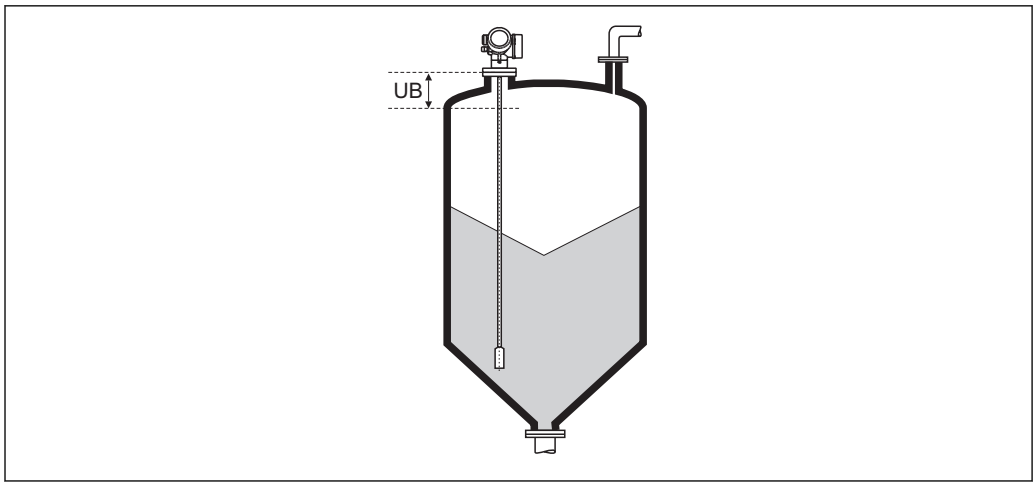
User entry 0 to 200 m

Factory setting
- For coax probes: 0 mm (0 in)
- For rod and rope probes up to 8 m (26 ft): 200 mm (8 in)
- For rod and rope probes above 8 m (26 ft): 0.025 * Sondenlänge

Additional information No echos are evaluated within the blocking distance UB. Therefore, UB can be used to suppress interference echos within the upper end of the probe.



31 Blocking distance (UB) for liquid measurements



32 Blocking distance (UB) for bulk solid measurements

4.4.9 "Gas phase compensation" submenu

For FMP51, FMP52 and FMP54: The **Gas phase compensation** submenu (→ 103) is only available if **Operating mode (→ 45)** = **Level**.

Einfluss der Gasphase

High pressures reduce the propagation velocity of the measuring signals in the gas/vapor above the fluid. This effect depends on the kind of gas/vapor and of its temperature. This results in a systematic measuring error that gets bigger as the distance increases between the reference point of the measurement (flange) and the product surface.

The following table illustrates this measured error for a few typical gases/vapors (with regard to distance; a positive value means that too large a distance is being measured):

Gas layer	Temperature		Pressure					
	°C	°F	1 bar (14.5 psi)	10 bar (145 psi)	50 bar (725 psi)	100 bar (1 450 psi)	200 bar (2 900 psi)	400 bar (5 800 psi)
Air	20	68	0.00 %	0.22 %	1.2 %	2.4 %	4.9 %	9.5 %
	200	392	−0.01 %	0.13 %	0.74 %	1.5 %	3.0 %	6.0 %
	400	752	−0.02 %	0.08 %	0.52 %	1.1 %	2.1 %	4.2 %
Hydrogen	20	68	−0.01 %	0.10 %	0.61 %	1.2 %	2.5 %	4.9 %
	200	392	−0.02 %	0.05 %	0.37 %	0.76 %	1.6 %	3.1 %
	400	752	−0.02 %	0.03 %	0.25 %	0.53 %	1.1 %	2.2 %

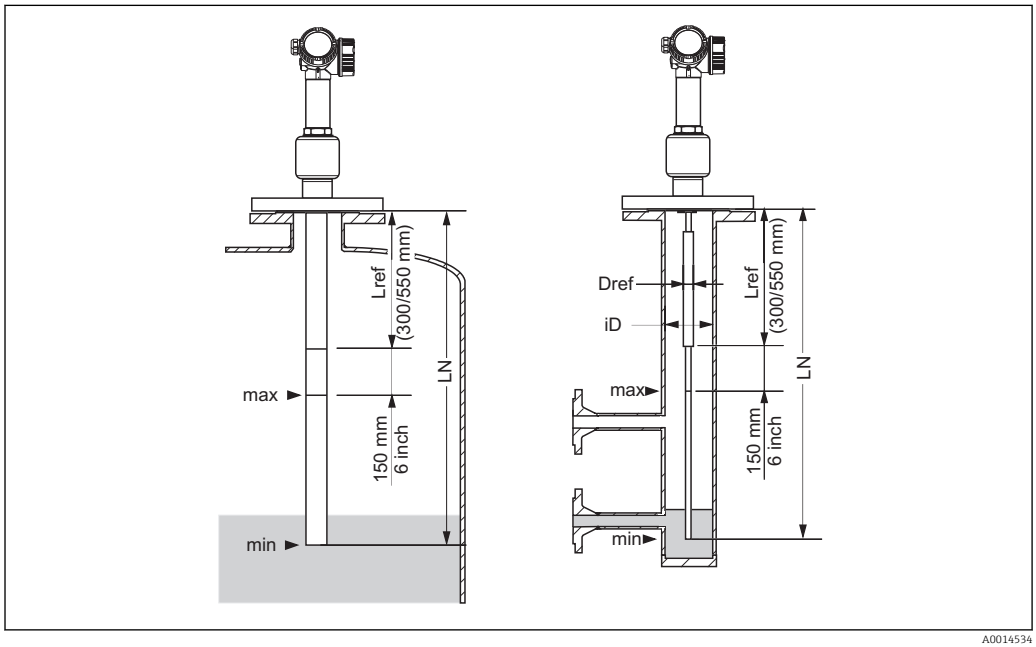
Gas layer	Temperature		Pressure							
	°C	°F	1 bar (14.5 psi)	2 bar (29 psi)	5 bar (72.5 psi)	10 bar (145 psi)	20 bar (290 psi)	50 bar (725 psi)	100 bar (1 450 psi)	200 bar (2 900 psi)
Water (saturated steam)	100	212	0.26 %	-	-	-	-	-	-	-
	120	248	0.23 %	0.50 %	-	-	-	-	-	-
	152	306	0.20 %	0.42 %	1.14 %	-	-	-	-	-
	180	356	0.17 %	0.37 %	0.99 %	2.10 %	-	-	-	-
	212	414	0.15 %	0.32 %	0.86 %	1.79 %	3.9 %	-	-	-
	264	507	0.12 %	0.26 %	0.69 %	1.44 %	3.0 %	9.2 %	-	-
	311	592	0.09 %	0.22 %	0.58 %	1.21 %	2.5 %	7.1 %	19.3 %	-
	366	691	0.07 %	0.18 %	0.49 %	1.01 %	2.1 %	5.7 %	13.2 %	76 %

Gas phase compensation with reference signal

This type of gas phase compensation requires a reference signal at a defined distance from the process connection which must be above the maximum level. The current speed of propagation is determined from the shift of this reference signal The envelope curve can be scaled accordingly.

Probes with reference signal (option for FMR54)

As an option, FMP54 is available in a version for gas phase compensation (feature 540 "Application Package", Option EF: "Gas phase compensation L_{ref} = 300mm" oder EG: "Gas phase compensation L_{ref} = 550mm"). This version of the FMP54 generates a reference reflection at the distance L_{ref} from the flange. The reference reflection must be at least 150 mm (6 in) above the highest level.



Coax probes with reference reflection can be installed in any tank (free in the tank or into a bypass). Coax probes are completely mounted and calibrated on delivery. After mounting they are ready for use; additional settings are not necessary.

Rod probes are only recommended if the installation of a coax probe is not possible (e.g. if the bypass diameter is too small).

Rod probes with reference reflection are only suited for mounting in stilling wells and side gauges (bypasses). The diameter D_{ref} of the probe rod in the range of the reference distance L_{ref} must be chosen depending on the pipe inner diameter iD, see table below. In the range of the reference distance L_{ref} the pipe has to be cylindrical; changes of the cross section, for example at flanged connections, are only allowed up to 5% of the inside diamter iD.

In addition, the distance of the reference signal must be measured in the depressurized state and this value must be entered in the **Reference distance** parameter (→ 106). This is necessary because the exact position of the reference signal is dependent on the mounting conditions (e.g. on the diameter of a nozzle or stilling well).

Inner diameter iD of the stilling well/bypass	Diameter D_{ref} of the rod probe within the reference distance L_{ref}
40 mm (1.57 in) ≤ iD < 45 mm (1.77 in)	22 mm (0.87 in)
45 mm (1.77 in) ≤ iD < 70 mm (2.76 in)	25 mm (0.98 in)
70 mm (2.76 in) ≤ iD < 100 mm (3.94 in)	30 mm (1.18 in)

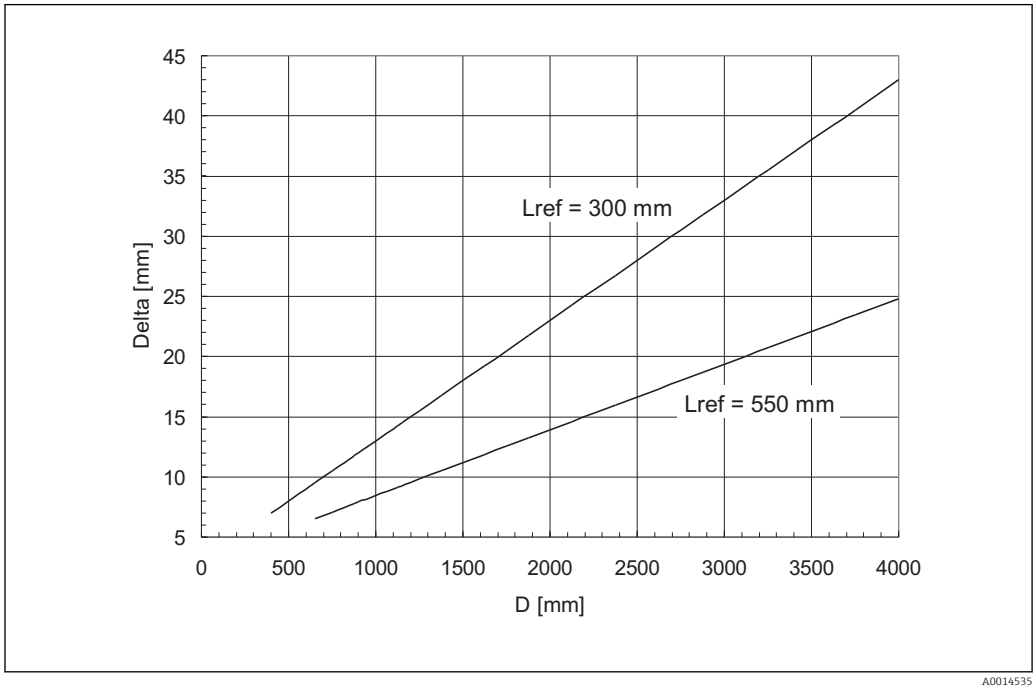
Limitations for coax/rod probes

Maximum probe length LN	LN ≤ 4 000 mm (157 in)
Minimum probe length LN	LN > L_{ref} + 200 mm (7.7 in)
Reference distance L_{ref}	300 mm (11.8 in) or 550 mm (21.7 in), see feature 540 of the product structure
Maximum level relative to sealing surface of flange	L_{ref} + 150 mm (5.9 in)
Minimum dielectric constant of the medium	DC > 7

When can the gas phase compensation with reference signal be used?

Level measurements with high pressure for measuring ranges up to a few meters in polar media with a dielectric constant DC > 7 (e.g. water or ammonia), which would cause a high measuring error without the compensation.

The accuracy of measurement at reference conditions is the higher the larger the reference length L_{ref} and the samller the measuring range is:



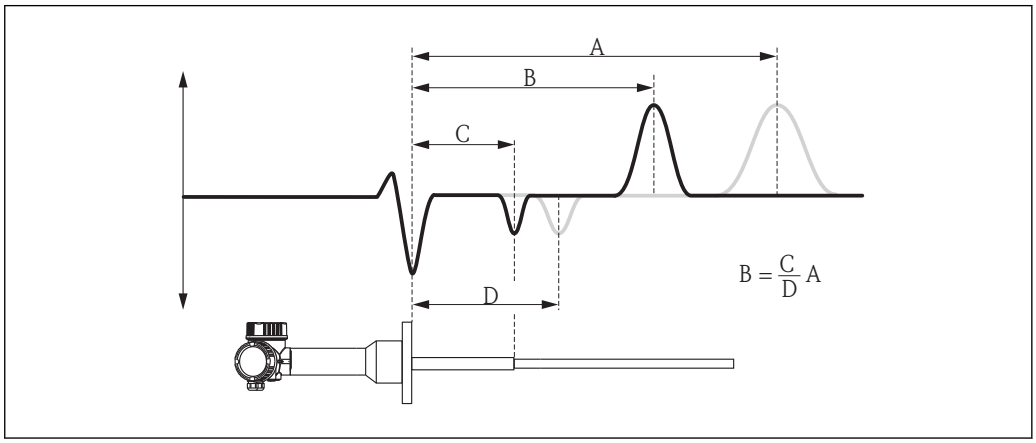
D *Distance from liquid surface to lower edge of the flange*
Delta *Measuring error*

If there are fast pressure changes, there may be an additional error, since the measured reference distance is filtered with the time constant of the level measurement. In addition, non-equilibrium conditions - for example due to heating - may cause density gradients within the medium and condensation of steam at the probe. As a result, the level readings at different locations inside the tank may vary slightly. Caused by this application influences the measuring error may be increased by a factor up to 2 to 3.

Calculation of the corrected distance

The position of the reference echo changes depending of the pressure. From this echo shift, Levelflex automatically calculates a correction factor for the microfactor (i. e. for the speed of signal propagation). This factor is used to adjust the envelope curve and thus the measured distance.

Owing to the correction of the microfactor, the corrected envelope curve is displayed in the operating tool in the case of an activated gas phase compensation.

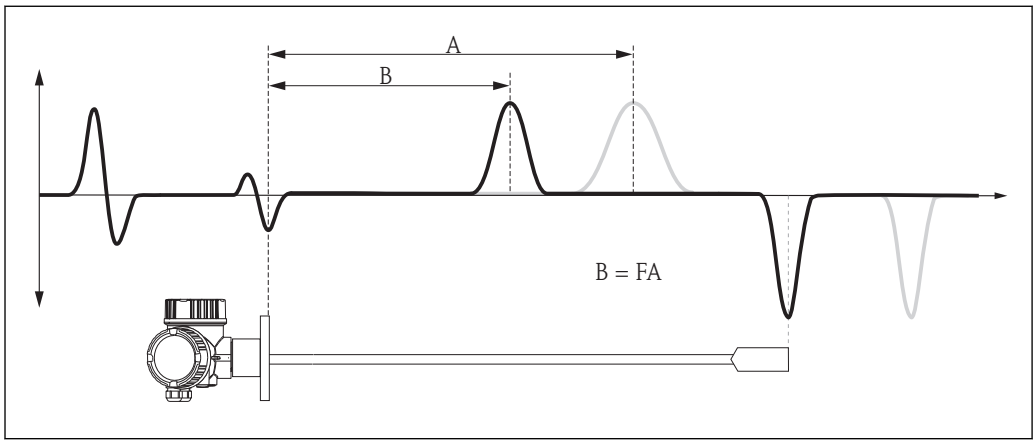


33 *Gas phase compensation with reference echo*

A Position of the level echo in the original envelope curve
B Position of the level echo in the adjusted envelope curve
C Actual position of the reference echo (to be entered into the "Reference distance" parameter (→ 106))
D Measured position of the reference echo

Constant gas phase compensation factor

If the properties of the gas phase (pressure, temperature, composition) do not change over the time and are known, a gas phase compensation can also be performed without a reference signal. Instead, a constant, user-defined correction factor is applied in this case. This factor is used to scale the envelope curve (and thus the measured echo distance).

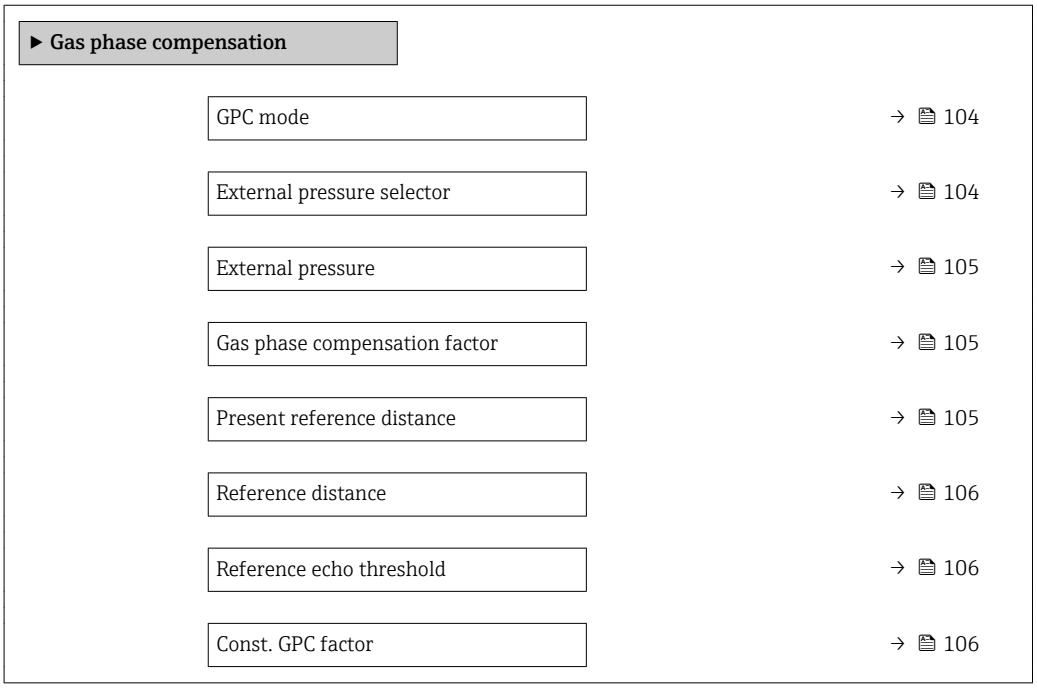


34 Gas phase compensation with a constant correction factor F

A Position of the level echo in the original envelope curve
B Position of the level echo in the corrected envelope curve.

Structure of the submenu

Navigation Expert → Sensor → Gas phase comp.



Description of parameters

Navigation Expert → Sensor → Gas phase comp.

GPC mode

Navigation Expert → Sensor → Gas phase comp. → GPC mode (1034)

Description Select gas phase compensation mode.

Selection
- Off
- On
- Without correction
- External correction
- Const. GPC factor

Factory setting Off

Additional information

Meaning of the options
- **Off**
  The gas phase compensation is deactivated.
- **On**
  This option can only be selected for probes with reference echo. The gas phase compensation is calculated from the position of this reference echo. In FieldCare, the displayed envelope curve does already contain the correction.
- **Without correction**
  The correction factor is calculated from the reference echo but not applied to the measurement. In FieldCare, the envelope curve is displayed without the correction. This option is only used for diagnostic purposes and should not be selected in normal applications.
- **External correction**
  The device receives the externally measured pressure through an AO block and uses it together with the gas phase compensation factor *F* to calculate the gas phase compensation. The displayed envelope curve does already contain the correction.
- **Const. GPC factor**
  The correction factor is a constant defined by the user. A reference echo is not needed. In FieldCare, the displayed envelope curve does already contain the correction.

External pressure selector

Navigation Expert → Sensor → Gas phase comp. → Ext. press.input (1073)

Prerequsite **GPC mode (→ 104) = External correction**

Description Allocate an AO block to the gas phase compensation. The externally measured pressure is read via this AO block.

Selection
- None
- Analog output 1
- Analog output 2
- Analog output 3

- Analog output 4
- Analog output 5
- Analog output 6
- Analog output 7
- Analog output 8

Factory setting None

External pressure

Navigation Expert → Sensor → Gas phase comp. → External press. (1233)

Prerequsite **GPC mode (→ 104)** = **External correction**

Description Indicates the measured pressure which is currently used for the gas phase compensation.

Gas phase compensation factor

Navigation Expert → Sensor → Gas phase comp. → Gas comp. factor (1209)

Prerequsite **GPC mode (→ 104)** = **External correction**

Description Define gas phase compensation factor *F*.

User entry Signed floating-point number

Factory setting 0

Additional information Suitable value for saturated steam in the temperature range 100 to 350 °C (212 to 662 °F):
F = 0.00505 / bar

Present reference distance

Navigation Expert → Sensor → Gas phase comp. → Pres. ref. dist. (1076)

Prerequsite **GPC mode (→ 104)** = **On** or **Without correction**

Description Displays the currently measured distance of the reference echo.

Reference distance

Navigation Expert → Sensor → Gas phase comp. → Reference dist. (1033)

Prerequsite **GPC mode (→ 104)** = **On** or **Without correction**

Description Enter actual distance of the reference echo.

User entry 0 to 200 m

Factory setting According to the probe

Reference echo threshold

Navigation Expert → Sensor → Gas phase comp. → Ref. echo thresh (1168)

Prerequsite **GPC mode (→ 104)** = **On** or **Without correction**

Description Define threshold for the reference echo.

User entry −999.0 to 999.0 mV

Factory setting −80 mV

Additional information
- Only echoes exceeding the defined threshold are accepted as reference echo.
- Positive reference echoes are not suited for Levelflex as they might be mistaken for the level echo.

Const. GPC factor

Navigation Expert → Sensor → Gas phase comp. → Const.GPC factor (1217)

Prerequsite **GPC mode (→ 104)** = **Const. GPC factor**

Description Specify constant correction factor for the measured distance.

User entry 0.5 to 1.5

Factory setting 1

4.4.10 "Sensor diagnostics" submenu

The **Sensor diagnostics** submenu comprises all parameters which contain information about the state of the probe and the HF cable.

Broken probe detection

In the case of a broken probe caused by mechanical wear, a negative echo arises at the breaking point. If the broken probe detection is active, the device looks for a signal of this type and creates an error message if required.

The borken probe detection can only be used if an interference echo suppression (map) has been correctly recorded.

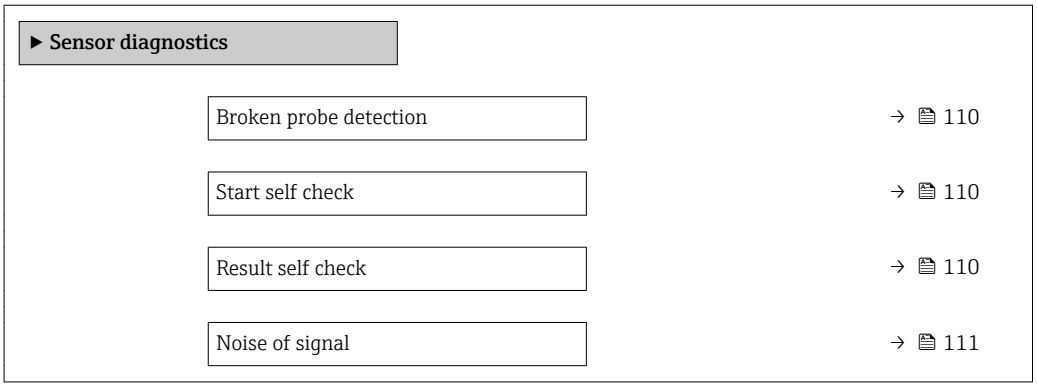
Self check

The **Start self check (→ 110)** and **Result self check (→ 110)** parameters are used for the proof-test which is required for SIL applications in regular intervals. For details refer to the description of the test procedure C in the Functional Safety Manual SD00326F.

For the self check, a test signal is generated in the sensor module and fed onto the analog signal path. The device software checks whether this test signal is within the admissible amplitude and distance ranges. The result of the self check is displayed in the **Result self check** parameter (→ 110).

Structure of the submenu

Navigation Expert → Sensor → Sensor diag.



Description of parameters

Navigation Expert → Sensor → Sensor diag.

Broken probe detection

Navigation Expert → Sensor → Sensor diag. → Brok.probe detec (1032)

Description Switch the broken probe detection on or off.

Selection
- Off
- On

Factory setting Off

Additional information If the broken probe detection is switched on: As soon as a broken probe is detected, the device generates ana alarm and the diagnostic message **Broken probe detected**.

Start self check

Navigation Expert → Sensor → Sensor diag. → Start self check (1133)

Description Start a self check of the device.

Selection
- No
- Yes

Factory setting No

Additional information For the self check, a test signal is generated in the sensor module and fed onto the analog signal path. The device software checks whether this test signal is within the admissible amplitude and distance ranges. The result of the self check is displayed in the **Result self check** parameter (→ 110).

The self check is used for the proof-test which is required for SIL applications in regular intervals. For details refer to the description of the test procedure C in the Functional Safety Manual SD00326F.

Result self check

Navigation Expert → Sensor → Sensor diag. → Result selfcheck (1134)

Description Displays the result of the self check.

Additional information

Meaning of the options
- **Ok**
  The self check has been passed.
- **Not ok**
  The self check failed.
- **Check not done**
  A self check has not been performed.

Noise of signal

Navigation Expert → Sensor → Sensor diag. → Noise of signal (1105)

Description Displays the noise of signal in the envelope curve

4.4.11 "Safety settings" submenu

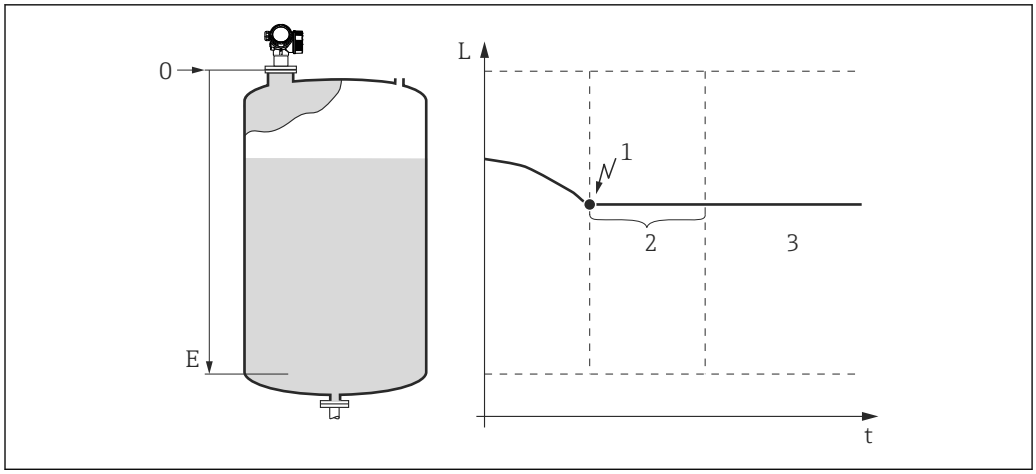
The **Safety settings** submenu contains all parameters which determnine the behavior of the device in critical situations such as an echo loss or an undershooting of a user defined safety distance.

Behavior in the case of an echo loss

The bahavior in case of an echo loss is defined in the **Output echo lost** parameter (→ 117). Depending on the selected option, suitable values must be selected in a number of additional parameters:

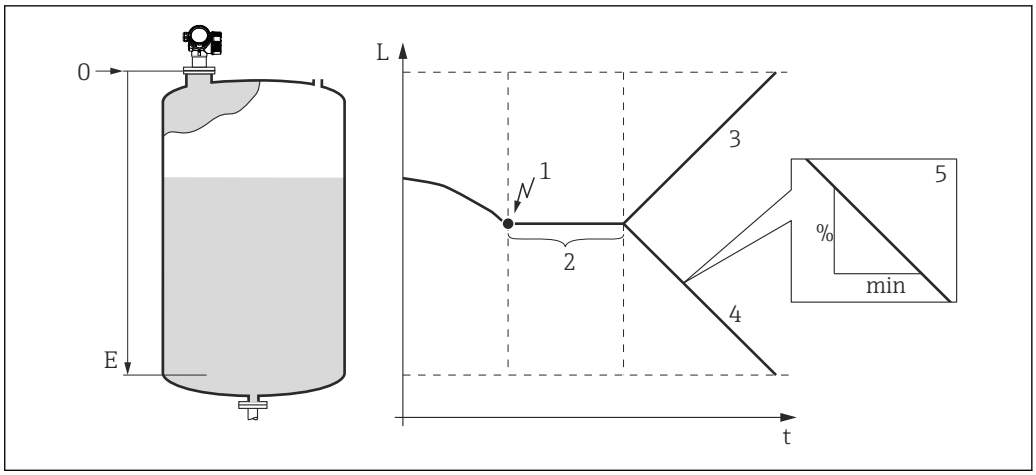
Option selected in in "Output echo lost (→ 117)"	Required additional parameters
Last valid value	Delay time echo lost (→ 119)
Ramp at echo lost	▪ Ramp at echo lost (→ 118) ▪ Delay time echo lost (→ 119)
Value echo lost	▪ Value echo lost (→ 117) ▪ Delay time echo lost (→ 119)
Alarm	1)

1) The alarm bahavior ist defined in the submenus "Current output" (HART) or "Analog input" (PROFIBUS PA, FOUNDATION Fieldbus).



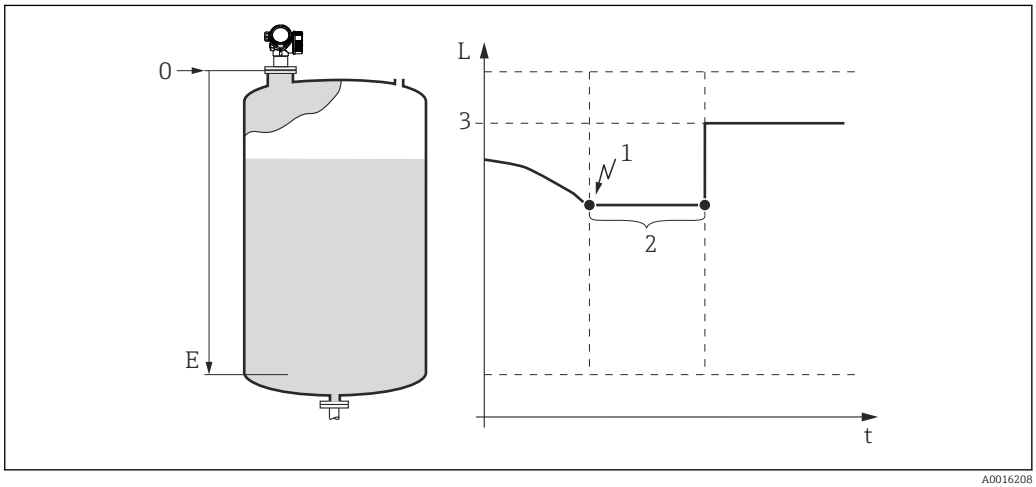
35 "Output echo lost (→ 117)" = "Last valid value"

1 Echo loss
2 Delay time echo lost (→ 119)
3 The last valid measured value is held.



36 "Output echo lost (→ 117)" = "Ramp at echo lost"

1 Echo loss
2 "Delay time echo lost (→ 119)"
3 For a positive ramp: The measured value is increased with a constant rate until it reaches the maximum value (100%).
4 For a negative ramp: The measured value is decreased with a constant rate until it reaches the minimum value (0%).
5 The ramp is specified as "percentage of the defined measuring span per minute".

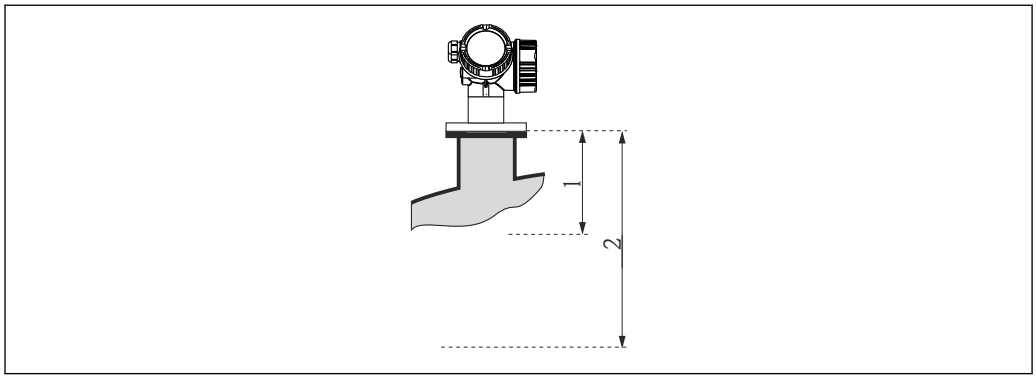


37 "Output echo lost (→ 117)" = "Value echo lost"

1 Echo loss
2 Delay time echo lost (→ 119)
3 Value echo lost (→ 117)

Safety distance

In order to get a warning message if the level rises into the proximity of the upper blocking distance, a safety distance can be defined in the **Safety distance** parameter (→ 🖹 119).

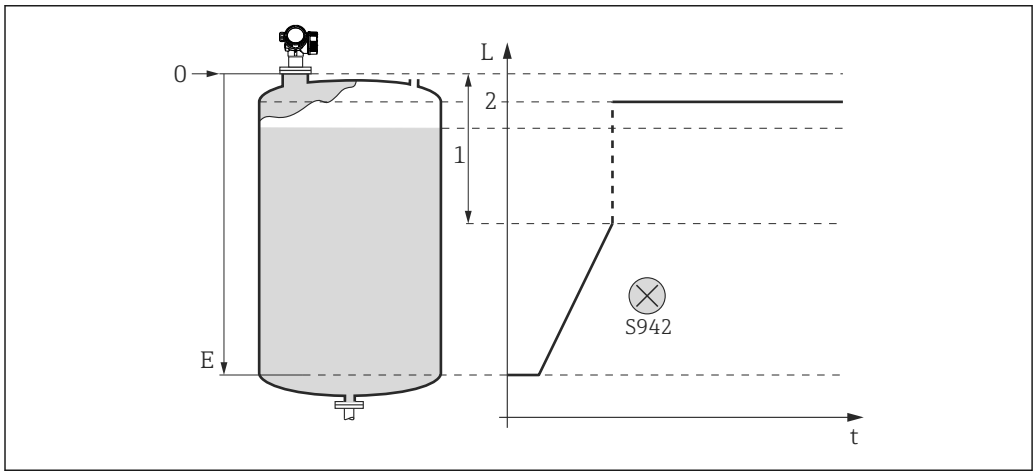


38 Definition of the safety distance

1 Blocking distance (→ 🖹 95)
2 Safety distance (→ 🖹 119)

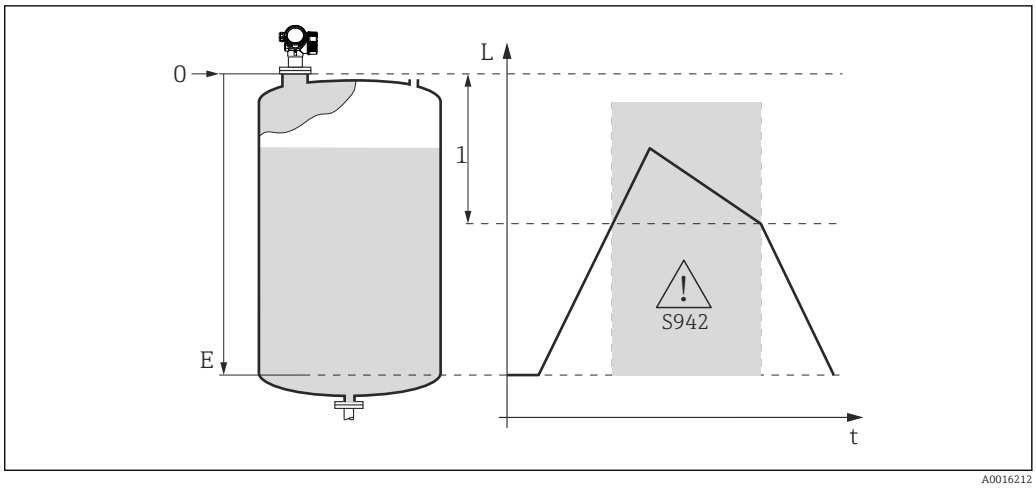
The behavior of the device in case the level rises into the safety distance is defined in the following parameters:

- **In safety distance (→ 🖹 120)**
- **Acknowledge alarm (→ 🖹 121)**



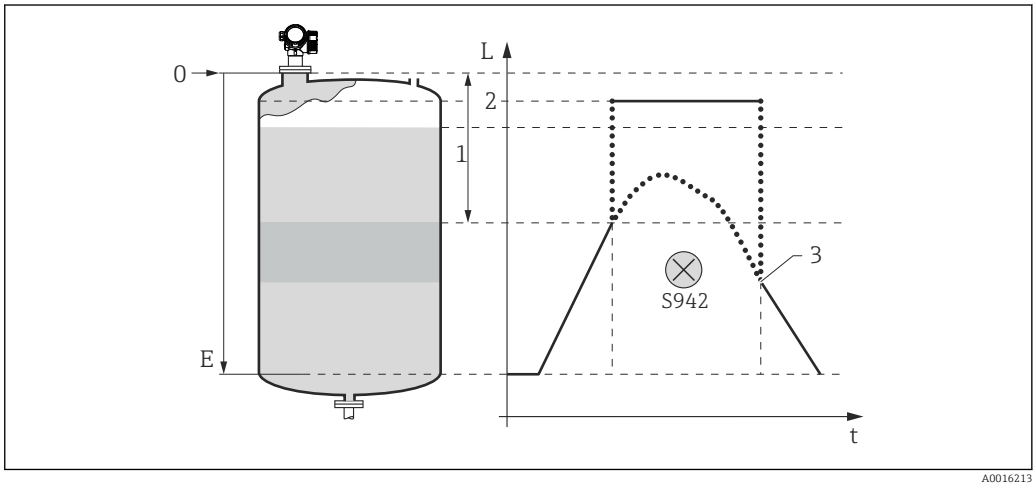
39 "In safety distance" = "Alarm": If the safety distance is undershot, the device generates an alarm.

1 Safety distance (→ 🖹 119)
2 Value defined in "Failure mode"



40 "In safety distance" = "Warning": If the safety distance is undershot, the device continues measuring but nevertheless generates a warning.

1 Safety distance (→ 119)

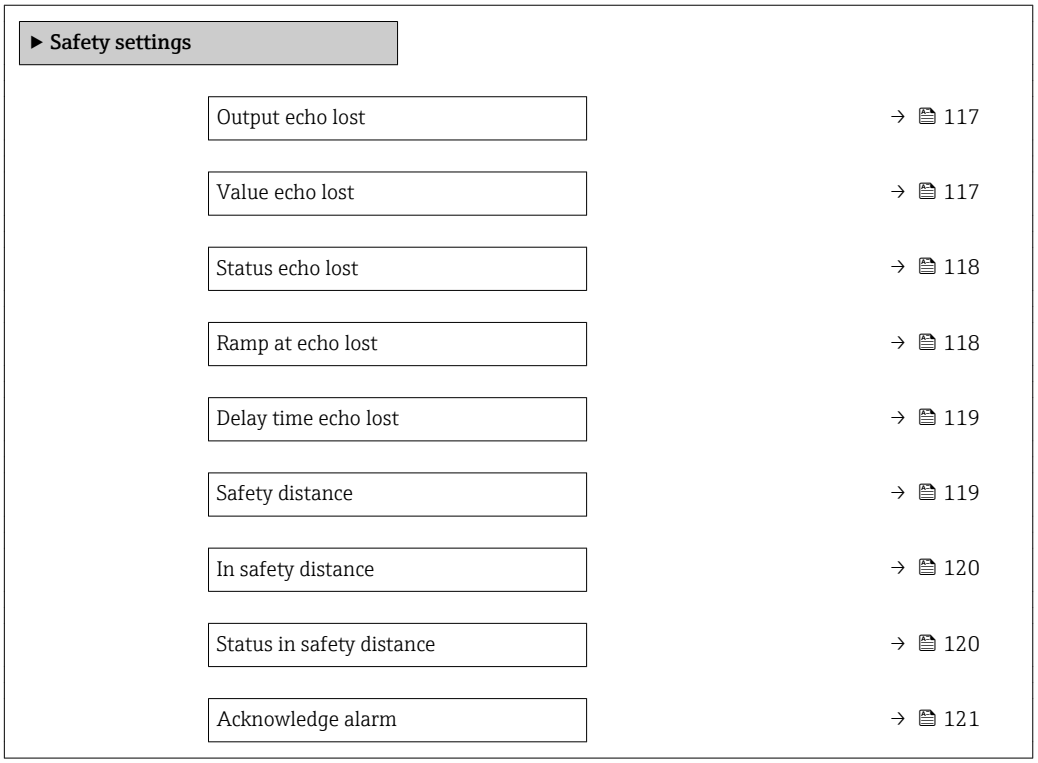


41 "In safety distance" = "Self holding": If the safety distance is undershot, the device generates an alarm. The measurement is not resumed until this alarm has been acknowledged by the user.

1 Safety distance (→ 119)
2 Value defined in "Failure mode"
3 Acknowledge alarm (→ 121)

Structure of the submenu

Navigation Expert → Sensor → Safety sett.



Description of parameters

Navigation Expert → Sensor → Safety sett.

Output echo lost

Navigation Expert → Sensor → Safety sett. → Output echo lost (2307)

Description Define the behavior of the output signal in case of a lost echo.

Selection
- Last valid value
- Ramp at echo lost
- Value echo lost
- Alarm

Factory setting Last valid value

Additional information

Meaning of the options
- **Last valid value**
  The last valid value is kept in the case of a lost echo.
- **Ramp at echo lost**
  In the case of a lost echo the output value is continously shifted towards 0% or 100%. The slope of the ramp is defined in the **Ramp at echo lost** parameter (→ 118).
- **Value echo lost**
  In the case of a lost echo the output assumes the value defined in the **Value echo lost** parameter (→ 117).
- **Alarm**
  In the case of a lost echo the device generates an alarm; see the **Failure mode** parameter

Value echo lost

Navigation Expert → Sensor → Safety sett. → Value echo lost (2316)

Prerequsite **Output echo lost (→ 117)** = **Value echo lost**

Description Define output value in case of a lost echo.

User entry 0 to 200 000.0 %

Factory setting 0.0 %

Additional information Use the unit which has been defined for the measured value output:
- without linearization: **Level unit (→ 60)**
- with linearization: **Unit after linearization (→ 71)**

Status echo lost

Navigation Expert → Sensor → Safety sett. → Status echo lost (1416)

Description Define status in case of a lost echo.

Selection
- Good
- Good: Maintenance required (M)
- Good: Maintenance demanded (M)
- Uncertain: Maintenance demanded (M)
- Bad: Maintenance alarm (F)
- Uncertain: Process related/no maint. (S)
- Bad: Process related/no maintenance (F)

Factory setting Depending on the **Output echo lost** parameter (→ 117)

Additional information *Dependence on the "Output echo lost" parameter*

Output echo lost (→ 117)	Status echo lost (→ 118)
Last valid value	Uncertain: Process related/no maint. (S)
Ramp at echo lost	Uncertain: Process related/no maint. (S)
Value echo lost	Uncertain: Process related/no maint. (S)
Alarm	Bad: Process related/no maintenance (F)

Ramp at echo lost

Navigation Expert → Sensor → Safety sett. → Ramp echo lost (2323)

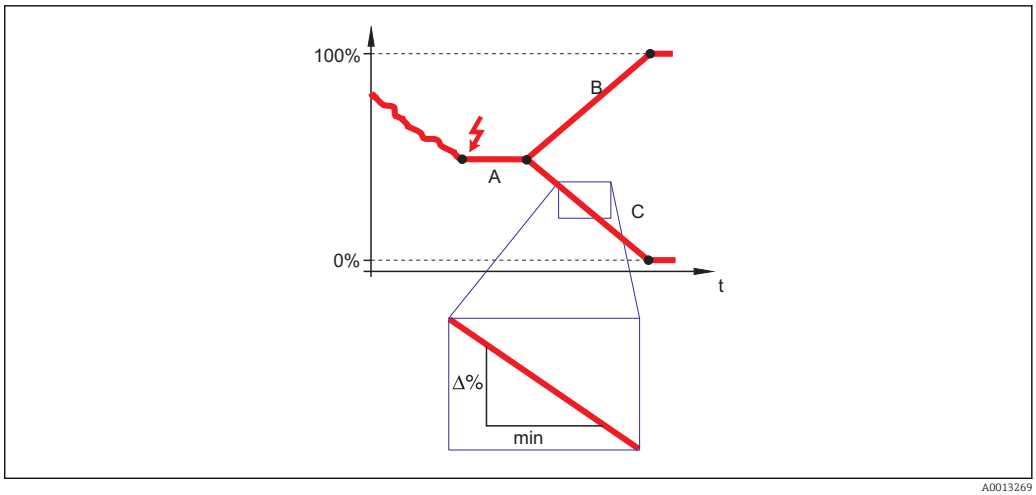
Prerequsite **Output echo lost (→ 117)** = **Ramp at echo lost**

Description Define the slope of the ramp in the case of a lost echo.

User entry Signed floating-point number

Factory setting 0.0 %/min

Additional information



A Delay time echo lost (→ 119)
B Ramp at echo lost (→ 118) (positive value)
C Ramp at echo lost (→ 118) (negative value)

- The unit for the slope of the ramp is "percentage of the measuring range per minute" (%/min).
- For a negative slope of the ramp: The measured value is continuously decreased until it reaches 0%.
- For a positive slope of the ramp: The measured value is continuosly increased until it reaches 100%.

Delay time echo lost

Navigation Expert → Sensor → Safety sett. → Delay echo lost (1193)

Description Define the delay in the case of an echo loss.

User entry 0 to 99 999.9 s

Factory setting 60.0 s

Additional information After an echo loss, the device waits for the time specified in this parameter before reacting as specified in the **Output echo lost** parameter (→ 117). This helps to avoid interruptions of the measurement by short-term interferences.

Safety distance

Navigation Expert → Sensor → Safety sett. → Safety distance (1093)

Description Define safety distance.

User entry −200 to 200 m

Factory setting 0 m

Additional information The safety distance is measured from the reference point of the measurement (lower edge of the flange or threaded connection). The safety distance can be used to generate a warning before the level rises into the blocking distance. The **In safety distance** parameter (→ 120) defines the reaction of the device if the level rises into the safety distance.

In safety distance

Navigation Expert → Sensor → Safety sett. → In safety dist. (1018)

Description Define reaction if the level rises into the safety distance.

Selection
- Off
- Alarm
- Warning
- Self holding

Factory setting Warning

Additional information

Meaning of the options
- **Off**
  No reaction if the level rises into the safety distance
- **Alarm**
  The device assumes the alarm state and generates the diagnostic message **In safety distance**.
- **Warning**
  The device assumes the warning state and generates the diagnostic message **In safety distance**.
- **Self holding**
  The device assumes the defined alarm state. Additionally, the diagnostic message **In safety distance** is generated. If the level drops out of the safety distance, the alarm remains active. The measurement is continued only after a reset of the self holding via the **Acknowledge alarm** parameter (→ 121).

Status in safety distance

Navigation Expert → Sensor → Safety sett. → Stat.safety dist (1417)

Description Define status in case the safety distance is undershot.

Selection
- Good
- Good: Maintenance required (M)
- Good: Maintenance demanded (M)
- Uncertain: Maintenance demanded (M)
- Bad: Maintenance alarm (F)
- Uncertain: Process related/no maint. (S)
- Bad: Process related/no maintenance (F)

Factory setting Dependent on the **In safety distance** parameter (→ 120)

Additional information

In safety distance (→ 120)	Status in safety distance (→ 120)
Off	-
Alarm	Bad: Process related/no maintenance (F)
Warning	Uncertain: Process related/no maint. (S)
Self holding	Bad: Process related/no maintenance (F)

Acknowledge alarm

Navigation Expert → Sensor → Safety sett. → Acknowl. alarm (1130)

Prerequsite **In safety distance (→ 120) = Self holding**

Description Reset the self holding alarm of the device.

Selection
- No
- Yes

Factory setting No

Additional information

Meaning of the options
- **No**
  The alarm is **not** rest.
- **Yes**
  The alarm is reset. The measurement is resumed.

4.4.12 "Envelope curve" submenu

The **Envelope curve** submenu (→ 123) is only available on the display module (not in FieldCare). It is used to display the envelope curve on the display module. When operating via FieldCare, the envelope curve can be displayed in the envelope curve editor (**Device Operation → Device Functions → Additional Functions → Envelope Curve**).

Description of parameters

Navigation Expert → Sensor → Env. curve

Envelope curve

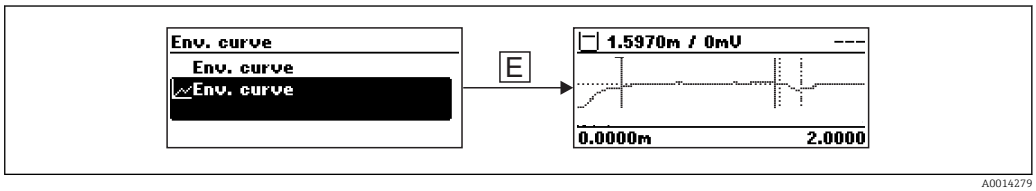
Navigation Expert → Sensor → Env. curve → Env. curve (1207)

Description Define which curves are included in the envelope curve display on the display module.

Selection
- Envelope curve
- Envelope + Map
- Subtracted + Threshold
- Envelope + Ref.

Factory setting Envelope curve

Additional information The display of the selected curve is called up as follows:



A0014279

To quit the envelope curve display, press the "+" and "-" keys simultaneously.

When operating via FieldCare, the envelope curve can be displayed in the envelope curve editor (**Device Operation → Device Functions → Additional Functions → Envelope Curve**).

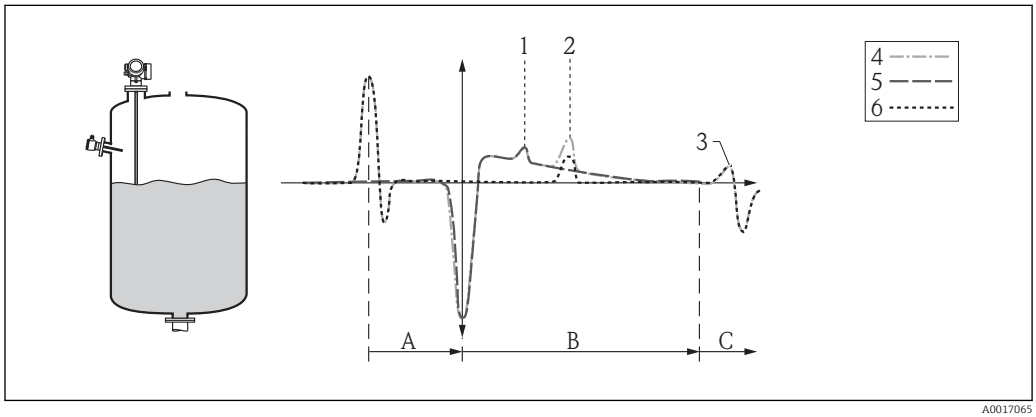
4.4.13 "Mapping" submenu

The mapping is used to suppress static interference signals which may be generatet by internal tank or silo fittings. A mapping curve, representing the envelope curve of an empty tank or silo as precisely as possible, is used for the mapping.

Mapping curve and subtracted curve

After a mapping, the signal evaluation does not use the envelope curve but the subtracted curve, instead:

Subtracted curve = Envelope curve - Mapping curve



42 Mapping and subtracted curve

1 Interference echo
2 Level echo
3 End-of-probe echo
4 Envelope curve
5 Mapping curve
6 Subtracted curve
A Internal area (Z distances)
B Level area
C End-of-probe area (EOP)

Static map

The static map is typically used for rod and coax probes. It is recorded during the commissioning. It is essential that the probe is completely uncovered when recording the map.

When recording a new static envelope curve, the previous curve is deleted.

Dynamic map

The dynamic map is, for example, used for probes with a reference signal for gas phase compensation. In the case of a static map this reference signal would be suppresed and would no longer be visible in the subtracted curve.

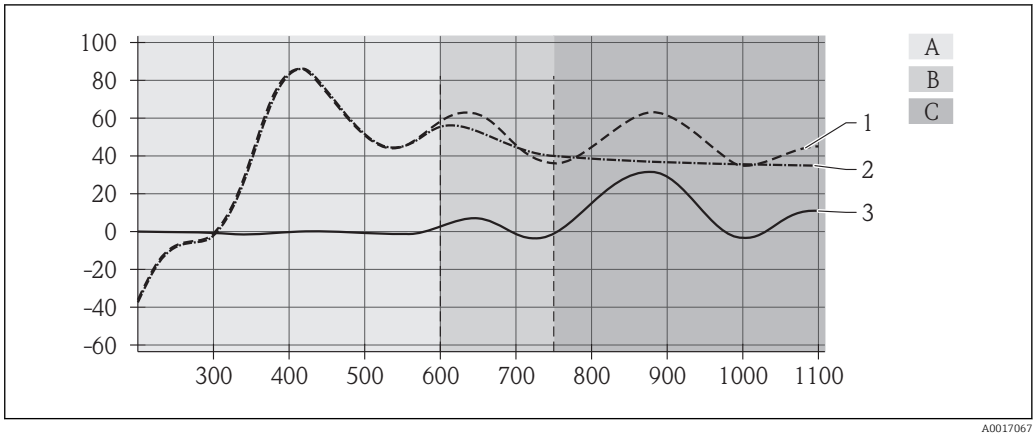
Before the dynamic mapping curve can be used, a static map - if present - must be deleted.

The dynamic map continuously adjusts itself to the changing conditions within the vessel. An averaging width of 1 500 mm (60 in) is used for this. This prevents the dynamic map from suppressing the acutal level echo.

Combined map

If it is not possible to record the map with the probe being completely uncovered (e.g. because the vessel can not be completely emptied during the commissioning procedure), a combined map can be used instead. In this case, a static map is only recorded for the upper part of the probe (defined by the **Mapping end point** parameter (→ 131)). In the

lower part, a dynamic map is used. Both curves are connected by an interpolation area to ensure a smooth transition.



43 Combined mapping curve

1 Envelope curve
2 Mapping curve
3 Subtracted curve
A Static area
B Transition area (interpolation)
C Dynamic area

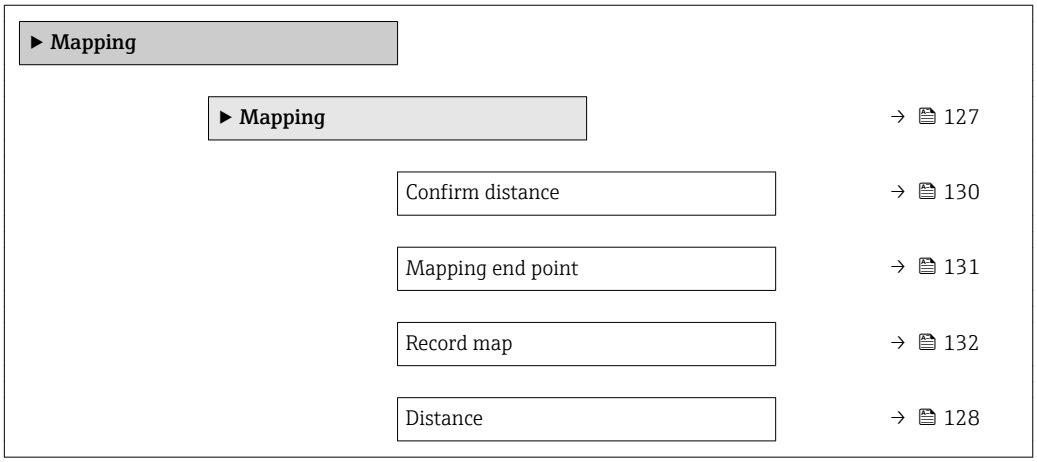
The initial map

An initial map is stored in the device. This map is active under the following conditions:
- if no static map has been recorded,
- if the static map has been deactivated,
- if the static map has been deleted.

The form of the initial map depends on a number of settings of the basic calibration and is designed to suppress typical interferences in the upper part of the probe. It can not be changed by the user.

Structure of the submenu on the local display

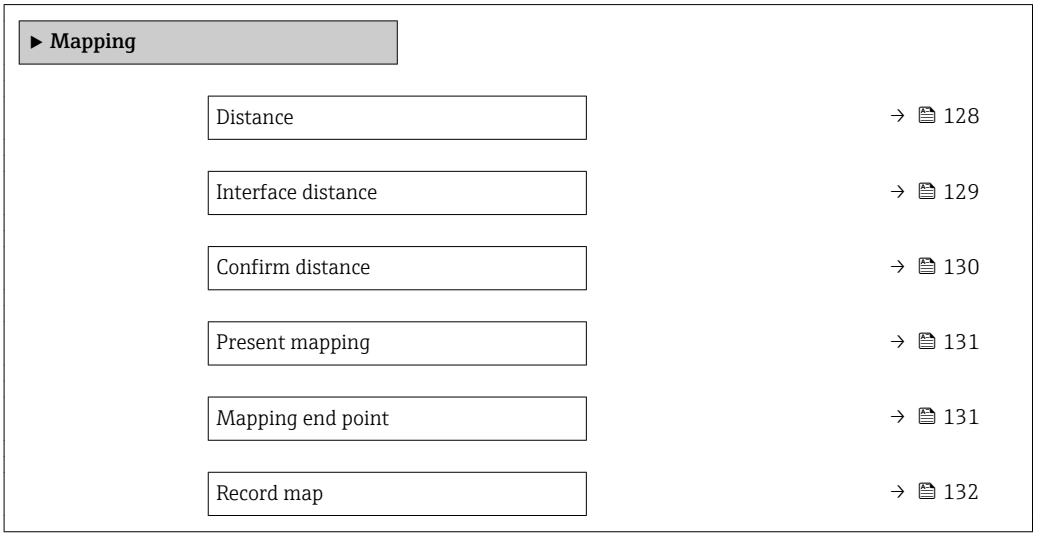
Navigation Expert → Sensor → Mapping



Structure of the submenu in an operating tool

Navigation Expert → Sensor → Mapping

"Mapping" submenu



Description of parameters

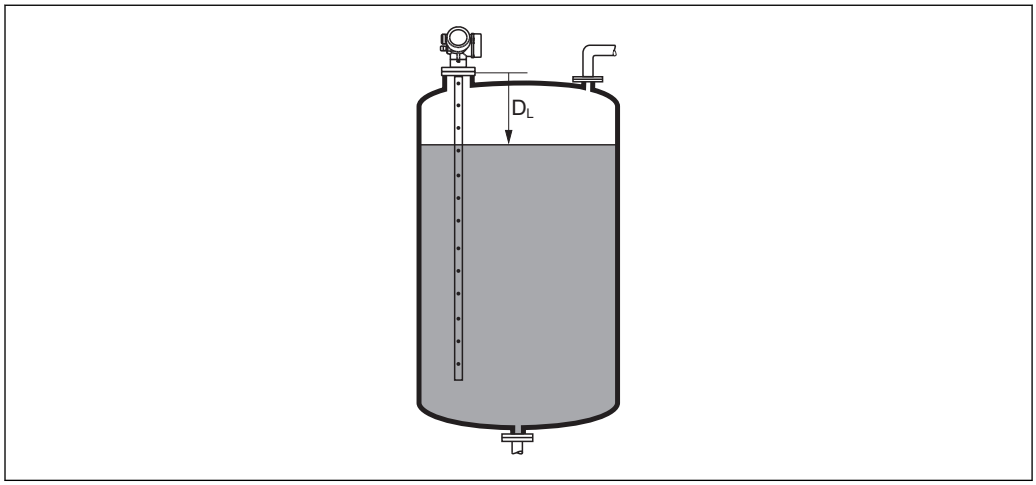
Navigation Expert → Sensor → Mapping

Distance

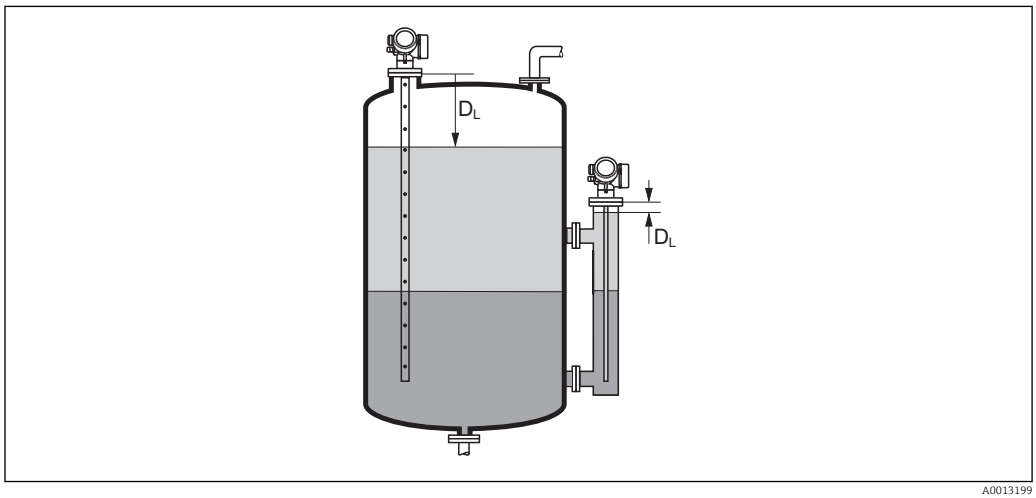
Navigation Expert → Sensor → Mapping → Distance (1124)

Description Displays the measured distance D_L between the reference point (lower edge of the flange or threaded connection) and the level.

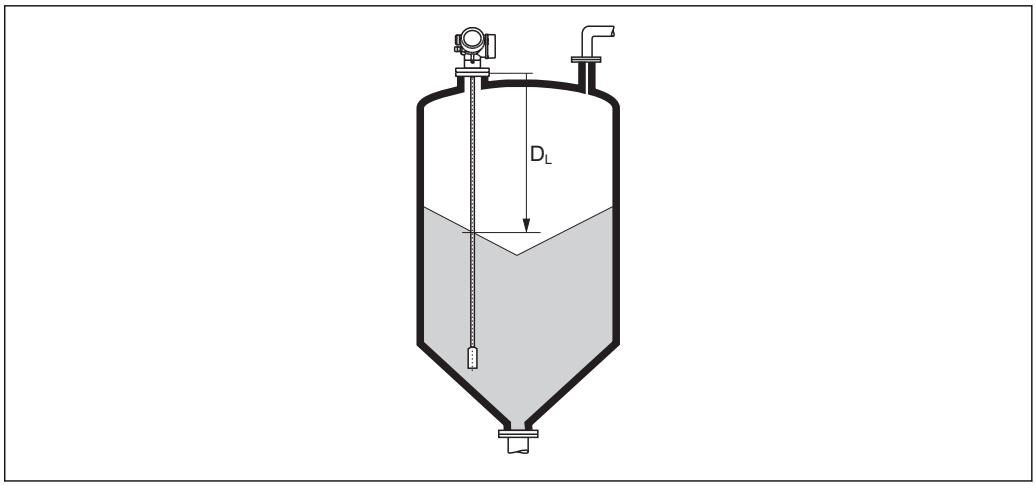
Additional information



44 *Distance for liquid measurements*



45 *Distance for interface measurements*



46 *Distance for bulk solid measurements*

The unit is defined in the **Distance unit** parameter (→ 45).

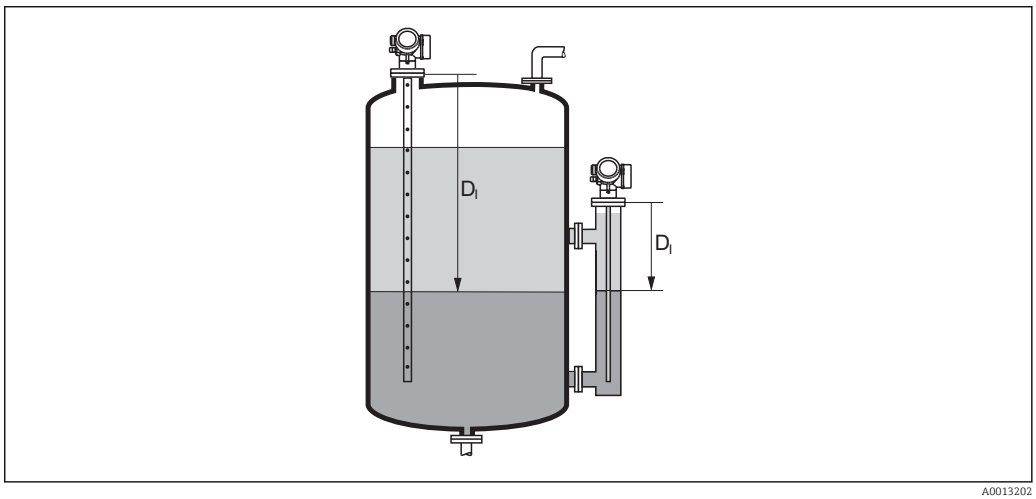
Interface distance

Navigation Expert → Sensor → Mapping → Interface dist. (1067)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays the measured distance D_I between the reference point (lower edge of flange or threaded connection) and the interface.

Additional information



The unit is defined in the **Distance unit** parameter (→ 45).

Confirm distance

Navigation Expert → Sensor → Mapping → Confirm distance (1045)

Description Specify, whether the measured distance matches the real distance.

Depending on the selection the device automatically sets the range of mapping.

Selection
- Manual map
- Distance ok
- Distance unknown
- Distance too small *
- Distance too big *
- Tank empty
- Delete map

Factory setting Distance unknown

Additional information

Meaning of the options
- **Manual map**
  To be selected if the range of mapping is to be defined manually in the **Mapping end point** parameter (→ 131). In this case it is not necessary to confirm the distance.
- **Distance ok**
  To be selected if the measured distance matches the actual distance. The device performs a mapping.
- **Distance unknown**
  To be selected if the actual distance is unknown. A mapping can not be performed in this case.
- **Distance too small**
  To be selected if the measured distance is smaller than the actual distance. The device searches for the next echo and returns to the **Confirm distance** parameter. The distance is recalculated and displayed. The comparison must be repeated until the displayed distance matches the actual distance. After this, the recording of the map can be started by selecting **Distance ok**.

* Visibility depends on order options or device settings

- **Distance too big** [29]
  To be selected if the measured distance exceeds the actual distance. The device adjusts the signal evaluation and returns to the **Confirm distance** parameter. The distance is recalculated and displayed. The comparison must be repeated until the displayed distance matches the actual distance. After this, the recording of the map can be started by selecting **Distance ok**.
- **Tank empty**
  To be selected if the tank is completely empty. The device records a mapping covering the complete measuring range.
- **Factory map**
  To be selected if the present mapping curve (if one exists) is to be deleted. The device returns to the **Confirm distance** parameter and a new mapping can be recorded.

When operating via the display module, the measured distance is displayed together with this parameter for reference purposes.

For interface measurements the distance always refers to the toatal level (not the interface level).

For FMP55 with rope probes and **Operating mode (→ 45) = Interface with capacitance** the mapping must be recorded with the tank being empty, and the **Tank empty** option must be selected. Otherwise the device can not register the correct empty capacitance.

For FMP55 with coax probes a mapping must be recorded at least in the upper part of the probe, as tightening the flange has an influence on the envelope curve. However, even with coax probes it is recommended to record the mapping with the tank being completely empty (and selecting the **Tank empty** option).

If the teaching procedure with the **Distance too small** option or the **Distance too big** option is quit before the distance has been confirmed, a map is **not** recorded and the teaching procedure is reset after 60 s.

For FMP54 with gas phase compensation (product structure: feature 540 "Application Package", option EF or EG) a map must **not** be recorded.

Present mapping

Navigation Expert → Sensor → Mapping → Present mapping (1182)

Description Indicates up to which distance a mapping has already been recorded.

Mapping end point

Navigation Expert → Sensor → Mapping → Map. end point (1022)

Prerequsite **Confirm distance (→ 130)** = **Manual map** or **Distance too small**

Description Specify new end of the mapping.

User entry 0 to 200 000.0 m

29) Only available for "Expert → Sensor → Echo tracking → **Evaluation mode** parameter (→ 142)" = "Short time history" or "Long time history"

Factory setting 0.1 m

Additional information This parameter defines up to which distance the new mapping is to be recorded. The distance is measured from the reference point, i.e. from the lower edge of the mounting flange or the threaded connection.

For reference purposes the **Present mapping** parameter (→ 131) is displayed together with this parameter. It indicates up to which distance a mapping has already been recorded.

Record map

Navigation Expert → Sensor → Mapping → Record map (1069)

Prerequisite **Confirm distance (→ 130)** = **Manual map** or **Distance too small**

Description Start recording of the map.

Selection
- No
- Record map
- Delete map

Factory setting No

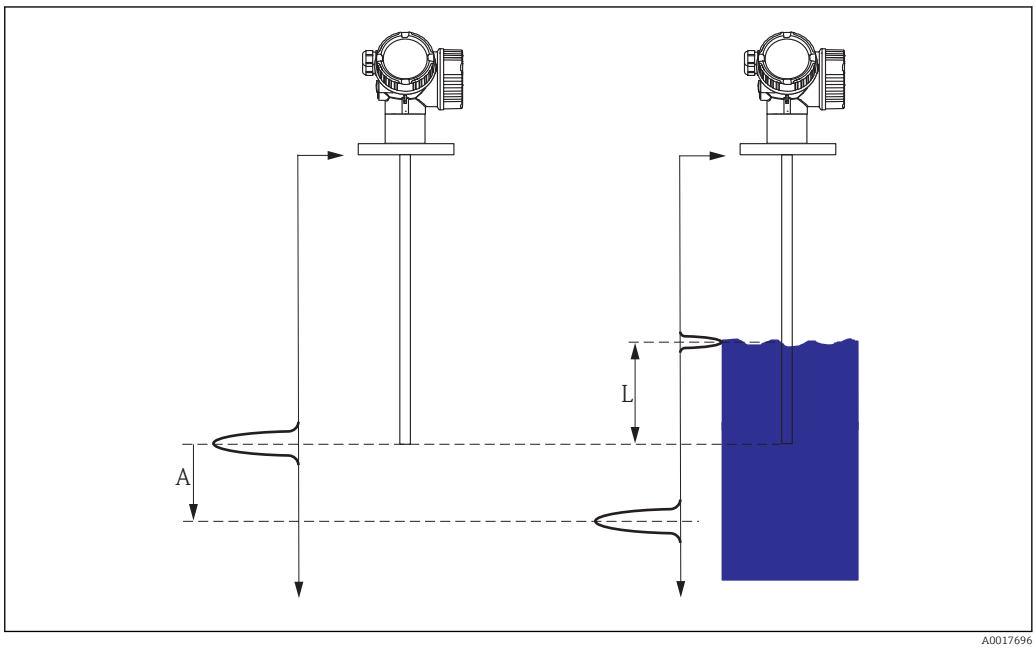
Additional information

Meaning of the options
- **No**
  The map is not recorded.
- **Record map**
  The map is recorded. After the recording is completed, the new measured distance and the new mapping range appear on the display. When operating via the local display, these values must be confirmed by pressing ☑.
- **Delete map**
  The mapping (if one exists) is deleted and the device displays the recalculated measured distance and the mapping range. When operating via the local display, these values must be confirmed by pressing ☑.

4.4.14 "EOP evaluation" submenu

As an alternative to evaluating the direct level signal, Levelflex can calculate the level via the shift of the end-of-probe signal (EOP). Details on the EOP evaluation are configured in the **EOP evaluation** submenu.

Shift of the end-of-probe signal (EOP)



47 *Shift of the end-of-probe signal (EOP) depending on the level*

A *EOP shift*
L *Level*

When evaluating the end-of-probe signal, you make use of the fact that electromagnetic pulses propagate more slowly in a medium than in air. As a consequence the end-of-probe signal moves downwards when the level is increased. By inverting this relationship one can calculate the level *L* from the end-of-probe shift *A*:

$L = A / (\mathrm{SQRT}(DK) - 1)$

Where *DC* is the dielectric constant of the medium.

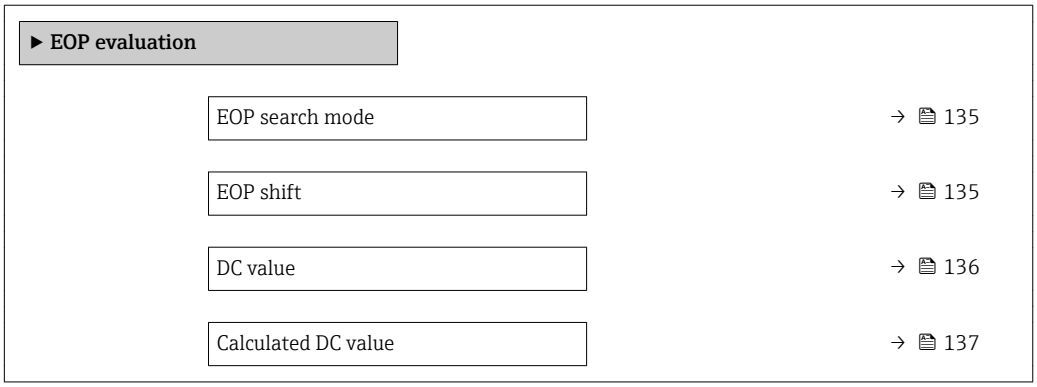
If both, the level signal and the end-of-probe signal are known, the dielectric constant *DC* can be calculated:

$DK = (A/L + 1)^2$

The calcluated DC value is displayed in the **Calculated DC value** parameter (→ 54).

Structure of the submenu

Navigation Expert → Sensor → EOP evaluation



Description of parameters

Navigation Expert → Sensor → EOP evaluation

EOP search mode

Navigation Expert → Sensor → EOP evaluation → EOP search mode (1026)

Prerequsite **Operating mode** parameter (→ 45) = **Level**

Description Select method for the detection of the end-of-probe signal.

Selection
- Empty recognition only
- Negative EOP
- Positive EOP
- Negative EOP high resolution

Factory setting Negative EOP

Additional information

Meaning of the options
- **Empty recognition only**
  Positive and negative end-of-probe signals are searched for. However, the level is not calculated from the end-of-probe signal.
  – If no level signal is present and if the end-of-probe signal is within the range defined in the **EOP range upper area** parameter, the level is set to 0%, which means an empty tank or silo is assumed.
  – If no level signal is present and if the end-of-probe-signal is beyond the range defined in the **EOP range upper area** parameter, an echo loss is reported.
- **Negative EOP**
  Only negative end-of-probe signals are searched for. This is the correct option if the probe end is insulated.
- **Positive EOP**
  Only positive end-of-probe signals are searched for. This is the correct option if the end of the probe is connected to ground.
- **Negative EOP high resolution**
  The resolution at the end of the probe is improved by a deconvolution algorithm. This is only possible if the end-of-probe postion in the case of an empty tank has been stored by selecting the **Tank empty** option in the **Confirm distance** parameter (→ 130).

EOP shift

Navigation Expert → Sensor → EOP evaluation → EOP shift (1027)

Prerequsite **EOP level evaluation ≠ Off**

Description Displays the current shift of the end-of-probe signal as compared to the empty vessel.

DC value

Navigation Expert → Sensor → EOP evaluation → DC value (1201)

Description
- For level measurements:
  Specify dielectric constant ε_r.
- For interface measurements:
  Specify dielectric constant ε_r of the upper medium.

User entry Signed floating-point number

Factory setting Dependent on the following parameters:
- Operating mode (→ 45)
- Medium property (→ 52)
- Medium type (→ 51)
- Bin type (→ 46)or Tank type (→ 46)

Additional information *Dependence of the factory settings on other parameters*

For "Operating mode" = "Level"

Medium property (→ 52)	Medium type (→ 51)	Bin type (→ 46) or Tank type (→ 46)	DC value
Unknown	Solid	Bin type (→ 46) ▪ Aluminium ▪ Plastic wood	1.9
		Bin type (→ 46) ▪ Concrete ▪ Metallic	1.6
	Liquid	Tank type (→ 46) Coaxial	1.4
		Any other tank type	1.9
DC 1.4 ... 1.6	Solid	Bin type (→ 46) ▪ Concrete ▪ Aluminium ▪ Plastic wood	1.6
		Bin type (→ 46) Metallic	1.4
	Liquid	Tank type (→ 46) ▪ Non metallic ▪ Mounted outside	1.6
		Any other tank type	1.4
DC 1.6 ... 1.9			1.6
DC 1.9 ... 2.5			1.9
DC 2.5 ... 4			2.5
DC 4 ... 7			4
DC 7 ... 15			7
DC > 15			15

For "Operating mode" = "Interface with capacitance" or "Interface":
DC value = 1.9

As the value defines the echo threshold, it may not exceed the actual DC of the medium. Dielectric constants above DC = 15 have only a very limited influence on the echo threshold.

Calculated DC value

Navigation Expert → Sensor → EOP evaluation → Calc. DC value (1118)

Prerequsite **EOP level evaluation** = **Automatic DC**

Description
- For level measurements:
  Displays calculated dielectric constant ε_r.
- For interface measurements:
  Displays calculated dielectric constant ε_r or the upper medium.

Additional information The exact meaning of this parameter is dependent on further settings:
- **Operating mode (→ 45)** = **Level**:
  Displays the dielectric constant which is calculated from the end-of-probe signal and the level [30)]
- **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**:
  - For **Interface property (→ 154)** = **Special: automatic DC**:
    Automatically calculated DC of the upper medium
  - In any other case:
    Identical to the **DC value** parameter (→ 53)

30) The correct calculation of the dielectric constant is only possible for media with a small dielectric constant and weak signal damping, for which the level signal and the end-of-probe signal can be evaluated simultaneously. Among these media are for example oil, solvents and synthetic granules.

4.4.15 "Echo tracking" submenu

The echo tracking algorithm takes into account the change in time of the individual echoes when evaluating the envelope curve. This improves the allocation of the echoes to the level or interface signal. Different types of echo tracking can be selected in the **Evaluation mode** parameter (→ 142). A number of further parameters is used to configure the echo tracking more precisely.

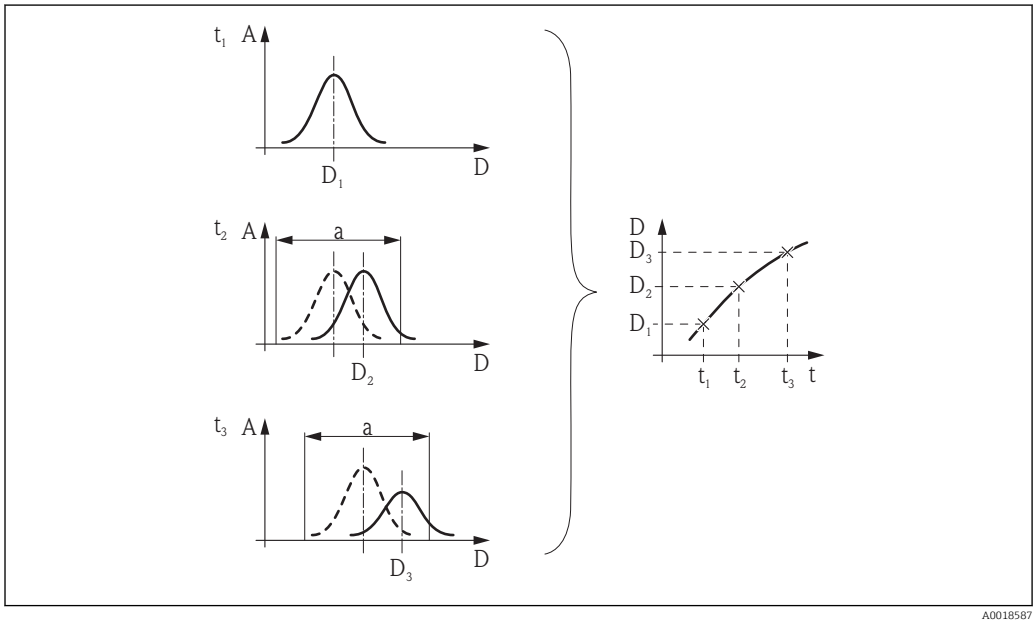
"Evaluation mode" = "History off"

The envelope curve is evaluated statically.

"Evaluation mode" = "Short time history"

The static envelope curve evalauation is taken as a starting point.

The position of the individual echoes is tracked. The track contains the position, the velocity, the relative and the absolute echo amplitude. Normally the strongest echo within a search window is selected and allocated to the track.



48 *Definition of a track: In a new envelope curve, the echo is searched for in a window of width "a" centered around the echo position in the previous envelope curve. The change of the echo position in the course of time defines the track.*

In this evaluation mode it is possible to activate the moving track recognition (**Moving track recognition** parameter).

The moving track recognition is used to distinguish the level echo from interference echoes. It makes use of the fact that an echo which moves in one direction for a certain time is likely to be the level echo. Interference echoes, on the other hand, normally stay at the same position within the envelope curve.

If the moving track recognition is switched on, this distinction is used as an additional criterion to identify the level echo.

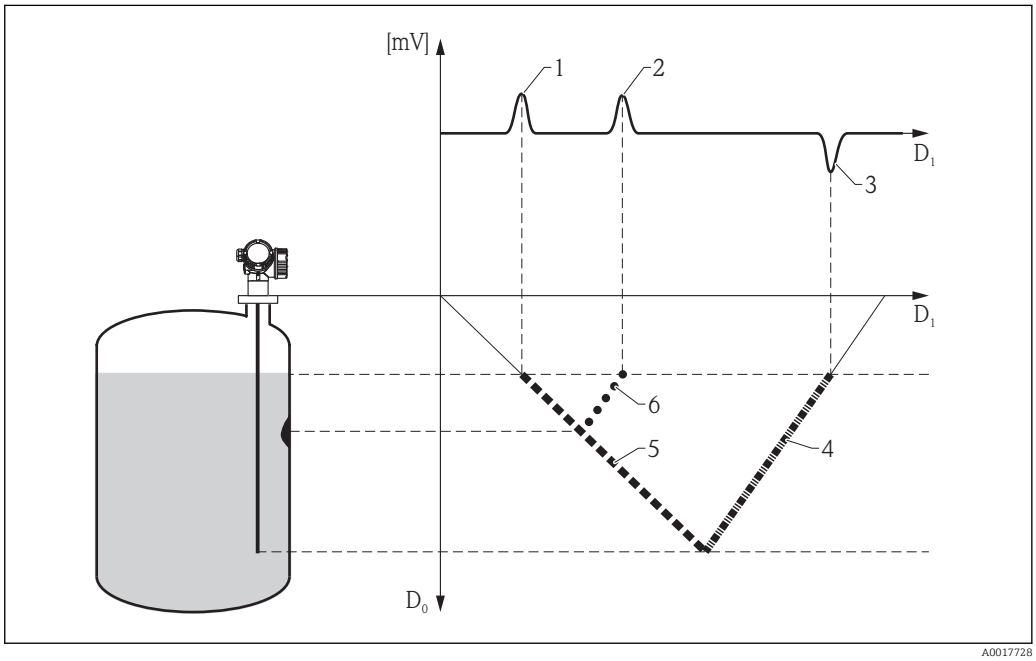
"Evaluation mode" = "Long time history"

The **Long time history** option is not available for interface measurements.

A so-called tank history is used for the determination of the level and a consistency check of the echoes.

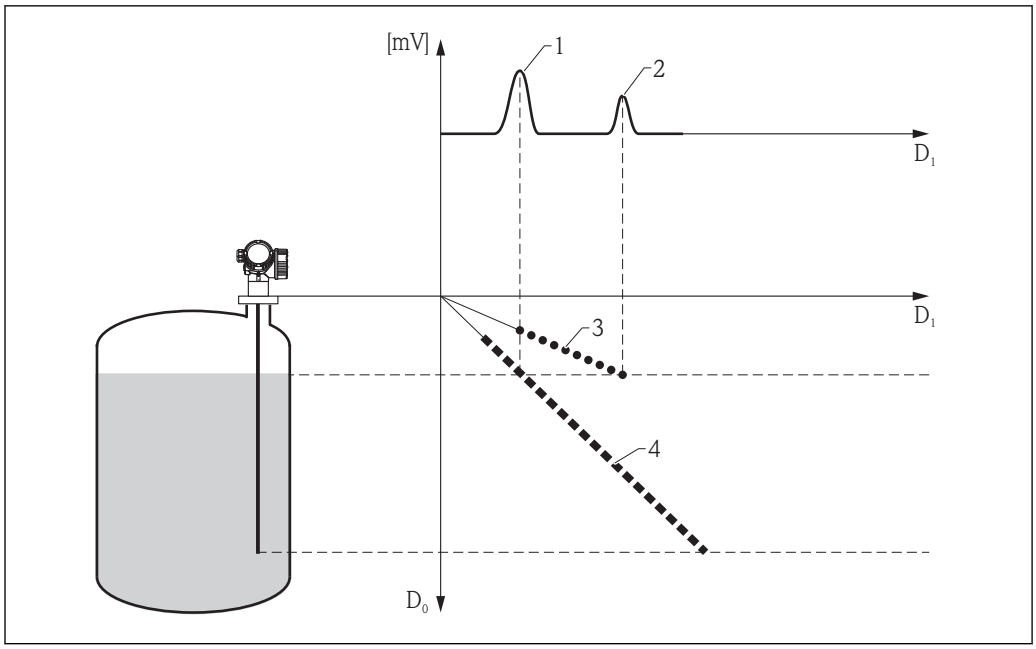
For a given tank with a given medium, the positions of the level, interface, multiple and end-of-probe or tank bottom echoes are in a defined relation to each other. This relationship is recorded during the operation of the device and stored in the tank history. On the basis of this tank history, echoes can be reliably allocated, even if one echo is lost temporarily or if the device was switched off for a while.

Schematic exmaples



49 *Example 1: Tank history with interference echo and end of probe echo (small DC values)*

D0 Actual level distance
D1 Distance of the signal in the envelope curve
1 Level echo
2 Interference echo
3 End-of-probe echo
4 Track "End-of-probe echo" (stored in the tank history)
5 Track "Level echo" (stored in the tank history)
6 Track "Interference echo" (stored in the tank history)

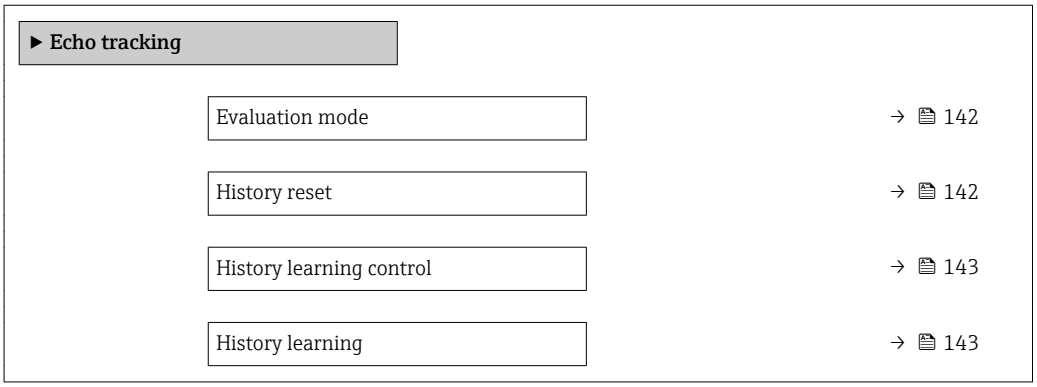


50 Example 2: Tank history with a multiple echo (large DC values)

D0 Actual level distance
D1 Distance of the signal in the envelope curve
1 Level echo
2 Multiple echo
3 Track "Multiple echo" (stored in the tank history)
4 Track "Level echo" (stored in the tank history)

Structure of the submenu

Navigation Expert → Sensor → Echo tracking



Description of parameters

Navigation Expert → Sensor → Echo tracking

Evaluation mode

Navigation Expert → Sensor → Echo tracking → Evaluation mode (1112)

Description Select evaluation mode for echo tracking.

Selection
- History off
- Short time history
- Long time history *

Factory setting
- For level measurements:
  Long time history
- For interface measurements:
  Short time history
- Exceptions:
  - For FMP54 and any FMP5x with center washer:
    Short time history
  - For **Tank type (→ 46)** = **Bypass / pipe**:
    Short time history
  - If the gas phase compensation is active, i.e. **GPC mode (→ 104)** ≠ **Off**:
    History off
  - For **Process property (→ 47)** = **Very fast > 100 m (333 ft) /h** or **No filter / test**:
    History off

Additional information

Meaning of the options
- **History off**
  The envelope curve is evaluated only statically.
- **Short time history**
  In addition to the static algorithms a dynamic echo trace is continuously created.
- **Long time history**
  (Only available for level measurements)
  In addition to the static algorithms and the dynamic echo trace a tank trace is continuously generated. Using the tank trace the device can determine the level even if the level echo ist lost temporarily.

- The **Long time history** option is not available for interface measurements.
- The **Long time history** option is not recommended if there are substantial changes of the medium or process conditions within a short period of time (e.g. in the case of changing dielectric constants or boiling media).

History reset

Navigation Expert → Sensor → Echo tracking → History reset (1145)

Description Reset history of the echo and tank tracking.

* Visibility depends on order options or device settings

Selection
- Reset done
- Restart echo tracking
- Delete history

Factory setting Reset done

Additional information

Meaning of the options
- **Reset done**
  Does not initiate an action but is only a display option. It is displayed as soon as the reset operation has been accomplished.
- **Restart echo tracking**
  The echo tracking is reset. The tank trace, however, is maintained.
- **Delete history**
  – The echo tracking and tank trace are reset.
  – Additionally for **Operating mode (→ 45)** = **Interface with capacitance**:
  All calibrations are reset.

History learning control

Navigation Expert → Sensor → Echo tracking → Hist. learn.ctrl (1074)

Prerequsite Device with PROFIBUS PA or FOUNDATION Fieldbus

Description Select DO block to be used for starting and stopping the recording of the track.

Selection
- None
- Digital output 1
- Digital output 2
- Digital output 3
- Digital output 4
- Digital output 5
- Digital output 6
- Digital output 7
- Digital output 8

Factory setting None

History learning

Navigation Expert → Sensor → Echo tracking → History learning (1094)

Prerequsite Device with PROFIBUS PA or FOUNDATION Fieldbus

Description Start or stop the recording of the echo track.

Selection
- Off
- On

Factory setting On

Additional information This parameter is only relevant for **History learning control (→ 143)** = **Manual**.

4.4.16 "Interface" submenu

With Levelflex, there are two types of interface measurement which can be selected in the **Operating mode** parameter (→ 🖹 45):

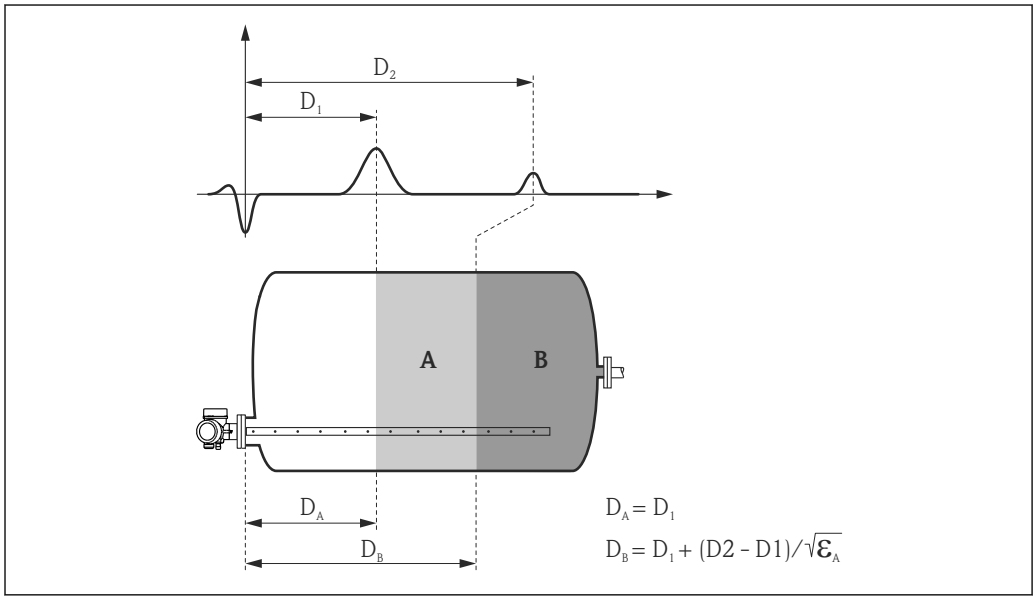
Operating mode (→ 🖹 45)	Evaluated signals	available for	Description
Interface	Signal of the guided radar	▪ FMP51 ▪ FMP52 ▪ FMP54 ▪ FMP55	(Verweisziel existiert nicht, aber @y.link.required='true')
Interface with capacitance	▪ Signal of the guided radar ▪ Measured capacitance	FMP55	(Verweisziel existiert nicht, aber @y.link.required='true')

Interface measurement with guided radar (without capacitance measurement)

Basic principles

When the high-frequency pulses hit the surface of the medium, only a percentage of the transmission pulse is reflected. In the case of media A with a low dielectric constant ε_A, in particular, the other part penetrates the medium. The pulse is reflected once more at the interface point to a second medium, B, with a higher dielectrdic constant ε_B. Thus, the envelope curve contains a level echo D_1 as well as an interface echo D_2.

When evaluating the interface echo, Levelflex must take into account the fact that electromagnetic pulses propagate slower in a medium than in air. Therefore, the interface echo appears shifted into the direction of larger distances. Using the dielectric constant of the upper medium, Levelflex can automatically compensate for this shift:



51 *Interface measurement with the guided radar*

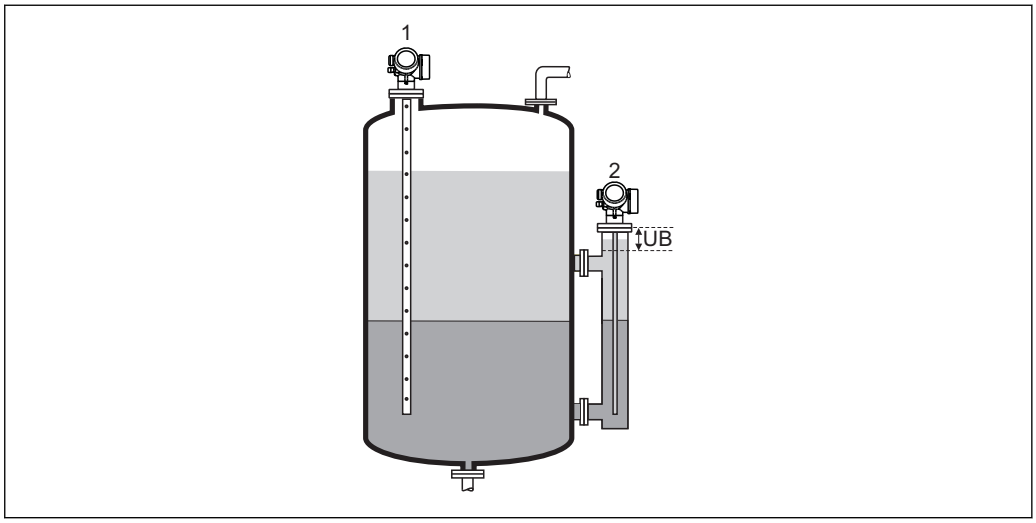
If an interface measurement is activated, **Evaluation mode (→ 142)** = **Short time history** is the only option. The **Long time history** option can not be used in combination with an interface meaurement.

Prerequisites for an interface measurement

- The dielectric constant of the upper medium must be constant and known.
- Dielectric constant of the upper medium: $\varepsilon_A \leq 10$
- Dielectric constant of the lower medium: $\varepsilon_B \geq \varepsilon_A + 10$

Tank level

For interface measurements it is important whether the container is partially filled or fully flooded. This must be specified by the user in the **Tank level** parameter (→ 154) :



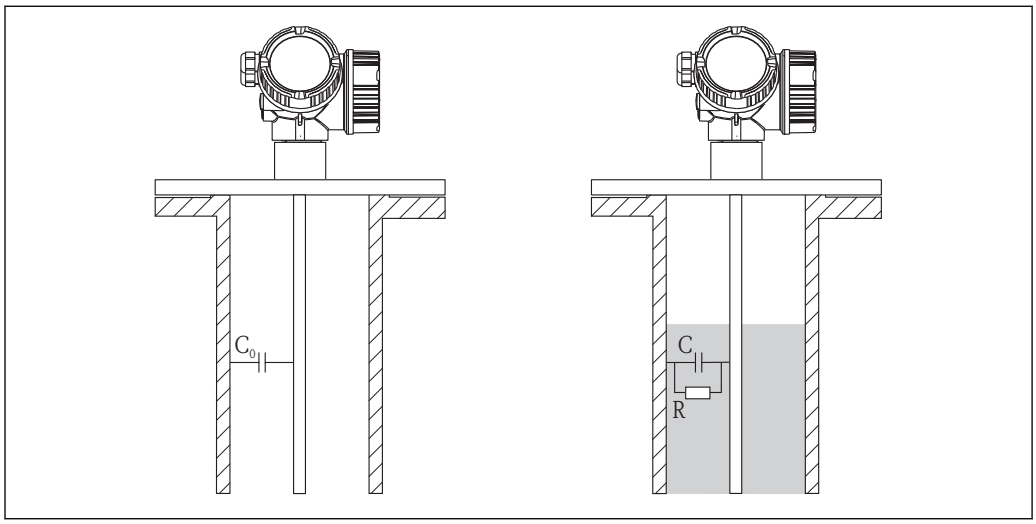
1 Partially filled
2 Fully flooded
UB Blocking distance (→ 95)

- **Tank level (→ 154)** = **Partially filled**
  In this case the device looks for two signals: the interface echo and the level echo; if required, the end-of-probe signal is used for signal evaluation, too → 133.
- **Tank level (→ 154)** = **Fully flooded**
  This is typically used for bypass applications. In this case, the device searches for the interface echo only; if required, the end-of-probe signal is used for signal evaluation, too → 133. If this option is selected, the total level must always be within the upper blocking distance (UB) in order to avoid that it is mistaken for the interface signal.

Interface measurement with guided level radar and capacitance measurement

With Levelflex FMP55, the probe can not only be used for a guided radar measurement, but for a simultaneous capacitance measurement as well. This enables interface measurements even if the interface echo is lost temporarily (e.g. due to foam or emulsion).

Basic principles of the capacitance level measurement



52 Capacitance level measurement

C_0 = Empty capacitance

C = Capacitance of the (partially) filled tank

The principle of capacitance level measurement is based on the change in capacitance of the capacitor due to the change in the level. The probe and container wall (conductive material) form an electric capacitor. When the probe is in air, a certain low initial capacitance is measured. When the container is filled, the capacitance of the capacitor increases the more the probe is covered.

"Interface property" = "Standard"

Basic idea

The capacitance measurement is used to calcluate the interface in the case of an echo loss.

Requirements concerning the upper medium (A)

- Conductivity $\sigma_A < 1$ µS/cm
- The dielectric constant ε_A must not change and must be known.
- Value of the dielectric constant: $1.4 < \varepsilon_A < 10$

Voraussetzungen an das untere Medium (B)

- Conductivity $\sigma_B > 100$ µS/cm
- Dielectric constant: $\varepsilon_B \geq \varepsilon_A + 10$

The factory setting for the dielectric constant of the lower medium is $\varepsilon_B = 80$. This is the value for water. If the lower medium is no water, its dielectric constant must be specified in the**DC value lower medium** parameter (→ 52).

Installation

- The measurement requires a coaxial measuring system. This can be achieved by a stilling well, a bypass or a coax probe.
- In the case of a rope or rod probe, the tank must be empty on commissioning and a mapping curve must be recorded with the tank being empty. To do so, select **Confirm distance (→ 130)** = **Tank empty**. This automatically calibrates the empty capacitance of the rope or rod probe.
- Build-up formation should be avoided.

Signal evaluation

- As long as both echos of the guided radar (level and interface) are found:
  - H_A and H_B are calculated from the guided level radar.
  - H_A, H_B and the measured capacitance C are used to recalculate the factors a and b continuously (more precisely: The thickness of the insulation is calculated from which a and b can be derived by a simple mathematical operation.)
- If the interface echo is lost:
  H_A is calculated from the measured capacitance and the last values of a and b.

"Interface property" = "Build up"

Basic idea

A comparison of the measuring results from the guided radar and the capacitance measurement shows whether build-up is present at the probe.

Requirements concerning the upper medium (A)

- Conductivity $\sigma_A < 1$ µS/cm
- The dielectric constant ε_A must not change and must be known.
- Value of the dielectric constant: $1.4 < \varepsilon_A < 10$

Requirements concerning the lower medium (B)

- Conductivity $\sigma_B > 100$ µS/cm
- Dielectric constant: $\varepsilon_B \geq \varepsilon_A + 10$

The factory setting for the dielectric constant of the lower medium is $\varepsilon_B = 80$. This is the value for water. If the lower medium is no water, its dielectric constant must be specified in the **DC value lower medium** parameter (→ 52).

Installation

- The measurement requires a coaxial measuring system. This can be achieved by a stilling well, a bypass or a coax probe.
- In the case of a rope or rod probe, the tank must be empty on commissioning and a mapping curve must be recorded with the tank being empty. To do so, select **Confirm distance (→ 130)** = **Tank empty**. This automatically calibrates the empty capacitance of the rope or rod probe.

Signalauswertung

The interface distance is independently calculated from the guided radar and from the capacitance. The relative deviation of these two distances is calculated:

$Q_D = (D_{I,TDR} - D_{I,C}) / D_I$

Q_D is displayed in the **Build-up ratio** parameter (→ 156).

If the absolute value of Q_D exceeds a predefined limit (defined in the **Build-up thres.** parameter (→ 156)), the diagnostic message **Build-up detected** is generated.

If the interface echo is lost (e.g. due to an emulsion layer), the interface height is calculated from the capcitance measurement.

The diagnostic message **Build-up detected** may also occur if the dielectric constant of the upper medium changes. It is crucial for the measurement that the exact values of the upper and the lower dielectric constants are entered:

- DC value (→ 53)
- DC value lower medium (→ 52)

"Interface property" = "Oil/Water condensate"

Basic idea

In the case of an emulsion layer, the interface echo is strongly attenuated and may even completely disappear. Therefore, if this option is selected, the interface height is always calculated from the measured capacitance.

Requirements concerning the upper medium (A)

- Conductivity $\sigma_A < 1$ µS/cm
- The dielectric constant ε_A must not change and must be known.
- Value of the dielectric constant: $1.4 < \varepsilon_A < 10$

Requirements concerning the lower medium (B)

- Conductivity $\sigma_B > 100$ µS/cm
- Dielectric constant: $\varepsilon_B \geq \varepsilon_A + 10$

The factory setting for the dielectric constant of the lower medium is $\varepsilon_B = 80$. This is the value for water. If the lower medium is no water, its dielectric constant must be specified in the **DC value lower medium** parameter (→ 52).

Installation

- The measurement requires a coaxial measuring system. This can be achieved by a stilling well, a bypass or a coax probe.
- In the case of a rope or rod probe, the tank must be empty on commissioning and a mapping curve must be recorded with the tank being empty. To do so, select **Confirm distance (→ 130)** = **Tank empty**. This automatically calibrates the empty capacitance of the rope or rod probe.
- Any build-up formation must be avoided in order to ensure the reliabilty of the capacitance measurement.

Signalauswertung

The total level is always calculated from the guided radar signal. The interface level is always calculated from the measured capacitance and the total level.

It is crucial for the measurement that the exact values of the upper and the lower dielectric constants are entered:

- DC value (→ 53)
- DC value lower medium (→ 52)

"Interface property" = "Special: automatic DC"

Basic idea

The capacitance measurement is used to continuously recalculate the dielectric constant of the upper medium. In this way ist is possible to measure processes with a changing dielectric constant.

This evaluation mode is very sensitive to errors in the radar or capacitance measurement. Errors of this type may be caused by a wrong grounding, a wrong interference echo suppression, a free-field installation of a rope probe, or build-up formation, for example. These errors result in a wrong dielectric constant and thus in wrong level values.

Requirements concerning the upper medium (A)

- Conductivity $\sigma_A < 1$ µS/cm
- Value of the dielectric constant: $1.4 < \varepsilon_A < 10$

Requirements concerning the lower medium (B)

- Conductivity $\sigma_B > 100$ µS/cm
- Dielectric constant: $\varepsilon_B \geq \varepsilon_A + 10$

The factory setting for the dielectric constant of the lower medium is $\varepsilon_B = 80$. This is the value for water. If the lower medium is no water, its dielectric constant must be specified in the **DC value lower medium** parameter (→ 🖹 52).

Process requirements

- The thickness of the upper medium must be at least 300 mm (12 in) throughout the process.
- The level and interface echoes must be detectable throughout the process.
- An interference echo suppression must be performed during commissioning.
- There must be no build-up at the probe.

Installation

- The measurement requires a coaxial measuring system. This can be achieved by a stilling well, a bypass or a coax probe.
- In the case of a rope or rod probe, the tank must be empty on commissioning and a mapping curve must be recorded with the tank being empty. To do so, select **Confirm distance (→ 🖹 130)** = **Tank empty**. This automatically calibrates the empty capacitance of the rope or rod probe.

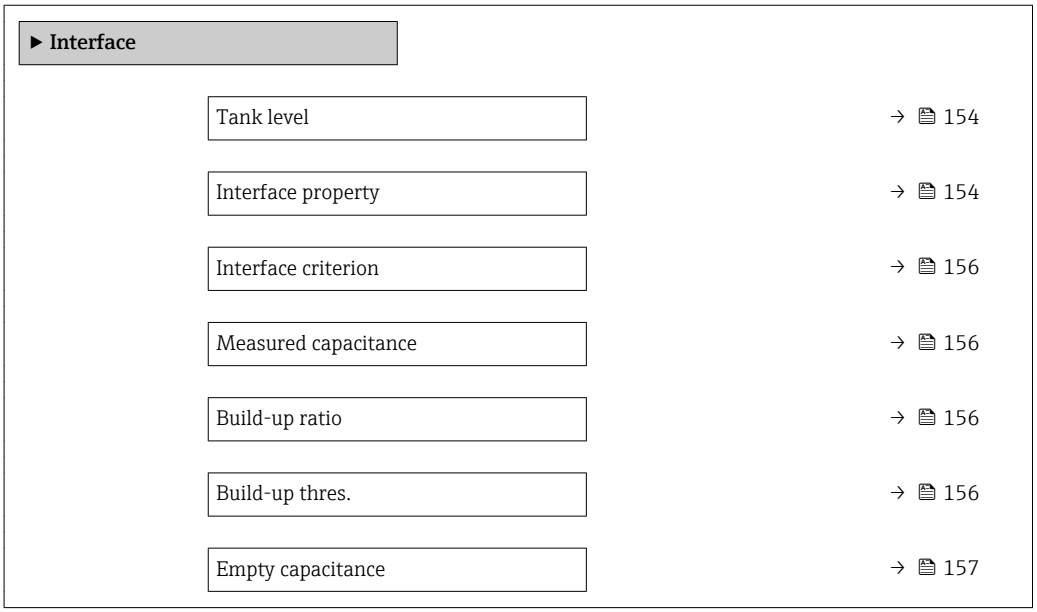
Signal evaluation

The level and the interface echo as well as the measured capcitance are used to calculate the dielectric constant of the upper medium, which is than used in turn to calculate the level and the total and interface level.

Small changes of the dielectric constant (e.g. from 2.2 to 2.3) can not be compensated by the algorithm. It is only useful in the case of larger changes, e.g. from 2 to 6.

Structure of the submenu

Navigation Expert → Sensor → Interface



Description of parameters

Navigation Expert → Sensor → Interface

Tank level

Navigation Expert → Sensor → Interface → Tank level (1111)

Prerequisite **Operating mode (→ 45) = Interface**

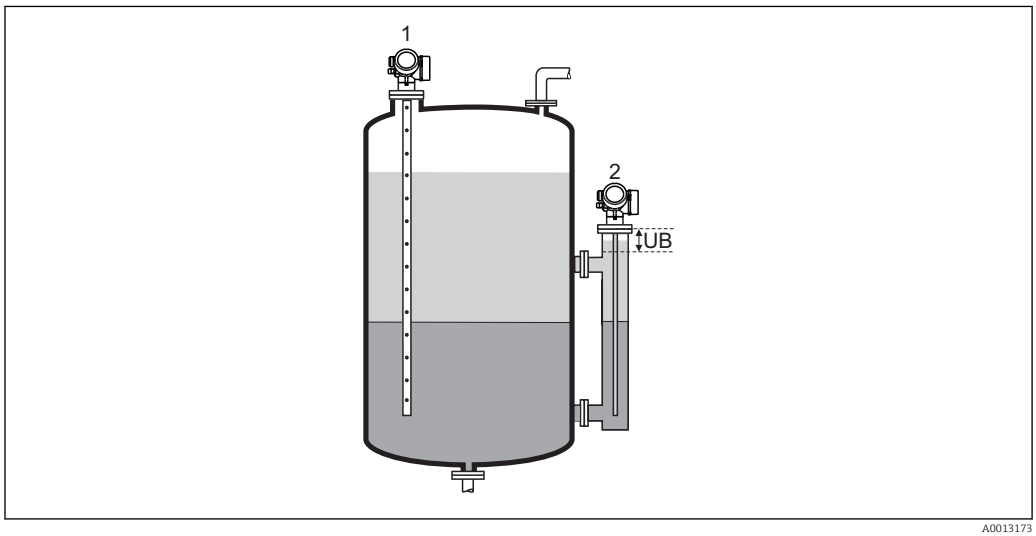
Description Specify whether the tank or bypass is completely flooded or not.

Selection
- Partially filled
- Fully flooded

Factory setting Partially filled

Additional information

Meaning of the options
- **Partially filled**
  The device searches for 2 echo signals, one for the interface and one for the total level.
- **Fully flooded**
  The device searches for the interface level only. With this setting it is essential that the upper level signal always is within the upper blocking distance (UB) in order to avoid that it is evaluated by mistake.



1 Partially filled
2 Fully flooded
UB Upper blocking distance

Interface property

Navigation Expert → Sensor → Interface → Interface prop. (1107)

Prerequisite **Operating mode (→ 45) = Interface with capacitance**

Description

Select interface property.

The interface property determines how the Guided Radar and the Capacitance Measurement interact.

Selection

- Special: automatic DC
- Build up
- Standard
- Emulsion layer

Factory setting

Standard

Additional information

Meaning of the options

- **Special: automatic DC**
  - Condition:
    The specific capacitance (pF/m) is known. [32)]
  - Signal evaluation:
    As long as a clear interface is detected, both the total and the interface level are determined via the Guided Radar. The dielectric constant of the upper medium is continuously adjusted. If an emulsion layer is present, the total level is determined via the Guided Radar whereas the interface level is determined via the Capacitance Measurement.
- **Build up**
  - Condition:
    The dielectric constant of the upper medium and the specific capacitance (pF/m) are known. [32)]
  - Signal evaluation:
    As long as a clear interface is detected, the interface level is determined via the Guided Radar as well as via the Capacitance Measurement. If these two values start to diverge from each other due to build-up formation, an error message is generated. If an emulsion layer is present, the total level is determined via the Guided Radar whereas the interface level is determined via the Capacitance Measurement.
- **Standard**
  - Condition:
    The dielectric constant of the upper medium is known.
  - Signal evaluation:
    As long as a clear interface is detected, the specific capacitance (pF/m) is continuously adjusted. Therefore build-up has only little influence on the measurement. If an emulsion layer is present, the total level is determined via the Guided Radar whereas the interface level is determined via the Capacitance Measurement.
- **Oil/Water condensate**
  - Condition:
    The dielectric constant of the upper medium and the specific capacitance (pF/m) are known. [32)]
  - Signal evaluation:
    The total level is always determined via the Guided Radar. The interface level is always determined via the Capacitance Measurement.

32) The specific capacitance of the media depends on the DC value and the geometry of the probe, which may differ noticeably. For rod probes < 2 m, the probe geometry is measured after production and the resulting specific capacitance for conductive media is preset on delivery.

Interface criterion

Navigation Expert → Sensor → Interface → Int. criterion (1184)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays the threshold (in mV) for the recognition of the interface signal.

Measured capacitance

Navigation Expert → Sensor → Interface → Measur. cap. (1066)

Prerequsite **Operating mode (→ 45)** = **Interface with capacitance**

Description Displays the measured capacitance (pF).

Build-up ratio

Navigation Expert → Sensor → Interface → Build-up ratio (1210)

Prerequsite **Interface property (→ 154)** = **Build up**

Description Indicates the relative deviation between the interface distance measured by the radar and the capacitance, respectively.

Additional information Formula by which this value is calculated:

$| (D_{Radar} - D_{Capa}) / D_{Radar} |$

If this ratio exceeds the value defined in the **Build-up thres.** parameter (→ 156), an error message is generated.

Build-up thres.

Navigation Expert → Sensor → Interface → Build-up thres. (1211)

Prerequsite **Interface property (→ 154)** = **Build up**

Description Define threshold for build-up detection.

User entry Signed floating-point number

Factory setting 0.1

Additional information If the **Build-up ratio** parameter (→ 156) exceeds the value specified in this parameter, the corresponding error message is generated.

Empty capacitance

Navigation Expert → Sensor → Interface → Empty capacitan. (1122)

Prerequsite **Operating mode (→ 45)** = **Interface with capacitance**

Description Specify capacitance for the empty tank.

User entry 0.0 to 10 000.0 pF

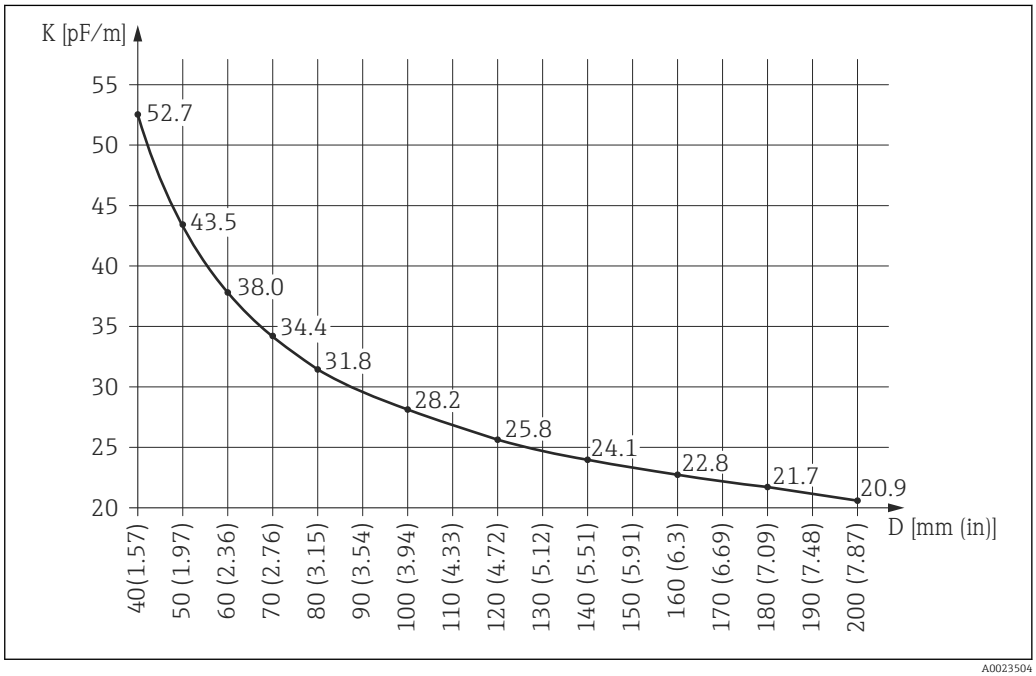
Factory setting 0.0 pF

Additional information Normally, the device determines the empty capacitance automatically if during commissioning **Confirm distance (→ 130)** = **Tank empty** is selected. In exceptional cases - if emptying the tank during commissioning is impossible - a calculated value can be entered manually.

Calculation of the empty capacitance

1. Read the empty capacitance per meter from the diagram.
2. Multiply the read value by the length of the probe.
3. Add the result to the basic capacitance of the device according to the following table:

Device version	Basic capacitance
Compact device	29.5 pF
Feature 600 "Probe Design", option model MB "Sensor remote, 3m/9ft cable, detachable +mounting bracket"	278.4 pF



53 Empty capacitance per meter according to bypass or stilling well diameter

D Bypass or stilling well diameter
K Capacitance per meter

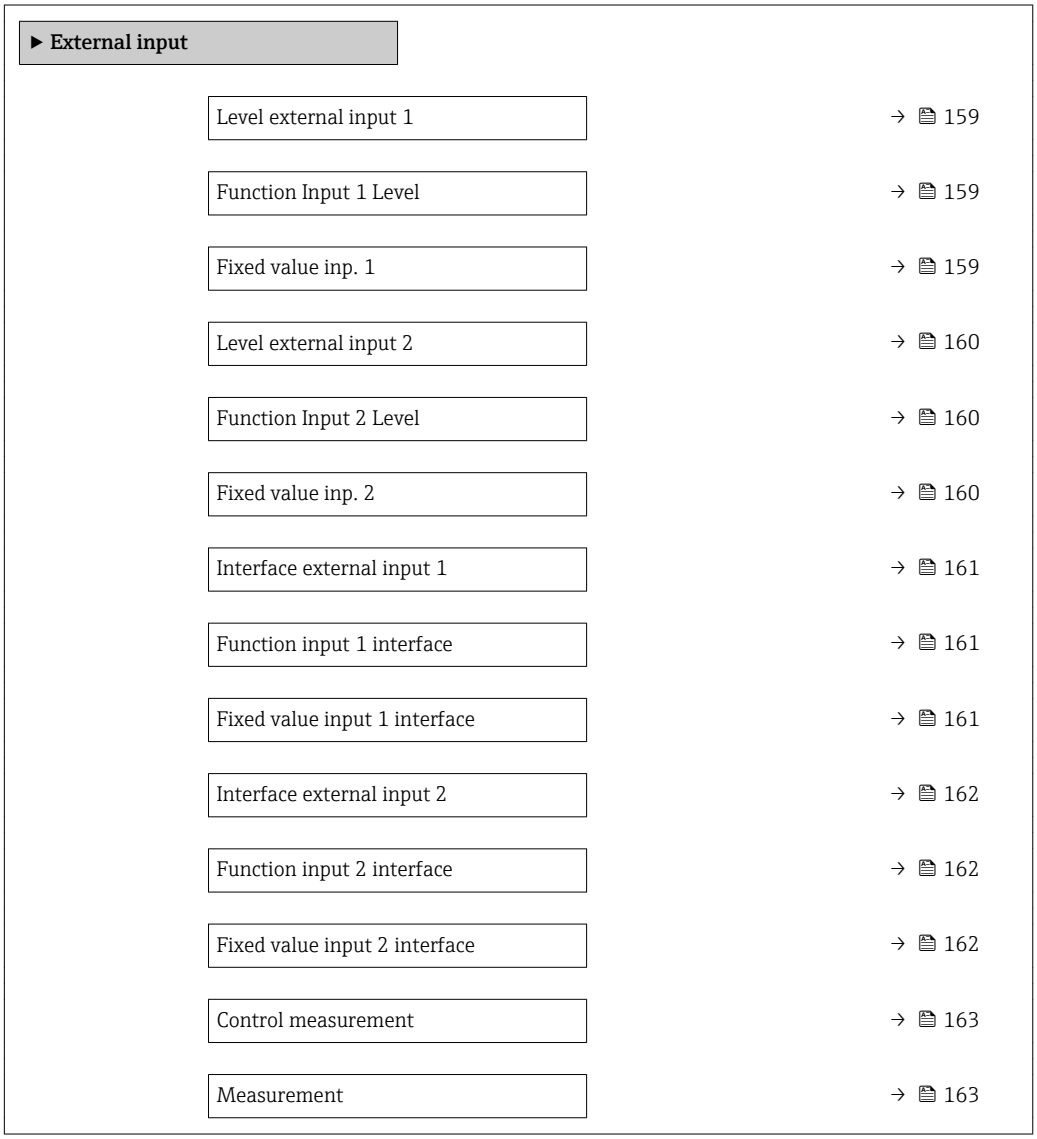
4.4.17 "External input" submenu

The **External input** submenu is only available for devices with PROFIBUS PA or FOUNDATION Fieldbus.

The behavior of the sensor can be controlled via two external switch inputs: The measurement can be switched on and off. Furthermore, a specific value can be assigned to the level when the digital switch signal is present, regardless of the actual measured value.

Structure of the submenu

Navigation Expert → Sensor → External input



Description of parameters

Navigation Expert → Sensor → External input

Level external input 1

Navigation Expert → Sensor → External input → Level ext. in. 1 (2305)

Description Assign a DO block to the external input. The switch signal is read from this block.

Selection
- None
- Digital output 1
- Digital output 2
- Digital output 3
- Digital output 4
- Digital output 5
- Digital output 6
- Digital output 7
- Digital output 8

Factory setting None

Function Input 1 Level

Navigation Expert → Sensor → External input → Fct. Inp. 1 Lvl (2311)

Prerequsite **Level external input 1 (→ 159) ≠ None**

Description Define the reaction of the level signal in case a switching signal is active at the external input.

Selection
- Off
- Low (0%)
- High (100%)
- Hold Last Value
- Fixed Value

Factory setting Off

Fixed value inp. 1

Navigation Expert → Sensor → External input → Fix. val. inp. 1 (2332)

Prerequsite **Function Input 1 Level (→ 159) = Fixed Value**

Description Specify the value the level signal assumes if a switch signal is active at the external input.

User entry 0.0 to 200 000.0 %

Factory setting 0.0 %

Level external input 2

Navigation Expert → Sensor → External input → Level ext. in. 2 (2306)

Description Assign a DO block to the external input. The switch signal is read from this block.

Selection
- None
- Digital output 1
- Digital output 2
- Digital output 3
- Digital output 4
- Digital output 5
- Digital output 6
- Digital output 7
- Digital output 8

Factory setting None

Function Input 2 Level

Navigation Expert → Sensor → External input → Fct. Inp. 2 Lvl (2331)

Prerequsite **Level external input 2 (→ 160) ≠ None**

Description Define the reaction of the level signal in case a switching signal is active at the external input.

Selection
- Off
- Low (0%)
- High (100%)
- Hold Last Value
- Fixed Value

Factory setting Off

Fixed value inp. 2

Navigation Expert → Sensor → External input → Fix. val. inp. 2 (2333)

Prerequsite **Function Input 2 Level (→ 160) = Fixed Value**

Description Specify the value the level signal assumes if a switch signal is active at the external input.

User entry 0.0 to 200 000.0 %

Factory setting 1.0 %

Interface external input 1

Navigation Expert → Sensor → External input → Interf. ext.in.1 (2334)

Description Assign a DO block to the external input. The switch signal is read from this block.

Selection
- None
- Digital output 1
- Digital output 2
- Digital output 3
- Digital output 4
- Digital output 5
- Digital output 6
- Digital output 7
- Digital output 8

Factory setting None

Function input 1 interface

Navigation Expert → Sensor → External input → Fct.In. 1 Interf (2336)

Prerequsite **Interface external input 1 (→ 161) ≠ None**

Description Define the reaction of the interface signal in case a switching signal is active at the external input.

Selection
- Off
- Low (0%)
- High (100%)
- Hold Last Value
- Fixed Value

Factory setting Off

Fixed value input 1 interface

Navigation Expert → Sensor → External input → Val.in 1 interf (2338)

Prerequsite **Function input 1 interface (→ 161) = Fixed Value**

Description Specify the value the interface signal assumes if a switch signal is active at the external input.

User entry 0.0 to 200 000.0 %

Factory setting 0.0 %

Interface external input 2

Navigation Expert → Sensor → External input → Interf. ext.in.2 (2335)

Description Assign a DO block to the external input. The switch signal is read from this block.

Selection
- None
- Digital output 1
- Digital output 2
- Digital output 3
- Digital output 4
- Digital output 5
- Digital output 6
- Digital output 7
- Digital output 8

Factory setting None

Function input 2 interface

Navigation Expert → Sensor → External input → Fct.In. 2 Interf (2337)

Prerequsite **Interface external input 2 (→ 162) ≠ None**

Description Define the reaction of the interface signal in case a switching signal is active at the external input.

Selection
- Off
- Low (0%)
- High (100%)
- Hold Last Value
- Fixed Value

Factory setting Off

Fixed value input 2 interface

Navigation Expert → Sensor → External input → Val.in 2 interf (2344)

Prerequsite **Function input 2 interface (→ 162) = Fixed Value**

Description Specify the value the interface signal assumes if a switch signal is active at the external input.

User entry 0.0 to 200 000.0 %

Factory setting 1.0 %

Control measurement

Navigation Expert → Sensor → External input → Ctrl. measurem. (1083)

Description Specify the DO block used to switch the measurement on or off.

Selection
- None
- Digital output 1
- Digital output 2
- Digital output 3
- Digital output 4
- Digital output 5
- Digital output 6
- Digital output 7
- Digital output 8

Factory setting None

Measurement

Navigation Expert → Sensor → External input → Measurement (1082)

Description Used to switch the measurement on or off manually.

Selection
- Off
- On

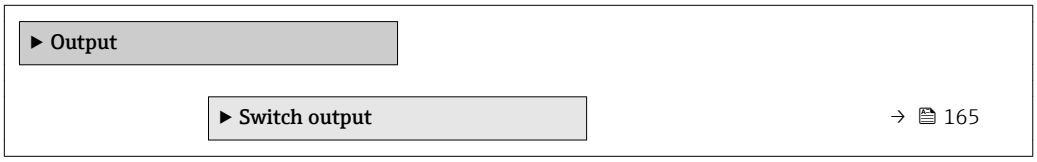
Factory setting On

4.5 "Output" submenu

The **Output** submenu contains all parameters needed to configure the current and switch outputs.

4.5.1 Structure of the submenu

Navigation Expert → Output

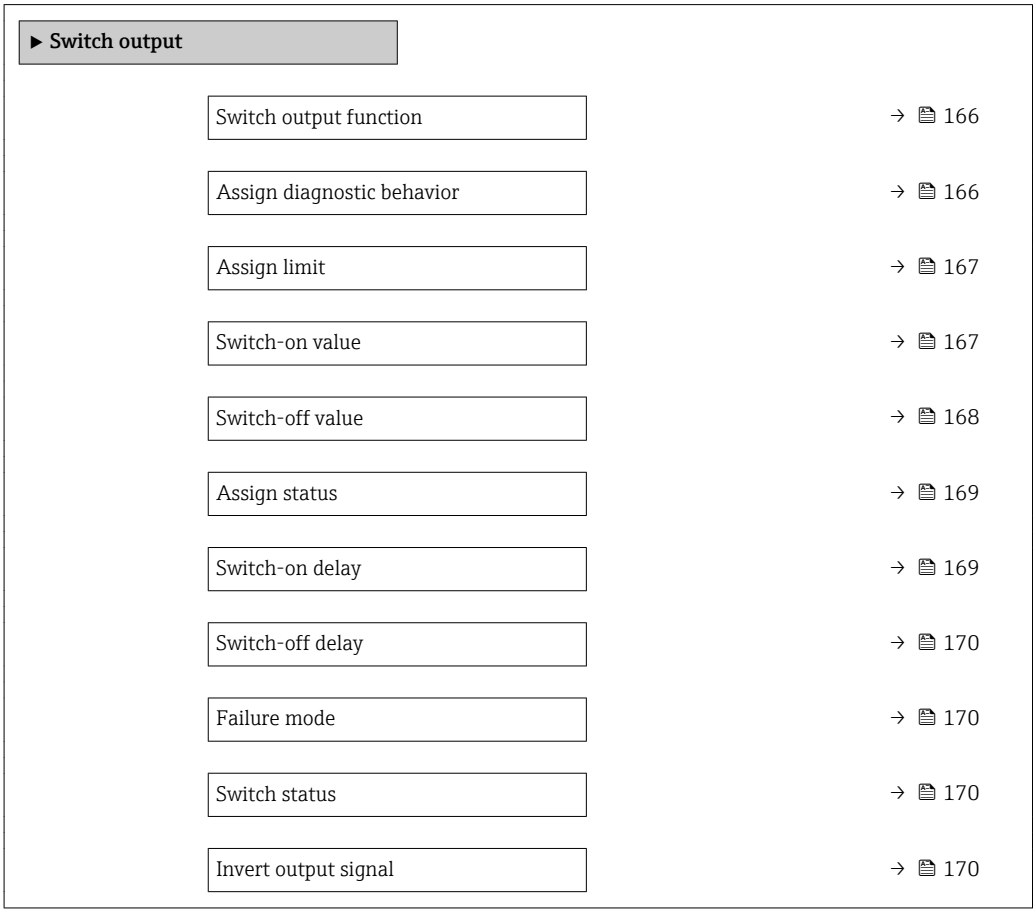


4.5.2 "Switch output" submenu

The **Switch output** submenu is used to configure the switch output of the device.

Structure of the submenu

Navigation Expert → Output → Switch output



Description of parameters

Navigation Expert → Output → Switch output

Switch output function

Navigation Expert → Output → Switch output → Switch out funct (0481)

Description Select function for switch output.

Selection
- Off
- On
- Diagnostic behavior
- Limit
- Digital Output

Factory setting Off

Additional information

Meaning of the options
- **Off**
  The output is always open (non-conductive).
- **On**
  The output is always closed (conductive).
- **Diagnostic behavior**
  The output is normally closed and is only opened if a diagnostic event is present. The **Assign diagnostic behavior** parameter (→ 166) determines for which type of event the output is opened.
- **Limit**
  The output is normally closed and is only opened if a measured variable exceeds or falls below a defined limit. The limit values are defined by the following parameters:
  – **Assign limit (→ 167)**
  – **Switch-on value (→ 167)**
  – **Switch-off value (→ 168)**
- **Digital Output**
  The switching state of the output tracks the output value of a DI function block. The function block is selected in the **Assign status** parameter (→ 169).

The **Off** and **On** options can be used to simulate the switch output.

Assign diagnostic behavior

Navigation Expert → Output → Switch output → Assign diag. beh (0482)

Prerequsite **Switch output function (→ 166)** = **Diagnostic behavior**

Description Select diagnostic behavior for switch output.

Selection
- Alarm
- Alarm or warning
- Warning

Factory setting Alarm

Assign limit

Navigation Expert → Output → Switch output → Assign limit (0483)

Prerequsite **Switch output function (→ 166) = Limit**

Description Select process variable for limit monitoring.

Selection
- Off
- Level linearized
- Distance
- Interface linearized *
- Interface distance *
- Thickness upper layer *
- Terminal voltage
- Electronic temperature
- Measured capacitance *
- Relative echo amplitude
- Relative interface amplitude *
- Absolute echo amplitude
- Absolute interface amplitude *

Factory setting Off

Switch-on value

Navigation Expert → Output → Switch output → Switch-on value (0466)

Prerequsite **Switch output function (→ 166) = Limit**

Description Enter measured value for the switch-on point.

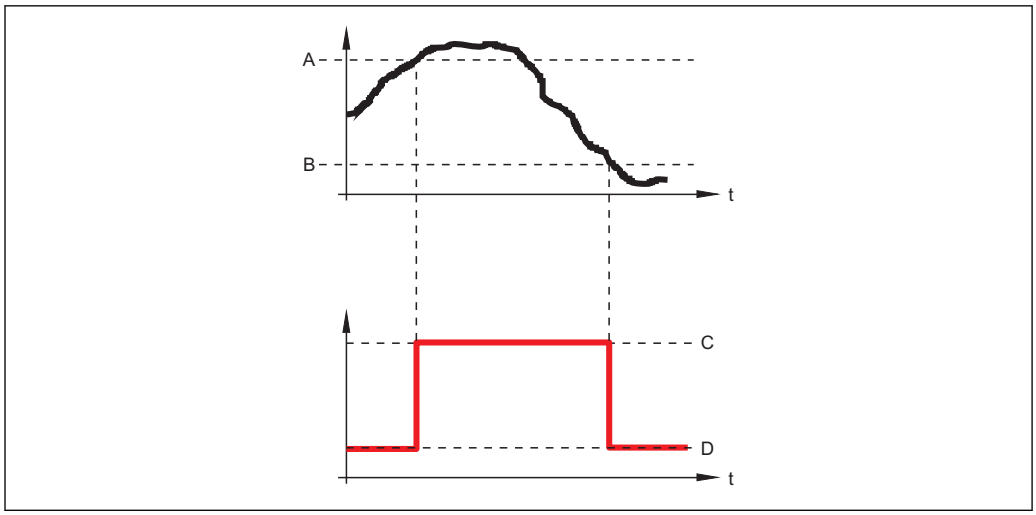
User entry Signed floating-point number

Factory setting 0

Additional information The switching behavior depends on the relative position of the **Switch-on value** and **Switch-off value** parameters:

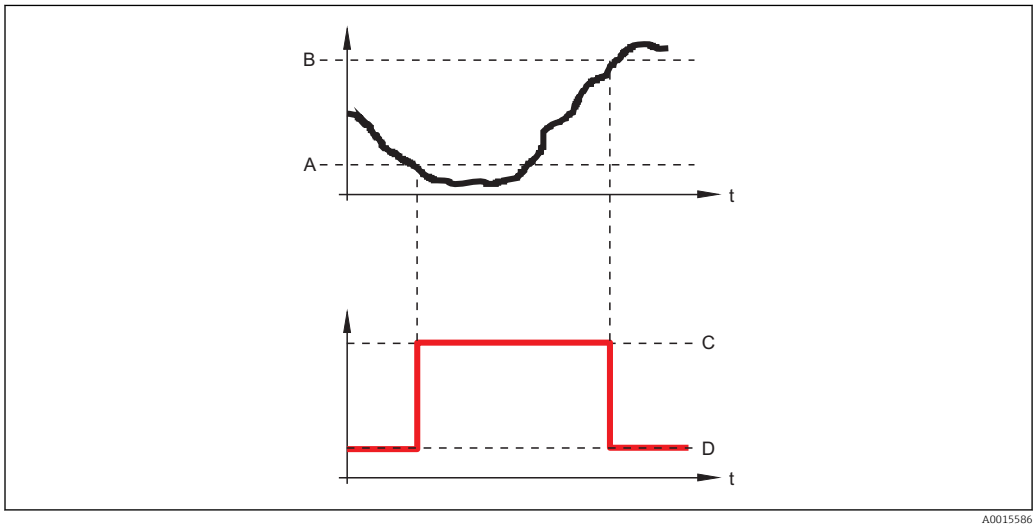
Switch-on value > Switch-off value
– The output is closed if the measured value is larger than **Switch-on value**.
– The output is opened if the measured value is smaller than **Switch-off value**.

* Visibility depends on order options or device settings



A Switch-on value
B Switch-off value
C Output closed (conductive)
D Output opened (non-conductive)

Switch-on value < Switch-off value
– The output is closed if the measured value is smaller than **Switch-on value**.
– The output is opened if the measured value is larger than **Switch-off value**.



A Switch-on value
B Switch-off value
C Output closed (conductive)
D Output opened (non-conductive)

Switch-off value

Navigation Expert → Output → Switch output → Switch-off value (0464)

Prerequisite **Switch output function (→ 166) = Limit**

Description Enter measured value for the switch-off point.

User entry Signed floating-point number

Factory setting 0

Additional information The switching behavior depends on the relative position of the **Switch-on value** and **Switch-off value** parameters; description: see the **Switch-on value** parameter (→ 167).

Assign status

Navigation Expert → Output → Switch output → Assign status (0485)

Prerequsite **Switch output function (→ 166)** = **Digital Output**

Description Select device status for switch output.

Selection
- Off
- Digital output AD 1
- Digital output AD 2
- Digital output 1
- Digital output 2
- Digital output 3
- Digital output 4
- Digital output 5
- Digital output 6
- Digital output 7
- Digital output 8

Factory setting Off

Additional information The **Digital output AD 1** and **Digital output AD 2** options refer to the Advanced Diagnostic Blocks → 204. A switch signal generated in these blocks can be transmitted via the switch output.

Switch-on delay

Navigation Expert → Output → Switch output → Switch-on delay (0467)

Prerequsite
- **Switch output function (→ 166)** = **Limit**
- **Assign limit (→ 167)** ≠ **Off**

Description Define switch-on delay.

User entry 0.0 to 100.0 s

Factory setting 0.0 s

Switch-off delay

Navigation Expert → Output → Switch output → Switch-off delay (0465)

Prerequsite
- **Switch output function (→ 166)** = **Limit**
- **Assign limit (→ 167)** ≠ **Off**

Description Define switch-off delay.

User entry 0.0 to 100.0 s

Factory setting 0.0 s

Failure mode

Navigation Expert → Output → Switch output → Failure mode (0486)

Description Define output behavior in alarm condition.

Selection
- Actual status
- Open
- Closed

Factory setting Open

Switch status

Navigation Expert → Output → Switch output → Switch status (0461)

Description Displays the current state of the switch output.

Invert output signal

Navigation Expert → Output → Switch output → Invert outp.sig. (0470)

Description Specify whether the output signal is to be inverted.

Selection
- No
- Yes

Factory setting No

Additional information

Meaning of the options

- **No**
  The behavior of the switch output is as described above.
- **Yes**
  The states **Open** and **Closed** are inverted as compared to the description above.

4.6 "Communication" submenu

Navigation Expert → Communication

4.6.1 "Resource block" submenu

This submenu contains the parameters of the Resource Block according to the FOUNDATION Fieldbus specification.

In the case of display operation only the most important parameters of the block are displayed.

The complete block is accessible via FieldCare or a FOUNDATION Fieldbus configuration tool.

Navigation Expert → Communication → Resource block

4.7 "Analog inputs" submenu

Navigation Expert → Analog inputs

4.7.1 "Analog input 1 to 5" submenu

There is an **Analog input** submenu for each Analog Input block of the device . It contains the parameters of the Analog Input block according to the FOUNDATION Fieldbus specification.

In the case of display operation only the most important parameters of the block are displayed.

The complete block is accessible via FieldCare or a FOUNDATION Fieldbus configuration tool.

Navigation Expert → Analog inputs → Analog input 1 to 5

4.8 "Discrete inputs" submenu

Navigation Expert → Discrete inputs

4.8.1 "Discrete input 1 to 3" submenu

There is a **Discrete input** submenu for each Discrete Input block of the device. It contains the parameters of the Discrete Input block according to the FOUNDATION Fieldbus specification.

In the case of display operation only the most important parameters of the block are displayed.

The complete block is accessible via FieldCare or a FOUNDATION Fieldbus configuration tool.

Navigation Expert → Discrete inputs → Discrete input 1 to 3

4.9 "Analog outputs" submenu

Navigation Expert → Analog outputs

4.9.1 "Multiple analog output" submenu

There is a **Multiple analog output** submenu for each Analog Output block of the device . It contains the parameters of the Analog Output block according to the FOUNDATION Fieldbus specification.

In the case of display operation only the most important parameters of the block are displayed.

The complete block is accessible via FieldCare or a FOUNDATION Fieldbus configuration tool.

Navigation Expert → Analog outputs → Multiple AO

4.10 "Discrete outputs" submenu

Navigation Expert → Discrete outputs

4.10.1 "Multiple discrete output" submenu

There is a **Multiple discrete output** submenu for each Discrete Output block of the device. It contains the parameters of the Discrete Output block according to the FOUNDATION Fieldbus specification.

In the case of display operation only the most important parameters of the block are displayed.

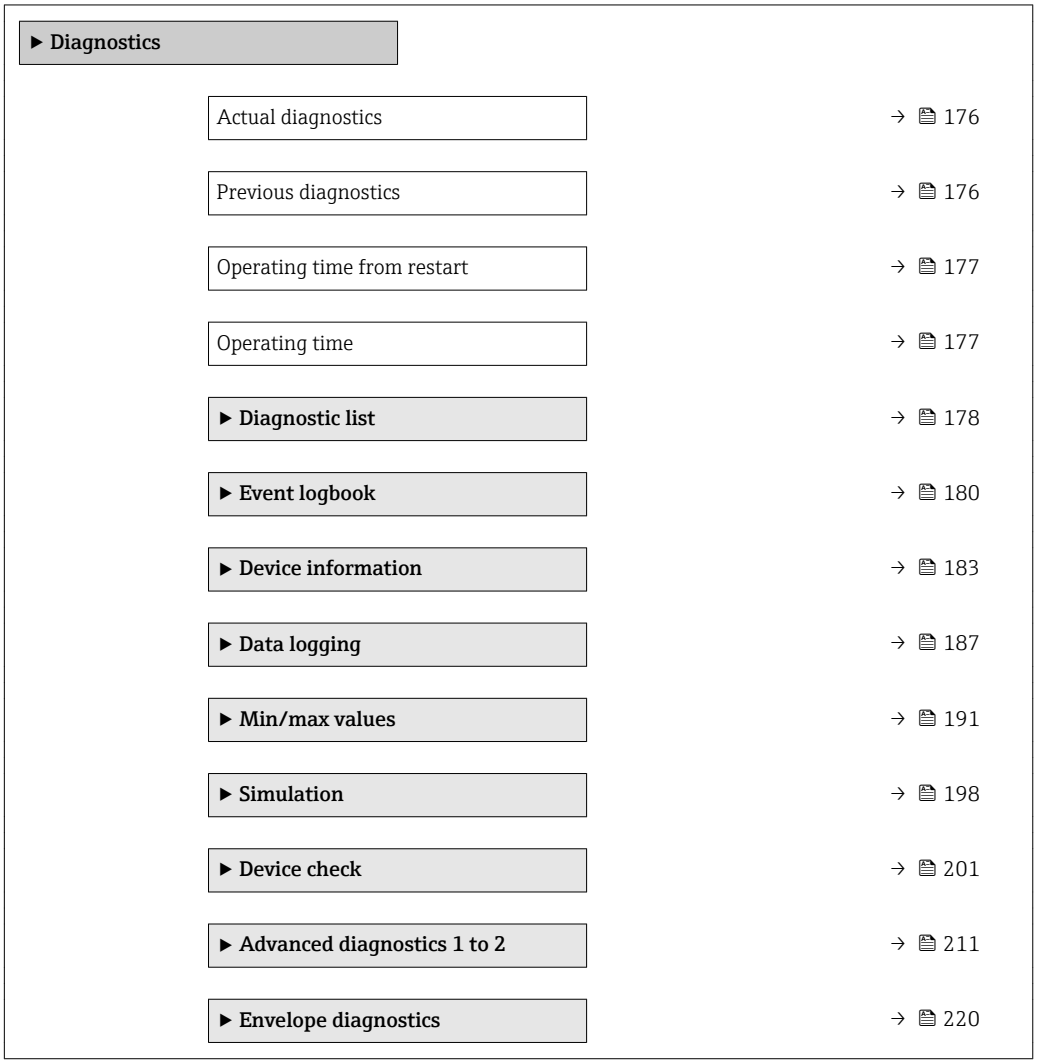
The complete block is accessible via FieldCare or a FOUNDATION Fieldbus configuration tool.

Navigation Expert → Discrete outputs → Multiple DO

4.11 "Diagnostics" submenu

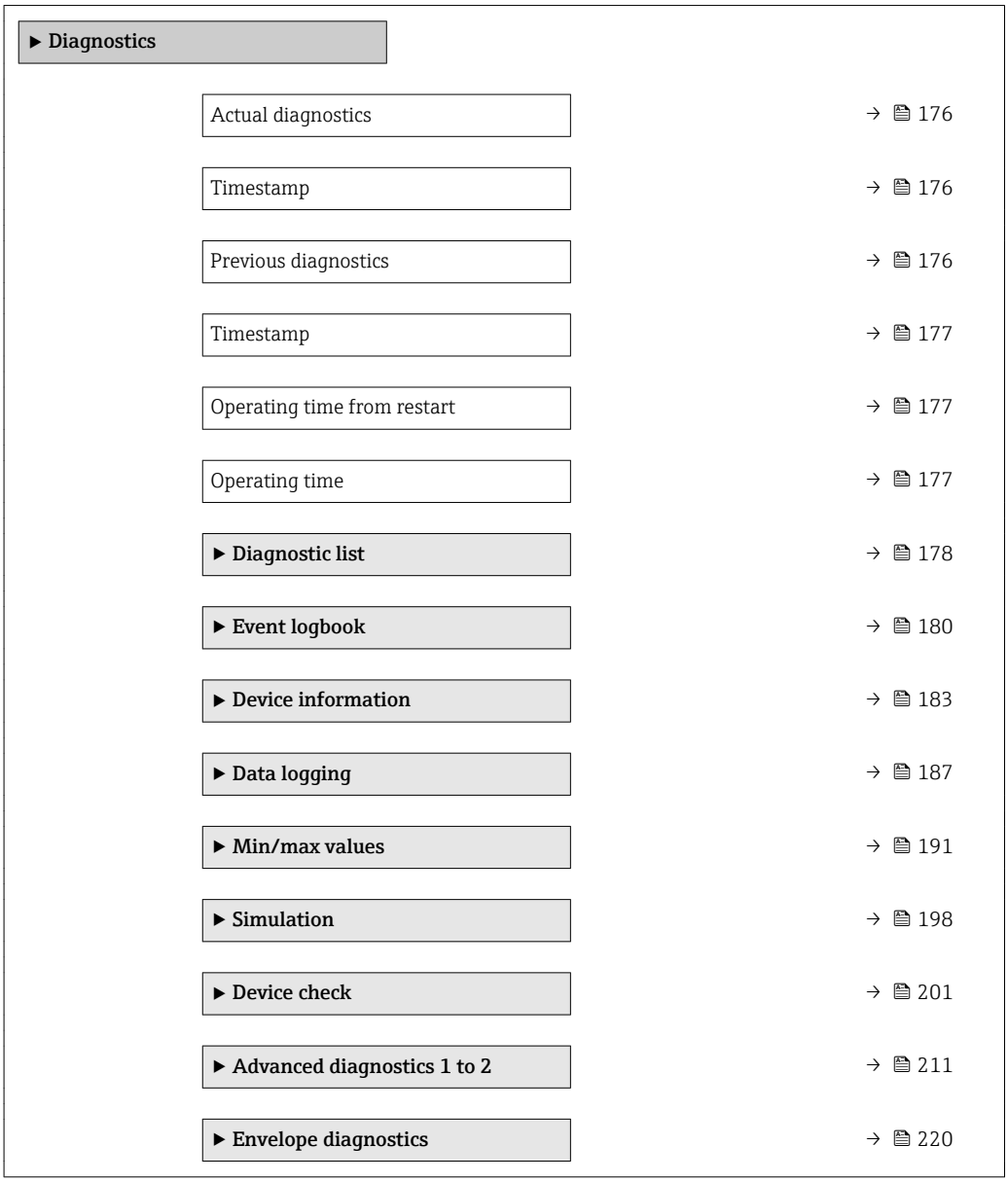
4.11.1 Structure of the submenu on the local display

Navigation Expert → Diagnostics



4.11.2 Structure of the submenu in an operating tool

Navigation Expert → Diagnostics



4.11.3 Description of parameters

Navigation Expert → Diagnostics

Actual diagnostics

Navigation Expert → Diagnostics → Actual diagnos. (0691)

Description Displays current diagnostic message.

Additional information The display consists of:
- Symbol for event behavior
- Code for diagnostic behavior
- Operating time of occurrence
- Event text

If several messages are active at the same time, the messages with the highest priority is displayed.

Information on what is causing the message, and remedy measures, can be viewed via the ⓘ symbol on the display.

Timestamp

Navigation Expert → Diagnostics → Timestamp (0667)

Description Displays timestamp for the **Actual diagnostics** parameter (→ 176).

User interface Days (d), hours (h), minutes (m), seconds (s)

Previous diagnostics

Navigation Expert → Diagnostics → Prev.diagnostics (0690)

Description Displays the last diagnostic message which has been active before the current message.

Additional information The display consists of:
- Symbol for event behavior
- Code for diagnostic behavior
- Operating time of occurrence
- Event text

The condition displayed may still apply. Information on what is causing the message, and remedy measures, can be viewed via the ⓘ symbol on the display.

Timestamp

Navigation Expert → Diagnostics → Timestamp (0672)

Description Displays timestamp for the **Previous diagnostics** parameter (→ 176).

User interface Days (d), hours (h), minutes (m), seconds (s)

Operating time from restart

Navigation Expert → Diagnostics → Time fr. restart (0653)

Description Displays the time the device has been in operation since the last device restart.

User interface Days (d), hours (h), minutes (m), seconds (s)

Operating time

Navigation Expert → Diagnostics → Operating time (0652)

Description Indicates how long the device has been in operation.

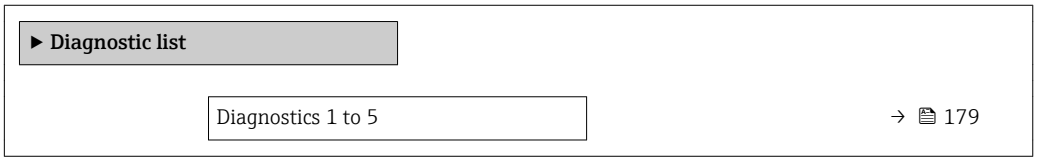
User interface Days (d), hours (h), minutes (m), seconds (s)

Additional information *Maximum time*
9 999 d (≈ 27 years)

4.11.4 "Diagnostic list" submenu

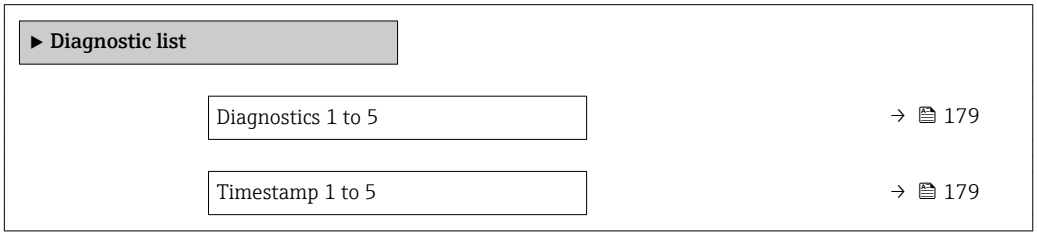
Structure of the submenu on the local display

Navigation Expert → Diagnostics → Diagnostic list



Structure of the submenu in an operating tool

Navigation Expert → Diagnostics → Diagnostic list



Description of parameters

Navigation Expert → Diagnostics → Diagnostic list

Diagnostics 1 to 5

Navigation Expert → Diagnostics → Diagnostic list → Diagnostics 1 to 5 (0692–1 to 5)

Description Display the current diagnostics messages with the highest to fifth-highest priority.

Additional information The display consists of:
- Symbol for event behavior
- Code for diagnostic behavior
- Operating time of occurrence
- Event text

Timestamp 1 to 5

Navigation Expert → Diagnostics → Diagnostic list → Timestamp (0683)

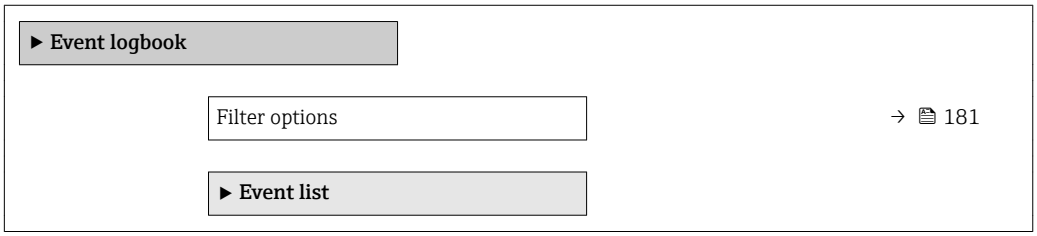
Description Displays timestamp for the **Diagnostics 1 to 5** parameter (→ 179).

User interface Days (d), hours (h), minutes (m), seconds (s)

4.11.5 "Event logbook" submenu

Structure of the submenu on the local display

Navigation Expert → Diagnostics → Event logbook



Structure of the submenu in an operating tool

Navigation Expert → Diagnostics → Event logbook

Description of parameters

Navigation Expert → Diagnostics → Event logbook

Filter options

Navigation Expert → Diagnostics → Event logbook → Filter options (0705)

Description Select category (status signal) whose event messages are displayed in the events list.

Selection
- All
- Failure (F)
- Function check (C)
- Out of specification (S)
- Maintenance required (M)
- Information (I)

Factory setting All

Additional information
- This parameter is only used for operation via the local display.
- The status signals are categorized according to NAMUR NE 107.

"Event list" submenu

The **Event list** submenu displays the history of past events of the category selected in the **Filter options** parameter (→ 181). A maximum of 20 events are displayed in chronological order. If the advanced HistoROM functionality has been activated in the device, the event list may comprise up to 100 entries.

The following symbols indicate whether an event has occurred or has ended:
- : Event has occurred
- : Event has ended

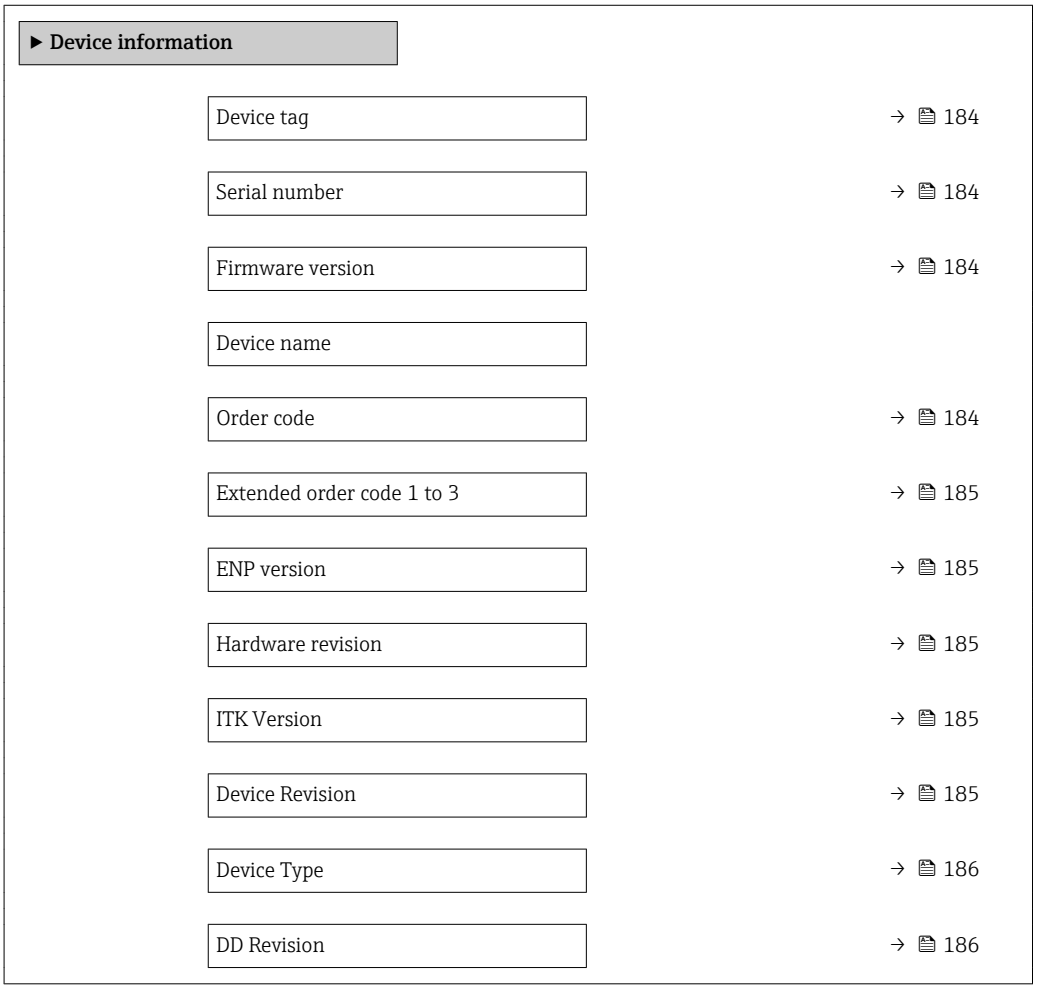
Information on what is causing the message, and remedy instructions, can be viewed via the ⓘ-button.

Display format
- For event messages in category I: information event, event text, "recording event" symbol and time the event occurred
- For event messages in category F, M, C, S (status signal): diagnostics event, event text, "recording event" symbol and time the event occurred

4.11.6 "Device information" submenu

Structure of the submenu

Navigation Expert → Diagnostics → Device info



Description of parameters

Navigation Expert → Diagnostics → Device info

Device tag

Navigation Expert → Diagnostics → Device info → Device tag (0011)

Description Enter tag for measuring point.

Factory setting FMP5x

Serial number

Navigation Expert → Diagnostics → Device info → Serial number (0009)

Description Displays serial number of the device.

Additional information

Uses of the serial number
- To identify the device quickly, e.g. when contacting Endress+Hauser.
- To obtain specific information on the device using the Device Viewer: www.endress.com/deviceviewer

The serial number is also indicated on the nameplate.

Firmware version

Navigation Expert → Diagnostics → Device info → Firmware version (0010)

Description Indicates the installed Firmware version.

User interface xx.yy.zz

Additional information For firmware versions differing only in the last two digits ("zz") there is no difference concerning functionality or operation.

Order code

Navigation Expert → Diagnostics → Device info → Order code (0008)

Description Displays order code of the device.

Additional information The order code is generated from the extended roder code, which defines all device features of the product structure. In contrast, the device features can not be read directly from the order code.

Extended order code 1 to 3

Navigation Expert → Diagnostics → Device info → Ext. order cd. 1 to 3 (0023–1 to 3)

Description Displays the three parts of the extended order code.

Additional information The extended order code indicates the version of all the features of the product structure and thus uniquely identifies the device.

ENP version

Navigation Expert → Diagnostics → Device info → ENP version (0012)

Description Displays version of the electronic nameplate (ENP).

User interface xx.yy.zz

Hardware revision

Navigation Expert → Diagnostics → Device info → Hardware rev. (10793)

Description Indicates the hardware revision of the device.

ITK Version

Navigation Expert → Diagnostics → Device info → ITK Version (10794)

Description Indicates the ITK version of the device.

Device Revision

Navigation Expert → Diagnostics → Device info → Device Revision (10710)

Description Indicates the device revision.

Device Type

Navigation Expert → Diagnostics → Device info → Device Type (10711)

Description Indicates the device type.

DD Revision

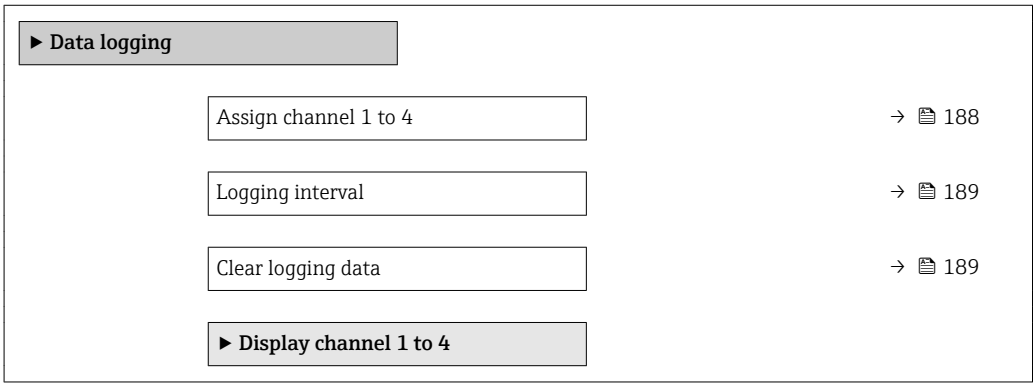
Navigation Expert → Diagnostics → Device info → DD Revision (10709)

Description Indicates the DD revision.

4.11.7 "Data logging" submenu

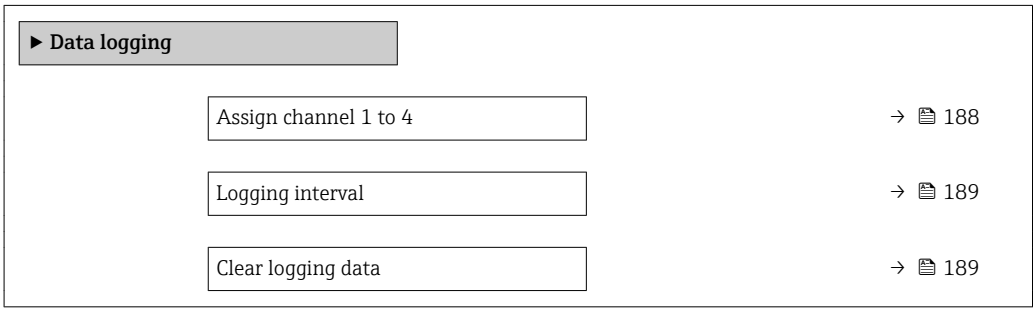
Structure of the submenu on the local display

Navigation Expert → Diagnostics → Data logging



Structure of the submenu in an operating tool

Navigation Expert → Diagnostics → Data logging



Description of parameters

Navigation Expert → Diagnostics → Data logging

Assign channel 1 to 4

Navigation Expert → Diagnostics → Data logging → Assign chan. 1 (0851)

Description Allocate a process variable to the respective data logging channel.

Selection
- Off
- Level linearized
- Distance
- Unfiltered distance
- Interface linearized *
- Interface distance *
- Unfiltered interface distance
- Thickness upper layer *
- Terminal voltage
- Electronic temperature
- Measured capacitance *
- Absolute echo amplitude
- Relative echo amplitude
- Absolute interface amplitude *
- Relative interface amplitude *
- Absolute EOP amplitude
- EOP shift
- Noise of signal
- Calculated DC value *
- Analog output adv. diagnostics 1
- Analog output adv. diagnostics 2
- Analog output 1
- Analog output 2
- Analog output 3
- Analog output 4

Factory setting Off

Additional information A total of 500 measured values can be logged. This means:
- 500 data points if 1 logging channel is used
- 250 data points if 2 logging channels are used
- 166 data points if 3 logging channels are used
- 125 data points if 4 logging channels are used

If the maximum number of data points is reached, the oldest data points in the data log are cyclically overwritten in such a way that the last 500, 250, 166 or 125 measured values are always in the log (ring memory principle).

The logged data are deleted if a new option is selected in this parameter.

* Visibility depends on order options or device settings

Logging interval

Navigation Expert → Diagnostics → Data logging → Logging interval (0856)

Description Define logging interval t_{log}.

User entry 1.0 to 3 600.0 s

Factory setting 30.0 s

Additional information This parameter defines the interval between the individual data points in the data log, and thus the maximum loggable process time T_{log}:

- If 1 logging channel is used: $T_{log} = 500 \cdot t_{log}$
- If 2 logging channels are used: $T_{log} = 250 \cdot t_{log}$
- If 3 logging channels are used: $T_{log} = 166 \cdot t_{log}$
- If 4 logging channels are used: $T_{log} = 125 \cdot t_{log}$

Once this time elapses, the oldest data points in the data log are cyclically overwritten such that a time of T_{log} always remains in the memory (ring memory principle).

The logged data are deleted if this parameter is changed.

Example

When using 1 logging channel
- $T_{log} = 500 \cdot 1$ s = 500 s ≈ 8.5 min
- $T_{log} = 500 \cdot 10$ s = 5 000 s ≈ 1.5 h
- $T_{log} = 500 \cdot 80$ s = 40 000 s ≈ 11 h
- $T_{log} = 500 \cdot 3\,600$ s = 1 800 000 s ≈ 20 d

Clear logging data

Navigation Expert → Diagnostics → Data logging → Clear logging (0855)

Description Initiate a deletion of the complete logging memory.

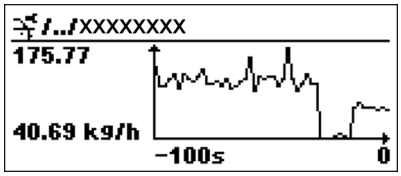
Selection
- Cancel
- Clear data

Factory setting Cancel

"Display channel 1 to 4" submenu

The **Display channel 1 to 4** submenu is only available when operating via the local display. When operating via FieldCare, the diagram can be displayed in the "Event List / HistoROM" function.

The **Display channel 1 to 4** submenu displays the measured value trend of the respective logging channel.



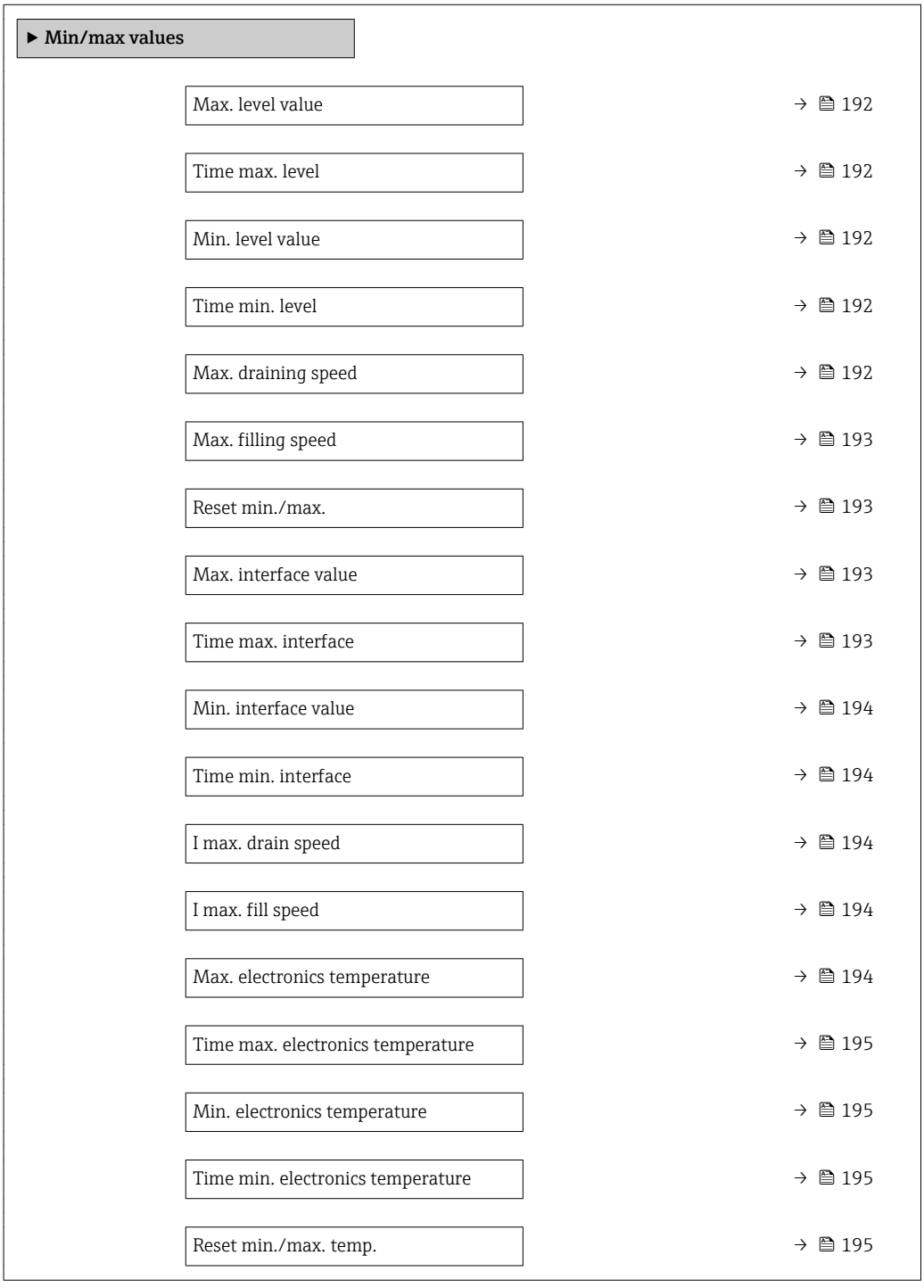
- x-axis: displays 125 to 500 measured values of a process variable (the number of values depending on the number of selected channels).
- y-axis: displays the approximate measured value span and constantly adapts this to the ongoing measurement.

To quit the diagram and to return to the operating menu, press ⊞ and ⊟ simultaneously.

4.11.8 "Min/max values" submenu

Structure of the submenu

Navigation Expert → Diagnostics → Min/max val.



Description of parameters

Navigation Expert → Diagnostics → Min/max val.

Max. level value

Navigation Expert → Diagnostics → Min/max val. → Max. level value (2357)

Description Displays maximum level measured in the past.

Time max. level

Navigation Expert → Diagnostics → Min/max val. → Time max. level (2385)

Description Displays operating time at which the maximum level has been obtained.

Min. level value

Navigation Expert → Diagnostics → Min/max val. → Min. level value (2358)

Description Displays minimum level measured in the past.

Time min. level

Navigation Expert → Diagnostics → Min/max val. → Time min. level (2386)

Description Displays operating time at which the minimum level has been obtained.

Max. draining speed

Navigation Expert → Diagnostics → Min/max val. → Max.drain.speed (2320)

Description Displays maximum draining speed measured in the past.

Max. filling speed

Navigation Expert → Diagnostics → Min/max val. → Max. fill. speed (2360)

Description Displays maximum filling speed measured in the past.

Reset min./max.

Navigation Expert → Diagnostics → Min/max val. → Reset min/max (2324)

Description Select which min/max values are to be reset.

Selection
- None
- Drain/fill speed
- Level
- I drain/fill speed *
- Interface *
- Reset all

Factory setting None

Max. interface value

Navigation Expert → Diagnostics → Min/max val. → Max.interf.value (2361)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays minimum interface height measured in the past.

Time max. interface

Navigation Expert → Diagnostics → Min/max val. → Time max. interf (2388)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays operating time at which the maximum interface height has been obtained.

* Visibility depends on order options or device settings

Min. interface value

Navigation Expert → Diagnostics → Min/max val. → Min.interf.value (2362)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays minimum interface height measured in the past.

Time min. interface

Navigation Expert → Diagnostics → Min/max val. → Time min. interf (2387)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays operating time at whicht the minimum interface height has been obtained.

I max. drain speed

Navigation Expert → Diagnostics → Min/max val. → I max. draining (2363)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays maximum drainging speed of the lower medium measured in the past.

I max. fill speed

Navigation Expert → Diagnostics → Min/max val. → I max.fill speed (2359)

Prerequsite **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**

Description Displays maximum filling speed of the lower medium measured in the past.

Max. electronics temperature

Navigation Expert → Diagnostics → Min/max val. → Max.electr.temp. (1031)

Description Displays maximum electronics temperature measured in the past.

Time max. electronics temperature

Navigation Expert → Diagnostics → Min/max val. → Time max.el.temp (1204)

Description Displays operating time at which the maximum electronics temperature has been obtained.

Min. electronics temperature

Navigation Expert → Diagnostics → Min/max val. → Min.electr.temp. (1040)

Description Displays minimum electronics temperature measured in the past.

Time min. electronics temperature

Navigation Expert → Diagnostics → Min/max val. → Time min.el.temp (1205)

Description Displays operating time at which the minimum electronics temperature has been obtained.

Reset min./max. temp.

Navigation Expert → Diagnostics → Min/max val. → Res.min/max temp (1173)

Description Select which min/max values are to be reset.

User interface
- None
- Electronic temperature
- Reset all

Factory setting None

4.11.9 "Simulation" submenu

The **Simulation** submenu is used to simulate specific measuring values or other conditions. This helps to check the correct configuration of the device and connected control units.

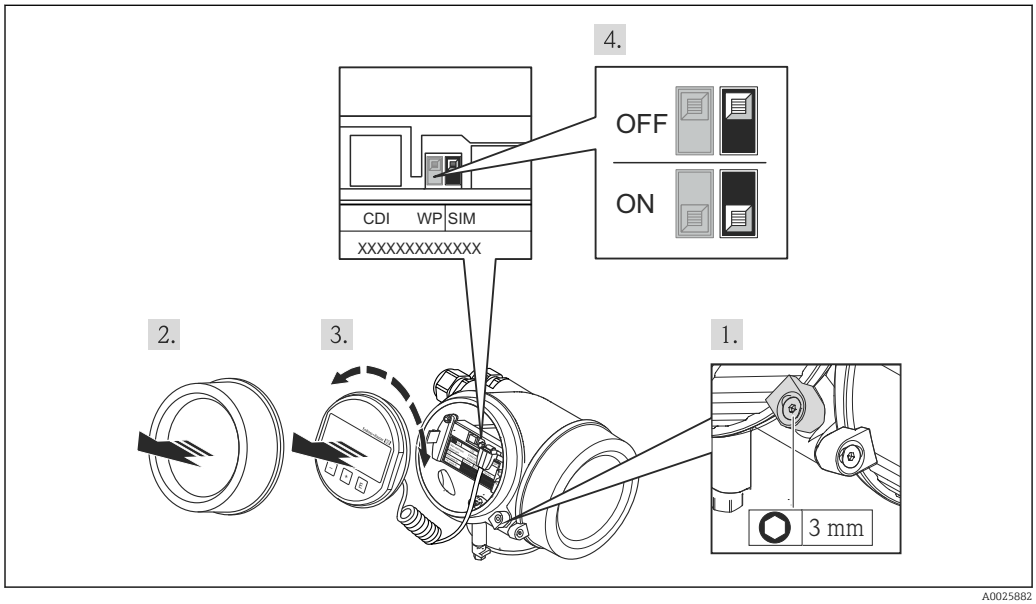
Conditions which can be simulated

Condition to be simulated	Associated parameters
Specific value of a process variable	▪ Assign measurement variable (→ 🖹 199) ▪ Process variable value (→ 🖹 199)
Specific state of the switch output	▪ Switch output simulation (→ 🖹 199) ▪ Switch status (→ 🖹 200)
Existence of an alarm	Simulation device alarm (→ 🖹 200)

Enable/disable simulation

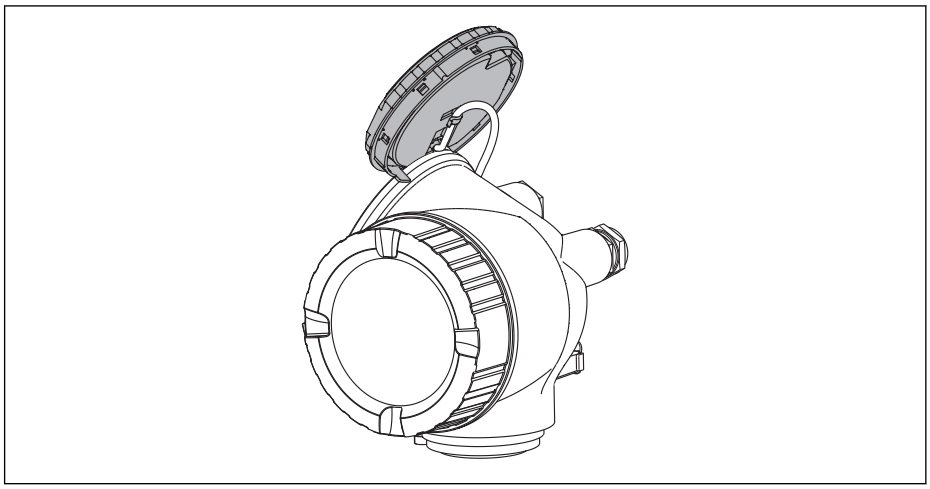
The simulation of measured values can be enabled or disabled via a hardware switch (SIM switch) at the electronics. Simulating a measured value is only possible if the SIM switch is in the ON position.

The switch output can always be simulated, irrespective of the position of the SIM switch.



1. Loosen the securing clamp.
2. Unscrew the housing cover.

3. Pull out the display module with a gentle rotation movement. To make it easier to access the SIM switch, attach the display module to the edge of the electronics compartment.
   ↳ Display module is attached to the edge of the electronics compartment.

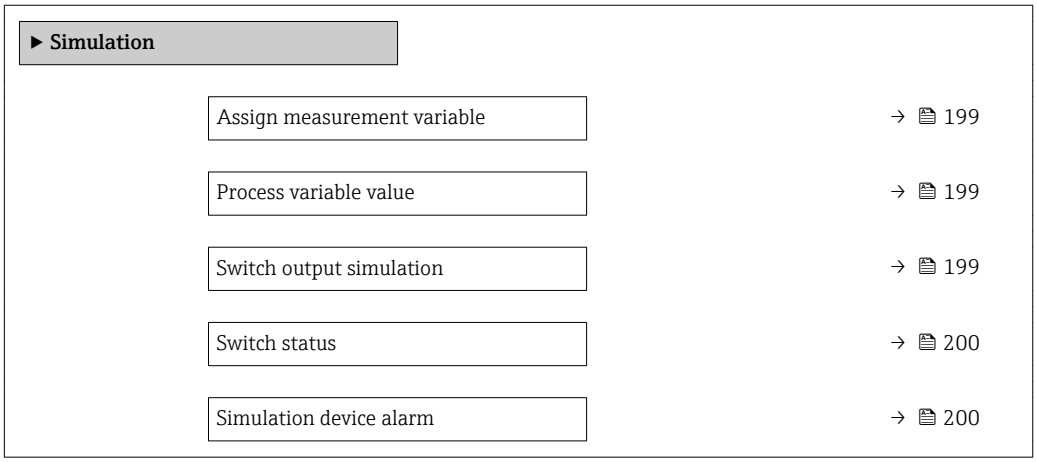


A0013909

4. SIM switch in the **ON** position: measured values can be simulated. SIM switch in the **OFF** position (factory setting): Simulation of measured values is disabled.
5. Feed the spiral cable into the gap between the housing and main electronics module and plug the display module into the electronics compartment in the desired direction until it engages.
6. Screw the electronics compartment cover closed and tighten the securing clamp.

Structure of the submenu

Navigation Expert → Diagnostics → Simulation



Description of parameters

Navigation Expert → Diagnostics → Simulation

Assign measurement variable

Navigation Expert → Diagnostics → Simulation → Assign meas.var. (2328)

Description Selct process variable to be simulated.

Selection
- Off
- Level
- Interface *
- Level linearized
- Interface linearized
- Thickness linearized

Factory setting Off

Additional information
- The value of the variable to be simulated is defined in the **Process variable value** parameter (→ 199).
- If **Assign measurement variable ≠ Off**, a simulation is active. This is indicated by a diagnotic message of the *Function check (C)* category.

Process variable value

Navigation Expert → Diagnostics → Simulation → Proc. var. value (2329)

Prerequsite **Assign measurement variable (→ 199) ≠ Off**

Description Specify value of the process value being simulated.

User entry Signed floating-point number

Factory setting 0

Additional information Downstream measured value processing and the signal output use this simulation value. In this way, users can verify whether the measuring device has been configured correctly.

Switch output simulation

Navigation Expert → Diagnostics → Simulation → Switch sim. (0462)

Description Switch the simulation of the switch output on or off.

* Visibility depends on order options or device settings

Selection
- Off
- On

Factory setting Off

Switch status

Navigation Expert → Diagnostics → Simulation → Switch status (0463)

Prerequsite **Switch output simulation (→ 199) = On**

Description Define the switch state to be simulated.

Selection
- Open
- Closed

Factory setting Open

Additional information The switch status assumes the value defined in this parameter. This helps to check correct operation of connected control units.

Simulation device alarm

Navigation Expert → Diagnostics → Simulation → Sim. alarm (0654)

Description Switch alarm simulation on or off.

Selection
- Off
- On

Factory setting Off

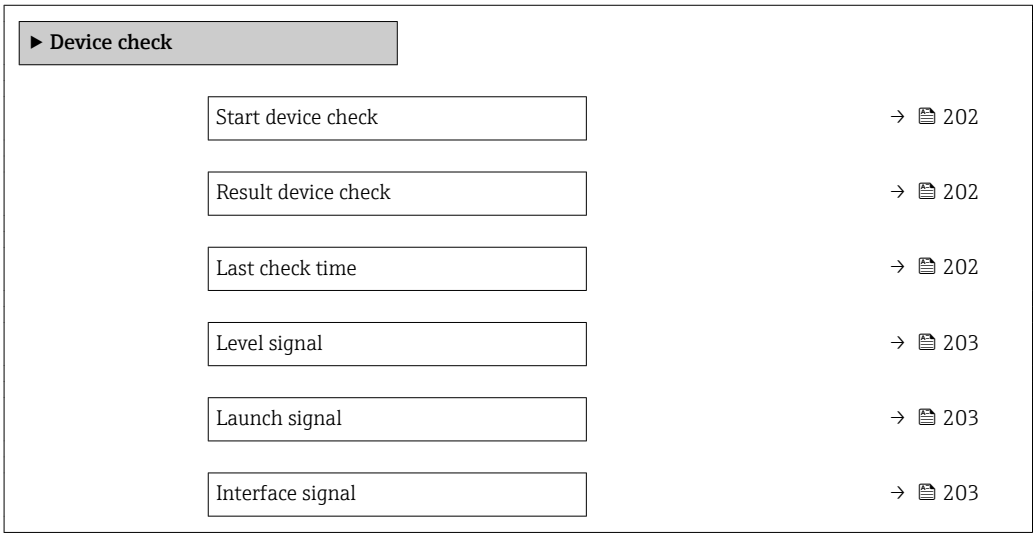
Additional information When selecting the **On** option, the device generates an alarm. This helps to check the correct output behavior of the device in the case of an alarm.

An active simulation is indicated by the diagnostic message **⊗C484 Simulation failure mode**.

4.11.10 "Device check" submenu

Structure of the submenu

Navigation Expert → Diagnostics → Device check



Description of parameters

Navigation Expert → Diagnostics → Device check

Start device check

Navigation Expert → Diagnostics → Device check → Start dev. check (1013)

Description Start a device check.

Selection
- No
- Yes

Factory setting No

Additional information In the case of a lost echo a device check can not be performed.

Result device check

Navigation Expert → Diagnostics → Device check → Result dev.check (1014)

Description Displays the result of the device check.

Additional information

Meaning of the display options
- **Installation ok**
  Measurement possible without restrictions.
- **Accuracy reduced**
  A measurement is possible. However, the measuring accuracy may be reduced due to the signal amplitudes.
- **Measurement capability reduced**
  A measurement is currently possible. Howerver, there is the risk of an echo loss. Check the mounting position of the device and the dielectric constant of the medium.
- **Check not done**
  No device check has been performed.

Last check time

Navigation Expert → Diagnostics → Device check → Last check time (1203)

Description Displays the operating time at which the last device check has been performed.

Level signal

Navigation Expert → Diagnostics → Device check → Level signal (1016)

Prerequsite Device check has been performed.

Description Displays result of the device check for the level signal.

User interface
- Check not done
- Check not OK
- Check OK

Additional information For **Level signal** = **Check not OK**: Check the mounting position of the device and the dielectric constant of the medium.

Launch signal

Navigation Expert → Diagnostics → Device check → Launch signal (1012)

Prerequsite Device check has been performed.

Description Displays result of the display check for the launch signal.

User interface
- Check not done
- Check not OK
- Check OK

Additional information For **Launch signal** = **Check not OK**: Check the mounting position of the device. In non-metallic vessels use a metal plate or a metal flange.

Interface signal

Navigation Expert → Diagnostics → Device check → Interface signal (1015)

Prerequsite
- **Operating mode (→ 45)** = **Interface** or **Interface with capacitance**
- Device check has been performed.

Description Displays result of the device check for the interface signal.

User interface
- Check not done
- Check not OK
- Check OK

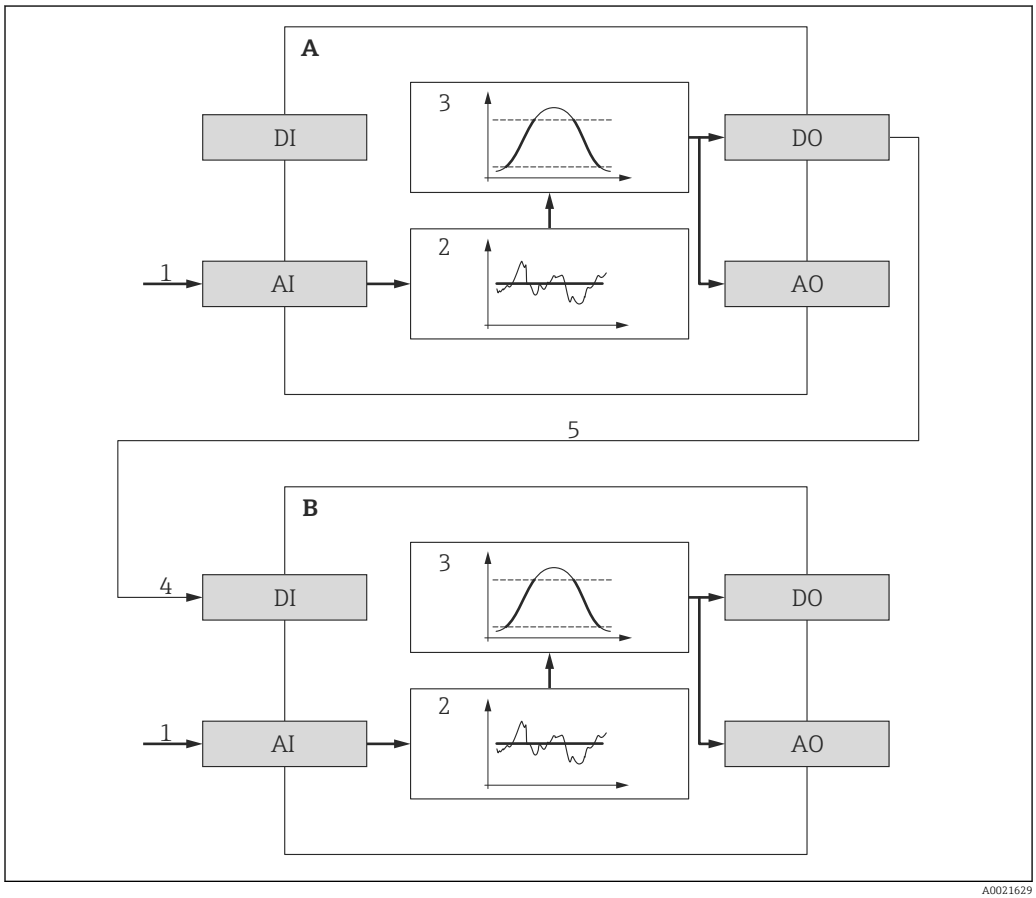
4.11.11 "Advanced diagnostics 1 to 2" submenu

Mode of operation

The Advanced Diagnostics offers additional options to monitor the process. The device contains two Advanced Diagnostic Blocks which can be used separately or in combination.

A measuring variable can be assigned to the input of each Advanced Diagnostic Block. Based on a freely configurable time interval, the variable can be submitted to a statistical function (e.g. maximum, minimum, mean, slope). Finally, a limit detection can be parametrized and its result can be transmitted to a digital output.

The result can be displayed and evaluated by a DCS or PLC. If required, it can also be linked to the second Advanced Diagnostic block and thus it is possible to combine the two results by the logical operators AND or OR.



54 *Combined Advanced Diagnostic blocks*

A Advanced Diagnsotics 1
B Advanced Diagnsotics 2
AI Analog input of the respective block
DI Digital input of the respective block
AO Analog output of the respective block
DO Digital output of the respective block
1 Analog process variable
2 Statistical calculation (maximum, minimum, mean, slope)
3 Limit check
4 Digital input of AD2
5 Digital output of AD1 is linked to digital input of AD2

Overview of the Advanced Diagnostic functionalities

Task	Associated parameters
Allocation of a process variable to the analog input of the block.	Assign diagnostic signal (→ 🖹 212)
Linking the digital input to the digital output of the other block.	▪ Link AD to (→ 🖹 212) ▪ Linking logic AD (→ 🖹 213)
Calculation of one of the following quantities for a freely configurable sampling interval: ▪ Maximum ▪ Minimum ▪ Mean ▪ Standard deviation ▪ Difference Max. - Min. ▪ Slope	▪ Sample time (→ 🖹 213) ▪ Calculation type (→ 🖹 213) ▪ Calculation unit (→ 🖹 215)
Drag indicator for the calculated quantity	▪ Maximum value (→ 🖹 217) ▪ Minimum value (→ 🖹 217) ▪ Reset min./max. (→ 🖹 217)
Limit check	▪ Check mode (→ 🖹 214) ▪ Upper limit (→ 🖹 216) ▪ Lower limit (→ 🖹 216) ▪ Hysteresis (→ 🖹 217)
Reaction in case of a limit violation	▪ Assign status signal to AD event (→ 🖹 218) ▪ Assign event behaviour (→ 🖹 218) ▪ Alarm delay (→ 🖹 218)

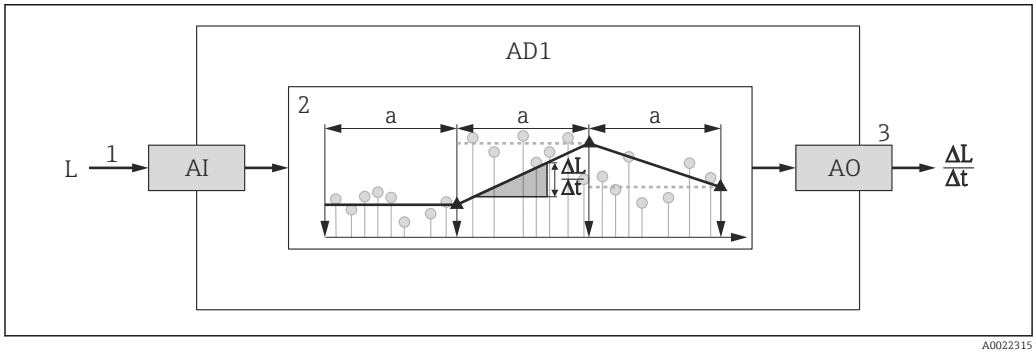
Example 1: Draining/filling speed

Only one Advanced Diagnostic Block is needed for this application. In the example this is **Advanced diagnostics 1 (→ 211)**. However, **Advanced diagnostics 2 (→ 211)** could be used just as well.

The level change rate (i.e. draining or filling speed) allows the customer to instantly realize whether or not the level is changing, and at which rate. The rate at which the level is changing must be observed as powerful pumps can create significant over and underpressure in a tank. Pressure relieve valves can only operate properly up to a certain level change rate. This is in particular valid for almost emptied tanks. The level change rate is also an intermediate result for calculating transfer estimates, such as time to fill, time to empty, time to target, etc.

Basic idea

The Advanced Diagnostics is used to calculate the draining or filling speed from the measured level. The result can be transmitted via the current output or the HART communication interface.



55 *Calculation of the draining or filling speed*

1 *Allocation of the (linearized) level to Advanced Diagnsotic Block AD1*
2 *Calculation of the draining or filling speed ΔL/Δt within the sampling interval a.*
3 *ΔL/Δt can be transmitted via the current output or the HART communication interface.*

Configuration of the calculation

The calculation of the rate of level change is configured as follows:

1. Select **Assign diagnostic signal 1** = **Level linearized**.
2. Select **Link AD 1 to** = **None** (= factory setting)
3. Define **Sample time 1** in accordance with the expected draining or filling speed.
4. Select **Calculation type 1** = **Slope**.
5. Select a suitable option in **Calculation unit 1**, e.g.: **"Level unit" / s**

As the rate of level change is not to be checked for limit violation, the following parameters may retain their factory settings:
- **Check mode 1**
- **Assign status signal to AD event (→ 218)**
- **Assign event behaviour (→ 218)**
- **Alarm delay (→ 218)**

With this configuration, the **Maximum value 1** and **Minimum value 1** drag indicators display the maximum or minimum value the rate of lavel change has obtained. Positive values indicate filling (rising level), negative values indicate draining (falling level). If required, the drag indicators can be reset by the **Reset min./ max. 1** parameter.

Allocation of the calculated rate of level change to the current output

1. Navigate to the following submenu: Expert → Output → Curr.output 1.
2. Select **Assign current output** = **Analog output adv. diagnostics 1**.
3. Select **Turn down** = **On**.
4. Enter maximum expected draining speed (negative value) in **4 mA value**.
5. Enter maximum expected filling speed (positive value) in **20 mA value**.

With this configuration, the rate of level change is transmitted via the current output. The relationship between the rate of level change and the output current is as follows:

$$\frac{\Delta L}{\Delta t} = \frac{5W_4 - W_{20}}{4} + \frac{W_{20} - W_4}{16\ mA}\ I$$

A0022342

Where:
- $\Delta L/\Delta t$: Rate of level change [49)]
- W_4 : **4 mA value**
- W_{20} : **20 mA value**
- I: Output current

In the case of a constant level ($\Delta L/\Delta t = 0$) the current is:

$$I_0 = 4\ mA - \frac{W_4}{W_{20} - W_4}\ 16\ mA$$

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Allocation of the calculated rate of level change to the HART output

1. Navigate to the following submenu: Expert → Communication → Output
2. Select **Assign PV** = **Analog output adv. diagnostics 1**.

With this configuration, the **Primary variable (PV)** parameter displays the calculated filling or draining speed. Positive values indicate filling; negative values indicate draining.

Instead of PV, it is also possible to allocate the rate of level change to SV, TV or QV.

49) Negative values: draining speed; Positive values: filling speed

Example 2: Foam detection

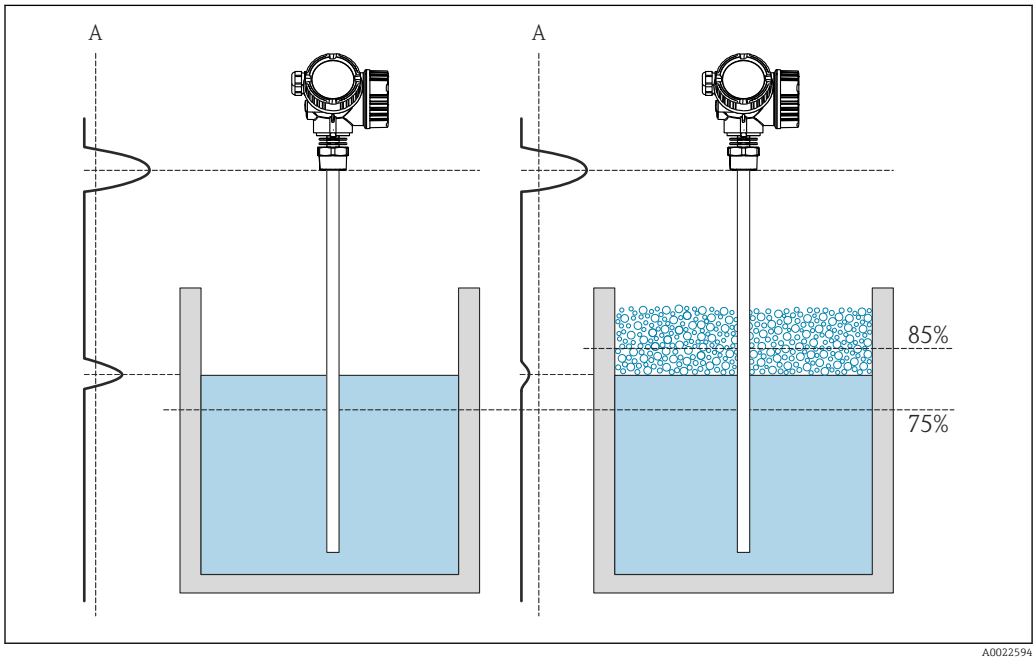
In this example, both Advance Diagnostic Blocks are used.

Preconditions

- The process runs at a fixed level (in the example: 80 %)
- If foam occurs during the operation, the vessel should automatically be sprinkled with water from the top or an antifoam agent should be added to dissolve the foam.

Basic idea

The echo amplitude decreases in the case of foam formation. This can be used by the Advanced Diagnostics to detect the foam. The foam detection, however, should only be active as long as the level is between 75 % and 85 %.



56 *Decrease of the amplitude in case of foam formation*

A Amplitude threshold for foam detection

Configuration of the level monitoring

In order to ensure that the level is within the correct range, configure the **Advanced diagnostics 1** submenu (→ 211) submenu as follows:

1. Navigate to the **Advanced diagnostics 1** submenu (→ 211)
2. Select **Assign diagnostic signal 1** = **Level linearized**.
3. Select **Check mode 1** = **Out of range**
4. Set **Upper limit 1** = 85 %.
5. Set **Lower limit 1** = 75 %.

Check mode 1 = **Out of range** checks whether the level is outside a defined range. As long as this is the case, the block outputs "0" (INACTIVE). If the level gets into the defined range, the block outputs "1" (ACTIVE).

Configuration of the foam detection

For the foam detection, configure the **Advanced diagnostics 2** submenu (→ 211) as follows:

1. Select **Assign diagnostic signal 2** = **Relative echo amplitude**.

2. Use the **Minimum value 2** parameter to observe the echo amplitude for the specified level (80 % in the example) for a while and determine a suitable lower limit for the amplitude (130 mV in the example).
3. Select **Calculation type 2** = **Mean**.
4. Enter **Sample time 2** = "60 s".
5. Select **Check mode 2** = **Lower limit**.
6. Enter the amplitude limit determined in step 2 into the **Lower limit 2** parameter (130 mV in the example).

With these settings, the Advanced Diagnostic Block behaves as follows:
- If the amplitude is above 130 mV (i.e.: no foam), the block assumes the digital value "0" (INACTIVE).
- If the amplitude is below 130 mV (i.e.: foam present), the block assumes the digital value "1" (ACTIVE).

Configuration of the block linking

The linking logic is configured in the **Advanced diagnostics 2** submenu (→ 211):

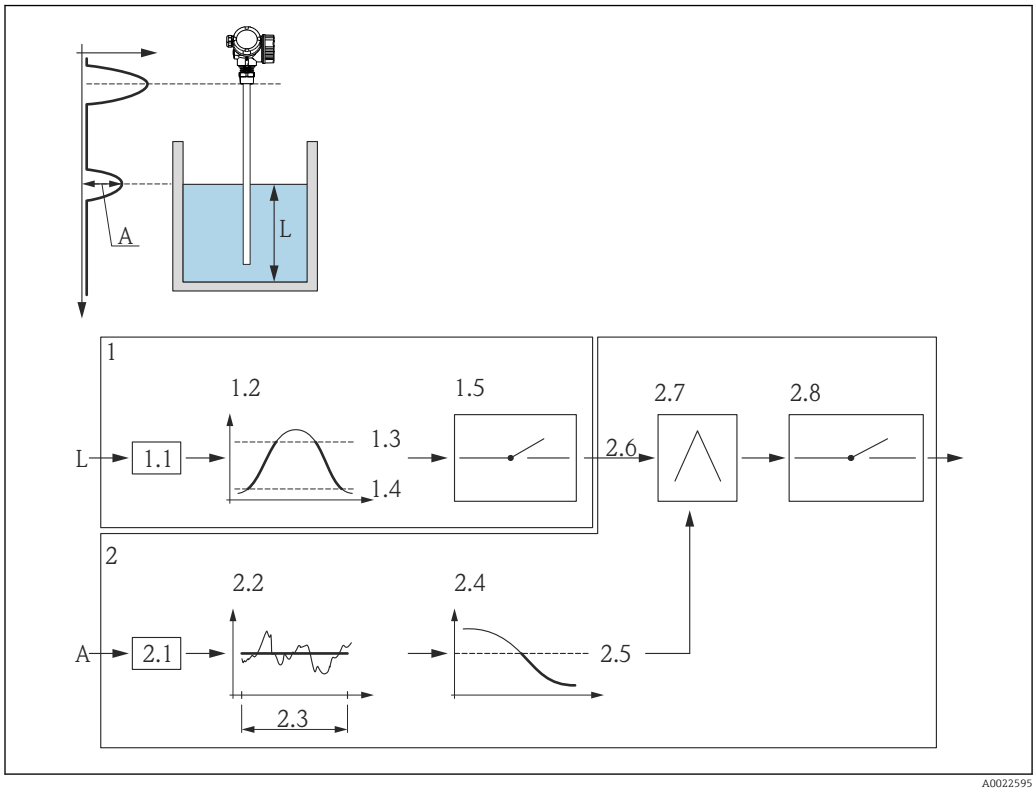
1. Select **Link AD 2 to** = **Digital output AD 1**.
2. **Select Linking logic AD 2** = **AND**.

With this configuration the output of **Advanced Diagnostics 2** assumes the following value:
- 0 (INACTIVE) - if at least one of the two blocks is in the "0" (INACTIVE) status.
- 1 (ACTIVE) - if both blocks are in the "1" (ACTIVE) status.
  For the example this means:
  - A diagnostic signal is output, if the level is within the defined range and the signal amplitude is below the threshold (i.e. foam is present).
  - If, on the other hand, the level is out of the defined range or if the signal amplitude exceeds the threshold (i.e. no foam), **no** diagnostic signal is transmitted via the switch output.

The digital output signal of **Advanced diagnostics 2** can be linked to the switch output of the device:

Expert → Output → Switch output → Assign status (0485) = Digital output AD 2

Overview: Foam detection with the advanced diagnostics



57 *Configuration of the Advanced Diagnostics for foam detection*

L Level
A Amplitude
1 Advanced diagnostics 1: Monitoring the level
1.1 "Assign diagnostic signal 1" = "Relative echo amplitude"
1.2 "Check mode 1" = "Out of range"
1.3 "Upper limit 1" = 85 %
1.4 "Lower limit 1" = 75 %
1.5 Digital output of Advanced Diagnostics 1
2 Advanced Diagnostics 2: Monitoring the amplitude
2.1 "Assign diagnostic signal 2" = "Relative echo amplitude"
2.2 "Calculation type 2" = "Mean"
2.3 "Sample time 2" = 60 s
2.4 "Check mode 2" = "Lower limit"
2.5 "Lower limit 2" = 130 mV
2.6 "Link AD 2 to" = "Digital output AD 1"
2.7 "Linking logic AD 2" = "AND"
2.8 Digital output of Advanced Diagnostics 2

Structure of the submenu

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2

► **Advanced diagnostics 1 to 2**	
Assign diagnostic signal 1 to 2	→ 212
Link AD 1 to 2 to	→ 212
Linking logic AD 1 to 2	→ 213
Sample time 1 to 2	→ 213
Calculation type 1 to 2	→ 213
Check mode 1 to 2	→ 214
Calculation unit 1 to 2	→ 215
Upper limit 1 to 2	→ 216
Lower limit 1 to 2	→ 216
Hysteresis 1 to 2	→ 217
Maximum value 1 to 2	→ 217
Minimum value 1 to 2	→ 217
Reset min./max. 1 to 2	→ 217
Assign status signal to AD event 1 to 2	→ 218
Assign event behaviour 1 to 2	→ 218
Alarm delay 1 to 2	→ 218

Description of parameters

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2

Assign diagnostic signal 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Assign signal 1 to 2 (11179–1 to 2)

Description Allocate a measuring variable to the Advanced Diagnostic Block.

Selection
- None
- Level linearized
- Distance
- Unfiltered distance
- Interface linearized *
- Interface distance *
- Unfiltered interface distance
- Thickness upper layer *
- Electronic temperature
- Measured capacitance *
- Relative echo amplitude
- Absolute echo amplitude
- Absolute interface amplitude *
- Relative interface amplitude *
- Absolute EOP amplitude
- EOP shift
- Noise of signal
- Terminal voltage
- Calculated DC value *
- Sensor debug
- Analog output 1
- Analog output 2
- Analog output 3
- Analog output 4
- Analog output 5
- Analog output 6
- Analog output 7
- Analog output 8

Factory setting None

Link AD 1 to 2 to

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Link AD 1 to 2 to (11180–1 to 2)

Description Link the digital input (DI) of the Advanced Diagnostic Block to the digital output (DO) of the other Advanced Diagnostic Block.

* Visibility depends on order options or device settings

Selection
- None
- Digital output AD 1
- Digital output AD 2

Factory setting None

Linking logic AD 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Link. logic AD 1 to 2 (11181–1 to 2)

Prerequsite **Link AD to (→ 212)** = **Digital output AD 1** oder **Digital output AD 2**

Description Select linking logic between the two Advanced Diagnostic Blocks.

Selection
- AND
- OR

Factory setting AND

Sample time 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Sample time 1 to 2 (11187–1 to 2)

Prerequsite **Assign diagnostic signal (→ 212)** ≠ **None**

Description Specify sampling interval for the calculation.

User entry 1 to 3 600 s

Factory setting 10 s

Calculation type 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Calc. type 1 to 2 (11174–1 to 2)

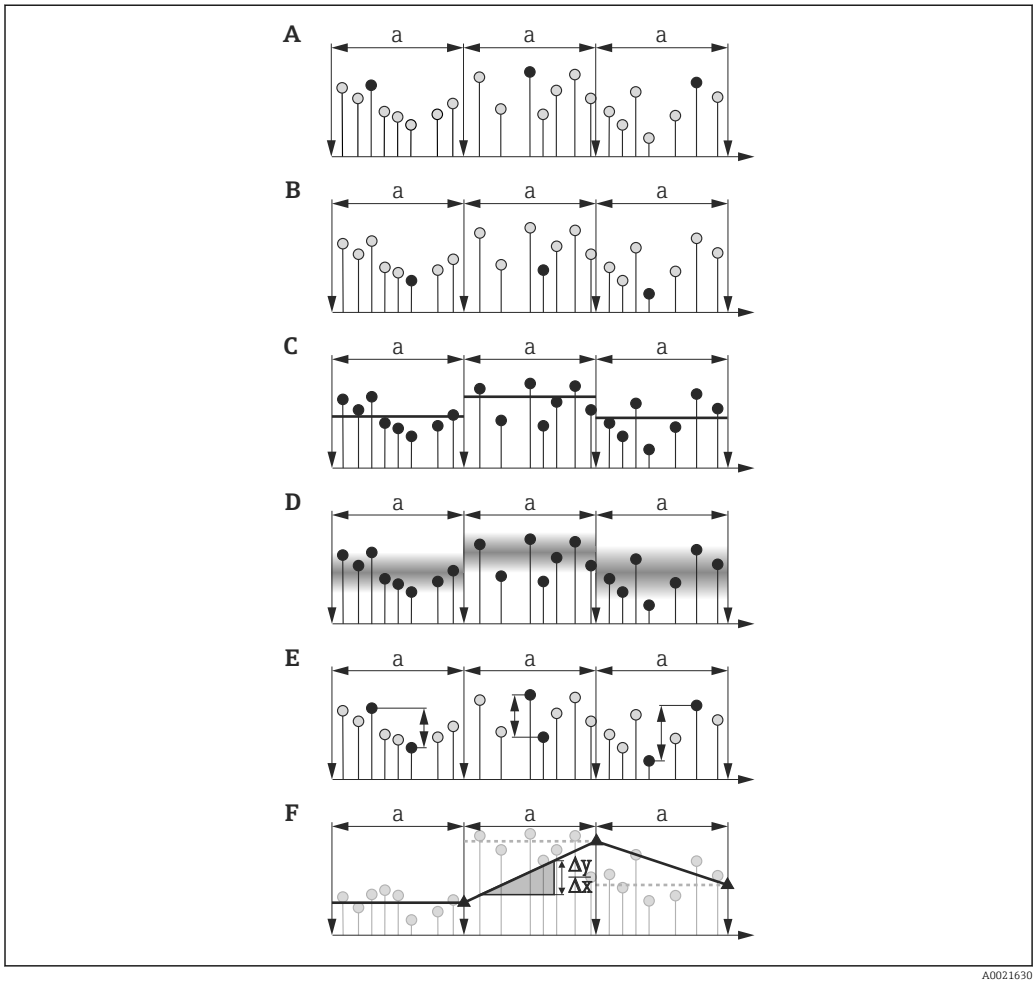
Prerequsite **Assign diagnostic signal (→ 212)** ≠ **None**

Description Select quantity to be calculated from the measured variable.

Selection
- Off
- Maximum
- Minimum
- Mean
- Standard deviation
- Difference Max. - Min.
- Slope

Factory setting Off

Additional information



58 *Options of the "Calculation type " parameter*

a Sample time (→ 213)
A "Calculation type " = "Maximum"
B "Calculation type " = "Minimum"
C "Calculation type " = "Mean"
D "Calculation type " = "Standard deviation"
E "Calculation type " = "Difference Max. - Min."
F "Calculation type " = "Slope"

The calculation is performed based on the sampling interval defined in the **Sample time** parameter (→ 213).

Check mode 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Check mode 1 to 2 (11175–1 to 2)

Prerequsite **Assign diagnostic signal (→ 212) ≠ None**

Description Define check mode for limit monitoring.

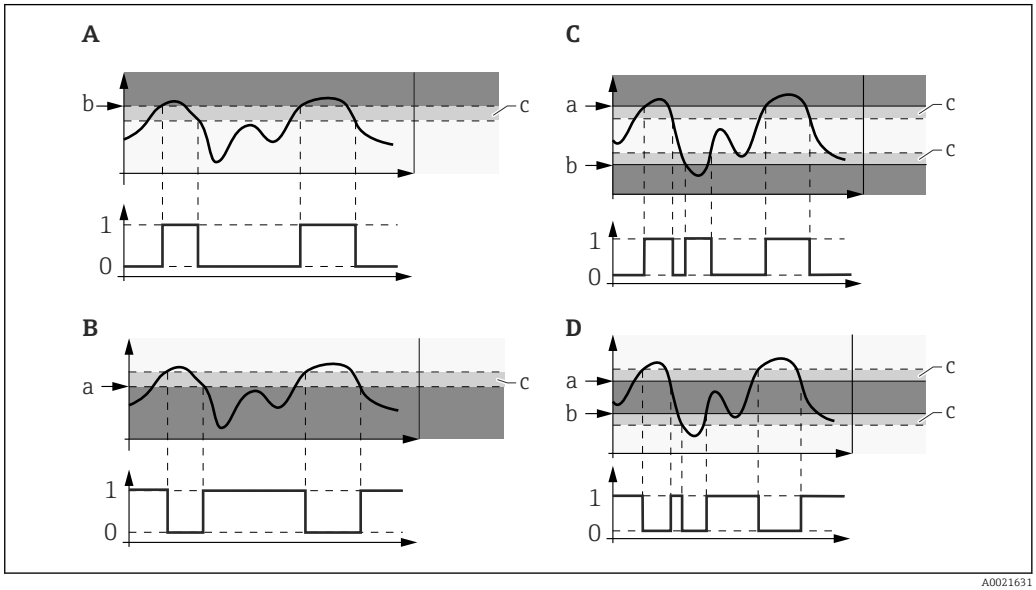
Selection

- Off
- Upper limit
- Lower limit
- In range
- Out of range

Factory setting

Off

Additional information



59 *Limit monitoring in the Advanced Diagnostic Block*

0 Status of digital output: 0 ("INACTIVE")
1 Status of digital output: 1 ("ACTIVE")
a Upper limit (→ 216)
b Lower limit (→ 216)
c Hysteresis (→ 217)
A "Check mode " = "Lower limit"
B "Check mode " = "Upper limit"
C "Check mode " = "In range"
D "Check mode " = "Out of range"

If a calculation has been selected in the **Calculation type** parameter (→ 213), the check does not refer to the assigned measuring variable but to the quantity calculated from it.

Calculation unit 1 to 2

Navigation

Expert → Diagnostics → Adv.diagn. 1 to 2 → Calc. unit 1 to 2 (11188–1 to 2)

Prerequsite

Assign diagnostic signal (→ 212) ≠ None

Description

Select unit for the calculation.

Selection

Dependent on the following parameters:
- Assign diagnostic signal (→ 212)
- Calculation type (→ 213)

Factory setting

Dependent on the following parameters:
- Assign diagnostic signal (→ 212)
- Calculation type (→ 213)

Upper limit 1 to 2

Navigation

Expert → Diagnostics → Adv.diagn. 1 to 2 → Upper limit 1 to 2 (11182–1 to 2)

Prerequisite

Check mode parameter (→ 214) has one of the following values:
- Upper limit
- In range
- Out of range

Description

Specify upper limit for the limit monitoring.

User entry

Dependent on the following parameters:
- Assign diagnostic signal (→ 212)
- Calculation type (→ 213)

Factory setting

Dependent on the following parameters:
- Assign diagnostic signal (→ 212)
- Calculation type (→ 213)

Lower limit 1 to 2

Navigation

Expert → Diagnostics → Adv.diagn. 1 to 2 → Lower limit 1 to 2 (11184–1 to 2)

Prerequisite

Check mode parameter (→ 214) has one of the following values:
- Lower limit
- In range
- Out of range

Description

Define lower limit for the limit monitoring.

User entry

Dependent on the following parameters:
- Assign diagnostic signal (→ 212)
- Calculation type (→ 213)

Factory setting

Dependent on the following parameters:
- Assign diagnostic signal (→ 212)
- Calculation type (→ 213)

Hysteresis 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Hysteresis 1 to 2 (11178–1 to 2)

Prerequsite **Check mode** parameter (→ 214) has one of the following values:
- Upper limit
- Lower limit
- In range
- Out of range

Description Select hysteresis for the limit monitoring.

User entry Dependent on the following parameters:
- Assign diagnostic signal (→ 212)
- Calculation type (→ 213)

Factory setting Dependent on the following parameters:
- Assign diagnostic signal (→ 212)
- Calculation type (→ 213)

Maximum value 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Maximum value 1 to 2 (11183–1 to 2)

Prerequsite **Assign diagnostic signal (→ 212) ≠ None**

Description Indicates the maximum value the assigned measuring variable has obtained in the past (drag indicator).

Minimum value 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Minimum value 1 to 2 (11185–1 to 2)

Prerequsite **Assign diagnostic signal (→ 212) ≠ None**

Description Indicates minimum value the assigned measuring variable has obtained in the past (drag indicator).

Reset min./max. 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Reset min/max 1 to 2 (11186–1 to 2)

Prerequsite **Assign diagnostic signal (→ 212) ≠ None**

Description Reset drag indicators (**Maximum value (→ 217)** and/or **Minimum value (→ 217)**).

Selection
- Off
- Reset max.
- Reset min.
- Reset min./max.

Factory setting Off

Assign status signal to AD event 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Stat. AD event 1 to 2 (11176–1 to 2)

Prerequsite **Assign diagnostic signal (→ 212) ≠ None**

Description Assign a category according to NAMUR NE107 to the event of the Advanced Diagnostic Block.

Selection
- Failure (F)
- Maintenance required (M)
- Function check (C)
- Out of specification (S)
- Not categorized

Factory setting Maintenance required (M)

Assign event behaviour 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Evt behaviour 1 to 2 (11177–1 to 2)

Prerequsite **Assign diagnostic signal (→ 212) ≠ None**

Description Assign an event behavior to the event of the Advanced Diagnostic Block.

Selection
- Off
- Alarm
- Warning
- Logbook entry only

Factory setting Warning

Alarm delay 1 to 2

Navigation Expert → Diagnostics → Adv.diagn. 1 to 2 → Alarm delay 1 to 2 (11171–1 to 2)

Prerequsite **Assign diagnostic signal (→ 212) ≠ None**

Description Define alarm delay for the Advanced Diagnostic Block.

User entry 0.0 to 3 600.0 s

Factory setting 10.0 s

4.11.12 "Envelope diagnostics" submenu

In devices which have been delivered with software version 01.00.zz, this submenu is only visible for the "Service" user role.

After the configuration of the measurement it is recommended to record the current envelope curve as a reference curve. The reference curve can be used later for diagnostic purposes. To record the reference curve use the **Save reference curve** parameter (→ 221).

The reference curve can only be displayed in the envelope curve diagram of FieldCare after it has been loaded from the device into FieldCare. This is performed by the "Load Reference Curve" function in FieldCare:

Structure of the submenu

Navigation Expert → Diagnostics → Envelope diag.

▶ **Envelope diagnostics**		
	Save reference curve	→ 221
	Time reference curve	→ 221

Description of parameters

Navigation Expert → Diagnostics → Envelope diag.

Save reference curve

Navigation Expert → Diagnostics → Envelope diag. → Save ref. curve (1218)

Description Save current envelope curve as reference curve.

Selection
- No
- Yes

Factory setting No

Additional information

Meaning of the options
- No
  No action
- Yes
  The current envelope curve is saved as reference curve.

Time reference curve

Navigation Expert → Diagnostics → Envelope diag. → Time ref. curve (1232)

Description Indicates at which time the existing reference curve has been recorded.

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